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Combining classic and novel tools in the study of Historical Collections of Chinese Materia Medica in the Netherlands

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Summary

Traditional Chinese medicine (TCM) is an ancient medical practice with a history spanning several thousand years, and it continues to be widely practiced in and outside of China today. Chinese *materia medica* (CMM) reflects the medicinal ingredients integral to TCM, and their use is guided by the principles of TCM theory. Over several thousand years of application and development, Chinese *materia medica* has not remained unchanged but has continually evolved. The evolution of CMM involves both continuity and dynamic change. The continuity of CMM is reflected by the preservation and inheritance of CMM ingredients and application methods that have proven effective through long-term research and practical validation over thousands of years. The dynamic change in CMM involves replacing established plants and animal species with different parts or species of CMM that have demonstrated superior therapeutic effects after research. It also involves abandoning and excluding CMM species with poor or adverse effects. Moreover, the names of CMM can be changed in time due to regional and changes of dynasties. Additionally, changes may occur due to the scarcity of natural resources for specific drugs or the pursuit of economically viable alternatives. These factors collectively drive the dynamic change of Chinese *materia medica*.

In the thousands of years of history of traditional Chinese medicine, the biological identity of CMM could only be determined through their vernacular names or simple descriptions of morphological characteristics. The current binomial nomenclature was not introduced in China until the early 20th century. Therefore, studying the evolution of Chinese *materia medica* by examining physical specimens in historic collections helps us accurately identify the plants and animals with expected therapeutic effects. This clarifies the confusion caused by (historic) vernacular names, ensuring the safe use of Chinese *materia medica*. This ensures that the development of new drugs based on information on traditional CMM from written sources stays on the right track. Artemisinin, discovered in *Artemisia annua* L., serves as a good example whose discovery begins with the clarification of the botanical identity of the medicinal plant, relying on the vernacular name documented in ancient literature.

Currently, much of the research on the evolution of Chinese *materia medica* (CMM) relies on comparing written texts: historical monographs and documents. While numerous issues related to CMM evolution have been successfully addressed through textual research, some uncertainties persist in confirming the evolution process and biological identity of specific CMM due to a lack of historical records or incomplete textual documentation. However, examining historical CMM specimens can compensate for the limitations of textual research from a physical specimen perspective. Furthermore, research on specimens and textual research complement each other, offering more comprehensive support for the study of CMM evolution.

In addition to studying the evolution of Chinese *materia medica*, historical specimens, because they have undergone long-term preservation, can also be used as important research

material for other fields of study. For example, historical specimens can be utilized to verify whether the delayed luminescence (DL) technique can serve as an effective method for measuring the dynamic changes of CMM or discriