CSCanada
Canadian Social Science
Vol. 11, No. 3, 2015, pp. 197-202
DOI: 10.3968/6598

ISSN 1712-8056[Print]
ISSN 1923-6697[Online]
www.cscanada.net
www.cscanada.org

A Preliminary Study of Plant Morphological Characteristics of Tao Hongjing's *A Variorum of Medicinal Properties of Plants (Bencaojingjizhu)* and Influence of the Book

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Received 10 December 2014; accepted 2 February 2015
Published online 26 March 2015

Abstract

Tao Hongjing (456-536 AD) lived in the Southern Dynasty of China. His book *A Variorum of Medicinal Properties of Plants* (also called *Bencaojingjizhu*) made a lot of achievements in morphological records of plants. The book has some characteristics, for example, it provided the largest number of plant forms and relevant structures, had detailed observation on plant organs, recorded and identified more plant forms and relevant structures, paid special attention to forms and structures of integral parts of plants and so on. These characteristics not only enriched content of medicinal substance books, laid a solid foundation for researching the history of plant morphology and had the influence on such book content, botanical research, spirit of academic research and so on at the time and later, but also provided an important reference for identifying medicines. Although the book has shortcomings, its function and status should not be ignored in the development history of plant morphology.

Key words: Tao Hongjing; *A Variorum of Medicinal Properties of Plants*; *Bencaojingjizhu*; Plant morphology; Characteristics; Influence

Lu, H. Y., & Hu, A. H. (2015). A Preliminary Study of Plant Morphological Characteristics of Tao Hongjing's *A Variorum of Medicinal Properties of Plants (Bencaojingjizhu)* and Influence of the Book. *Canadian Social Science, 11*(3), 197-202. Available from: http://www.cscanada.net/index.php/css/article/view/6598
DOI: http://dx.doi.org/10.3968/6598

INTRODUCTION

Plant morphology refers to the physical form and external structure of plant vegetative organs (roots, stems, and leaves) and reproductive organs (flowers, fruits and seeds) (Botanical Society of China, 1994). Each plant has its relatively stable morphology which is the main basis for identification of different plants, so medical experts always paid great attention to plant morphology. China's first herbal classic, *Shen Nong's Herbal Classic* has already been lost and it is still controversial whether there is the content of plant form and structure in that book. However, *Wu Pu Medicinal Properties of Plants* (Shang et al., 1987), *Famous Physicians' Records* (Shang et al., 1986) and *A Variorum of Medicinal Properties of Plants* (Tao, 1994) written in the Wei, Jin, Southern and Northern Dynasties has spread and the three books have the description of plant morphology (Shang, 2009, p.14)[1]. *A Variorum of Medicinal Properties of Plants* (Hereinafter referred to as the "*Variorum*", later cited content of the book is no longer annotated) has the most records of plant morphology in the three books. Unfortunately, so far there is not a relevant monograph published in academic circles in researching "A Variorum of Medicinal Properties of Plants". This paper takes the book as the research object to study its characteristics in recording plant morphology and its influence in providing reference information for identifying plant medicines. There is a need to say that this paper's discussion of plant morphology is based on medicinal part morphology of plants, because the book is a medicinal monograph, which had the limitations of the time and the technology, mainly recorded medicinal part morphology of the plants without completely describing the plant vegetative and reproductive organs.

[1] In Wei, Jin, Southern and Northern Dynasties, approximately 60 herbal books were published, but only 3 of them have been saved today and the 3 books only are compiled books.

1. CHARACTERISTICS OF *A VARIORUM OF MEDICINAL PROPERTIES OF PLANTS* IN RECORDING PLANT MORPHOLOGY

The book recorded plant morphology that was the most abundant at the time. Its main characteristics are.

1.1 There Was an Achievement in Recording Plant Morphology

According to statistics, the *Variorum* (*A Variorum of Medicinal Properties of Plants*) recorded 438 medicinal plants, which included clearly records of plant morphology about 287 medicinal plants, accounting for about 65.5% of the total number of medicinal plants in that book. At the same time or slightly earlier, *Wu Pu Medicinal Properties of Plants* (Wu, 1987) (Hereinafter cited content of the book is no longer annotated) contained medicinal plant 148 and recorded plant morphology of 48 medicinal plants, accounting for about 32.4% of the total number of the medicinal plants. At the same time or slightly earlier, *Natural History* contained 42 plants and recorded plant morphology of 6 plants, namely Radix asparagi, Radix bupleuri, Arenga pinnata (wurmb.) merr., Hengye, Zhancao, Jiuzhencao (Zhang, 1987, p.39, 134, 135, 140), accounting for about 14% of the total number of the plants. At the same period, *Famous Physicians' Records* (Shang, 1986) (Hereinafter cited content of the book is no longer annotated) contained 488 medicinal plants, and recorded plant morphology of 63 medicinal plants, accounting for about 12.9% of the total number of the medicinal plants. Obviously, the *Variorum* was much better than the *Wu Pu Medicinal Properties of Plants*, *Natural History* and *Famous Physicians' Records* in both the absolute number of the records of plant morphology and the proportions, so the number of recording plant morphology was maximum in the *Variorum* during the Wei, Jin, Southern and Northern dynasties and the *Variorum* had an important status in the history of pharmacy.

1.2 The Careful Observation of Plant Organs

The *Variorums* had careful observation of plant organs. Such as the description of internal parts of stems: broken Eucommia "with more white filaments is better"; Radix Glycyrrhizae's surface has "longitudinal broken lines" and its underneath has white longitudinal lines". Although such records are a few, it shows that the *Variorum* had quite detailed observation. As the description of plant organ secretion: Medulla tetrapanacis "grows around trees or vines and its juice is white"; Herba euphorbiae helioscopiae's "juice is white when picking its leaves"; Yicao's "horns are on its stems and its juice is white"; agate has "moisturizing juice", Herba seu radix metaplexis' "juice is milk white when picking its leaves". And as for plant seeds description: Deutzia scabra thunb's "seeds are like seeds of the fruit of Chinese wolfberry medlar". Seeds of the fruit of Chinese wolfberry medlar are very small and it is not easy to observe seeds of the fruit of Chinese wolfberry medlar. The research of pharmacognosy also shows that Deutzia scabra Thunb's seeds have the kidney shape and are very small; Semen celosiae's "seeds are very small". The result of the pharmacognostical study shows that the diameter of a seed of Semen celosiae is only about 1.5 mm and very fine. These very accurate descriptions came from very careful observation because the seed morphology of Deutzia and Semen celosiae is extremely small. Another example is in inflorescence records. Inflorescence is part of a flower and inflorescence is divided into finite and infinite inflorescence. The infinite inflorescence is divided into raceme, spike, hypanthium and 9 others (Xu, 1990, p.37). The *Variorum* paid attention to plant inflorescence, for example, it wrote that the Kejushi's ear "is like the wheat ear". The "ear" is Kejushi's spike. It shows that the book gave more detailed description of plant morphology, which provided great help for people to better identify plants.

We should point out that *Famous Physicians'* Records did not describe internal components of plant vegetative organs and reproductive organs. *Wu Pu Medicinal Properties of Plants* had a few records about internal components of plants, such as Rhizoma paridis tetraphyllae "has red lines"; Radix oblongifoiae "has black lines inside and its shape is like a wheel with spokes". *Wu Pu Medicinal Properties of Plants* also had a few records of plant organ secretion, such as Wisteria sinensis's "stems and leaves have juice", but the book did not have records of inflorescence. Especially, the *Variorum* had records of internal components and secretions of Pollia japonica thunb., Medulla tetrapanacis, agate and so on, but *Wu Pu Medicinal Properties of Plants* did not mention them. Both *Famous Physicians' Records* and *Wu Pu Medicinal Properties of Plants* did not mention plant seeds. It shows that the observation of plant organs in the *Variorum* was more detailed and it fully represented Tao Hongjing's progress in the understanding of plant morphology.

1.3 Increasing Content of Recording and Identifying Plant Morphology

For example, *Famous Physicians' Records* wrote that Ophiopogon japonicus' " leaves are like Folium allii tuberosi's leaves". The *Variorums* recorded: "Ophiopogon japonicus' fruits are like Qingzhu's fruits and its roots are like wheat's roots" and "the bigger one is the better one." The former only explained that Ophiopogon japonicus' leaves are like Folium allii tuberosi's leaves, while the latter added that Ophiopogon japonicus' fruits are like Qingzhu's fruits and its roots are like wheat's roots. *Wu Pu Medicinal Properties of Plants* wrote that Herba

artemisiae scopariae's "leaves are like Fructus polygoni tinctorii's leaves"; the "Variorums" recorded: Herba artemisiae scopariae was "like crown daisy and its leaves are tight and thin. Its stems does not die in the winter and grow in the spring again." The former only explained that Herba artemisiae scopariae's leaves are like Fructus polygoni tinctorii's leaves, but the latter not only depicted that the overall morphology of Herba artemisiae scopariae is like crown daisy, but also depicted that the leaves' morphology is tight and thin and also gave information about the stems.

According to *Wu Pu Medicinal Properties of Plants*, "Leaves of *Nepeta cataria L. are* like leaves of Chenopodium album L. and thin." The *Variorums* wrote: "Underneath of leaves of *Nepeta cataria L.* is purple and it is very fragrant. If no purple and fragrant smell, it is Yesu, and we do not use it." Obviously, the former, "Leaves of *Nepeta cataria L. are* like leaves of Chenopodium album L. and thin." That only was a specific description of *Nepeta cataria L.*. The latter, "Underneath of leaves of *Nepeta cataria L.* is purple and it is very fragrant, if no purple and fragrant smell, it is Yesu, and we do not use it" were to add the identifying content and evaluation of their medicinal value. Again, *Famous Physicians' Records* only said that ginseng "is better if it is like a human shape". The *Variorum* not only described the state of Wei's ginseng, "long and yellow, and is like Radix ledebouriellae", but also recorded the Baekje ginseng shape, thin, solid and white", and Korea ginseng morphology, "big and soft", and leaves are like Paulownia kawakamii's leaves and very big." Obviously, *Famous Physicians' Records* had a quite simple description of the ginseng's shape, but the *Variorums* had the description of ginseng's morphology of different regions. Also such as Osmanthus heterophyllus (G.Don) P. S. , *Famous Physicians*' *Records* wrote: "Its shape is circle like bamboo." The *Variorums* wrote:

> Now we can not find Osmanthus heterophyllus (G.Don) P.S. like bamboo. We can only find broken twigs are made into a round, which is used as Osmanthus heterophyllus (G.Don) P.S. but it may not be Osmanthus heterophyllus (G.Don) P. S..

Clearly, this was discrimination to the content of *Famous Physicians' Records*. According to statistics, the *Variorums* discriminated 63 plants, accounting for about 22% of the total number of medicinal plant morphology in the book. *Famous Physicians' Records* did not have any plant morphology discrimination; *Wu Pu Medicinal Properties of Plants* identified only 1 plant i.e. Rhizoma cibotii, the number is accounting for about 2.1% of the total number of medicinal plant morphology in the book. Compared with *Famous Physicians' Records* and *Wu Pu Medicinal Properties of Plants*, the *Variorum* had much more identifying content of plant morphology of root, stem and leaf. The content gives us a lot of help to identify plants definitely.

1.4 Paying Special Attention to Complete Plant Morphology

After carefully reading the *Variorum*, it is not difficult to find the *Variorum* attached great importance to complete plant morphology, such as, Radix polygalae "is like Herba ephedrae and greener"; Rhizoma cynanchi stauntonii "is like Asarum sieboldii miq., is larger and white with easily broken"; Laplacea canescens' "shape is like Daphne genkwa sieb. et zucc. and very thin". According to statistics, such records have a total of 122, accounting for about 43% of the total number of plant medicines recorded by the book. *Wu Pu Medicinal Properties of Plants* has 11 places to describe the overall shapes of the medicinal plants, accounting for about 23% of the total number of plant medicines recorded by the book. *Famous Physicians' Records* has 22 places to describe the overall shapes of the medicinal plants, accounting for about 35% of the total number of plant medicines recorded by the book. Obviously, the description of the overall shapes of the medicinal plants in the "Variorum" is the most abundant.

2. THE INFLUENCE OF THE *VARIORUM* RECORDS OF PLANT MORPHOLOGY

The plant morphological description of the *Variorum* has had a major impact on the time and aftertime.

2.1 Enriching Content and Becoming a Model for Later Such Books

As mentioned before, compared with *Wu Pu Medicinal Properties of Plants*, *Natural History* and *Famous Physicians' Records*, the *Variorum* records not only increased the number and the proportion of plant morphology, but also added more detailed records of plant morphology, and paid attention to identifying plant morphology in order to understand medicinal properties, such as,

> There are Atractylodes macrocephala and Atractylodes lancea (thunb.) DC.. Atractylodes macrocephala's leaves are bigger, have hair and the forks, and it has sweet roots and less cream. We can make Atractylodes macrocephala into pills; leaves of Atractylodes lancea (thunb.) DC. are thin and have not the forks, and it has small, bitter roots and more cream. It can be boiled for making medicines.

There were no such records in same kinds of books before. Thus, the *Variorum* records of plant morphology enriched content of medicinal plant books at the time. After the *Variorum* appeared, same kinds of books in other dynasties had followed the style of the *Variorum* to explicitly record plant morphology, have been more scientific in recording plant morphology, and have more rich content. For example, when the government of Tang Dynasty compiled *New Revised Compendium of Plant Medicines*, it only took the *Variorum* as the blueprint in nearly popular 60 herbal works. This shows that the

Variorums better summarized the content and style of the previous plant medicine books than other plant medicine books at the time. Therefore, the style and content of *New Revised Compendium of Plant Medicines* basically followed the *Variorum* (Shang, 1999). The *Variorum* was the plant medicine model for same kinds of books in other dynasties after Tang Dynasty. The content of plant morphology of the *Variorum* was also inherited and developed in the plant medicine books after Tang Dynasty, such as *Compendium of Plant Medicines* (Bencaogangmu) in Ming Dynasty (Shang, 2010, pp.188-189).

2.2 Recording Plant Organs and Laying the Foundation for the Research of the History of Plant Morphology

The *Variorums* recorded 730 medicines, and the majority of them were plant medicines. As mentioned before, the *Variorum* clearly recorded plant morphology of medicinal plants, accounting for about 65.5% of the total number of medicinal plants in the book. In plant morphology, Tao Hongjing focused on leaves, roots, stems, fruits, and flowers, such as the description of the roots: Herba agrimoniae's "root buds are like teeth of a beast"; Pulsatilla chinensis (bunge) regel "has the white downy stem near its root, which is like a person's white hair"; Rhizoma bletillae's "root shape is like Fructus trapae bispinosae and there is hair on its middle". Another example is the description of leaves: Herba eupaturii odorati's "leaves seem to be cut"; water chestnut's "leaves have the forks and it is like Alisma"; "Rhizoma atractylodis macrocephalae's leaves are bigger, have hair and the forks"; "leaves of Atractylodes lancea (thunb.) DC. are thin and have not the forks" and so on. Also, the description of fruits: Dried rehmannia is "solid like wheat"; Lepironia articulata is "solid and red"; also such as stems, Radix achyranthis bidentatae's "stems have nodes and are like cattle's knees..... Male stems are purple. It is good if its nodes are bigger." Dendrobium's "stem shape is longer, bigger and light color," etc.. According to statistics, the "Variorum" recorded leaves, roots, stems, fruits, and flowers, and the numbers respectively were 93, 51, 51, 47 and 35, accounting for about 21.2%, 11.6%, 11.6%, 10.7% and 8% of the total number 438 of plant medicines in the book. The *Variorum* also had other content on ears, seeds and so on.

Leaves, roots, stems, fruits, flowers and seeds are basic parts of plants, and are basic objects of plant research. In the Southern and Northern Dynasties, the *Variorums* had massive records about the basic parts of plants and it undoubtedly shows the outstanding contributions which Tao Hongjing made the plant study. It not only provides the basis for people's cognition of plants, description of plant morphology, identification of plants and the use of plants from the time, but also laid down the foundation for the study of plant morphological history.

2.3 The Scientific Method of Focusing on Both Practice and Literature in Plant Morphological Descriptions Had Exerted a Far-Reaching Influence on the Scholars' Research

Liang History · Tao Hongjing Biography wrote: Tao Hongjing "likes writing, has curiosity, and is good at saving time and he does more work when he gets older." He had always had the diligent, rigorous truth-seeking spirit, "deep shame for lack of knowledge" (Li, 1975, p.1897). His book, the *Variorum* is the proof, in which, plant morphological records reflect his realistic attitude and rigorous scientific spirit. The book has had a good influence on scholars.

The *Variorum* description of plant morphology not only focused on the previous literature, but also paid attention to the folk experience. In the literature, the *Variorum* quoted a large number of books, such as *Natural History*, *Liu Juanzi's Ghost Prescriptions*, *Tong Jun Herbal Records*, *On Health*, *Fan Wang's Prescriptions*, etc.. Especially, the *Variorum* annotated literature sources of the plant morphology and even researched the literature sources. The spirit of rigorous scholarship had given a great influence on later generations' medical scholars. When they wrote the medicinal plant books, basically followed the *Variorum* and indicated the sources of literature. As for the observation for plant morphology, the *Variorum* also included a lot of folk practical experience. In the preface of the *Variorum* wrote: Recorded "rural households" test methods, special medical knowledge of different fields, such as lotus root skin dissipating blood stasis was found by a butcher, semen pharbitidis curing edema was found by a farmer, ascarid is killed by garlic sauce of restaurants, and roadside herba saginae japonicae cures incised wound." It not only shows that ordinary people could carefully observe plant morphology, but also reflects that Tao Hongjing's attention to folk medical experience. After Tao Hongjing, in recording plant morphology, Sun Simiao, Tang Shenwei, Li Shizhen, Zhao Xuemin and other medical experts not only focused on the previous literature, but also paid attention to the folk practical experience, at the same time, paid more attention to personally careful observations of various medicines (Hu, 1975, p.897). It can be said that Tao Hongjing influenced them to a certain extent.

As everyone knows, the idle talk flourished in Wei, Jin, Southern and Northern Dynasties. In Eastern Jin Dynasty, the scholar Sun Sheng and the military general Yin Hao once talked about food, someone described the fierce talk: "Indignantly throws a duster, the duster's hair falls in their meal which has been heated several times, and they do not reach an agreement in a day." (Fang,1974, p.2147) The high rank official, Dr. Zhang Ping and the emperor's adviser Liu Tan "talk for a day. Zhang Ping lets Liu Tan stay in his home and sends Liu Tan away in the next morning." (Ibid., p.1992) It shows that the two people had a long talk. During this period, people liked to

talk about *Lao Zi*, *Zhuang Zi* and *The Book of Changes*. These talks basically were out of touch with the real life and most of them were sophistry, and even leading to a disaster (Meng, 2007, p.138). No wonder, in Western Jin Dynasty, the famous minister and empty talker Wang Yan said before he died: "If I did not like the empty talk and made an effort to improve the nation, I would be like this today" (Tang, 1974, p.1238). In this social context, the "Variorum" could still have the spirit of focusing on both literature and practical experience in recording plant morphology that fully reflects Tao Hongjing's scientific, rigorous academic attitude, which not only had a very good demonstration role in Tang, Song, Ming and Qing Dynasties, but also has a strong practical significance in academic research today.

2.4 The Detailed Description of Plant Morphology Providing an Important Reference for the Identification of Medicines

Pseudo medicines appeared in the period of Warring States (475-221 B.C.) and even before. In Wei, Jin, Southern and Northern Dynasties, some medicines were false. Tao Hongjing mentioned several pseudo medicines, such as stalactitum, Asarum sieboldii miq. , Radix astragali, Angelica sinensis, *Mantidis ootheca*, centipedes and so on in the preface to his book, and wrote: "Some princes or rich people let servants make medicines but the servants steal expensive materials to sell." The fraud not only affected the efficacy of medicines, but also affected the social atmosphere. Tao Hongjing hated the phenomenon and wrote in the preface of his book, "Making some medicines by wrong materials have been for a long time and become a habit. If we do not change it, what is the result finally?" "In all of these examples, medicines are cleverly counterfeited in every possible way, even if there is the supervision and inspection, the fraud has not been found. Thus, when using the medicines, there is no the efficacy." Tao Hongjing had a noble medical ethics and he could not remain indifferent on such phenomenon. In the preface of the *Variorum*, he criticized: "If do not know the hot and cold of medicines, do not know true or false medicines, the weights are wrong, and do not divide medicinal soup and pills, will aggravate the condition and even let the people die." He analyzed the reason of fake medicines appearing:

> Many doctors do not know plant medicines, just listen to the sellers on the streets. The sellers also can not identify plant medicines and only rely on people who collect these herbs. The collecting people's methods, herbal knowledge, moral characters are not easily known.

So Tao Hongjing showed that the root of pseudo medicine appearing was that the doctors did not know plant medicines and only relied on the collecting people. In dealing with the fake medicines, of course, there are a lot of methods, and the most effective method is to let people identify the real medicines. To identify the real medicines, you should know the appearance of plants, such as roots, stems, leaves, flowers, fruits, seeds and further understand the internal components. So Tao Hongjing paid attention to the detail description of plant morphology and traits to help people understand the real plant medicines, so as to achieve the purpose of preventing counterfeit medicines. In the *Variorums*, Tao Hongjing in addition to paying attention to records of plant morphology, also carefully explained methods of identifying true and false medicines for warning people to identify the medicines. For example, the *Variorum* wrote:

> Li Dangzhi said that Jansi was a parasitic plant on big catalpa trees, which held Jansi in their bark. At present, people take juglans to make Cortex magnoliae officinalis as Jansi. It is not right. The *Tong Jun Lu* wrote that Jansi grew in Luo, was the bark and was like Cortex magnoliae officinalis. Its color was white and was like the bark color of the laurel trees. Its bark had the vertical and horizontal lines. Now some people make it by using something like Cortex magnoliae officinalis but the fake one is lack of the vertical and horizontal lines. We do not know what the fake one is and what a true Jansi is like.

Therefore, Jansi is a parasitic plant on big catalpa trees and is the bark like Cortex magnoliae officinalis. Its color is white and is like the bark color of the laurel trees with the vertical and horizontal lines. However, at the time, some people make juglans to be like Cortex magnoliae officinalis for faking Jansi. Because of this, after the *Variorums*, *New Revised Plant Medicines* of Tang Dynasty, *Classified Plant Medicines* of Song Dynasty, *Plant Medicines* and *Compendium of Plant Medicines* of Ming Dynasty and other works, not only quoted the faking methods of Stalacititum, asarum, etc. in the *Variorum*, but also exposed faking methods of several new medicinal materials (Lu, 2011), So Tao Hongjing's detailed description of plant morphology had provided a method for identifying medicines.

Needless to say, because Tao Hongjing believed in Taoism, his ideological system was idealism, therefore, his analysis and observation of some plant morphology was also affected by the Taoist immortal thought to a certain extent. It affected scientific records of plant morphology in the *Varioru* to a certain extent; and Tao Hongjing lived in the confrontation situation between the north and south regimes, had a long life in the south, was lack of the field survey and personal understanding for medicines of the north, therefore the *Variorum* had a few records of the north plant morphology (Wang, 2000, p.61). Although the *Varioru*" has some limitations, its records of plant morphology help us to understand its history contribution for the history of pharmacology and plant morphology, provide an important reference for the pharmaceutical industry and the plant research in ensuring accurate plant medicine sources and medical security, are conducive to identify medicines, proofread herbal research books, distinguish medicinal plant resources in different regions, better develop and utilize new medicinal plant resources.

Therefore, the role and status of the *Variorum* can not be ignored in the development history of plant morphology in our country.

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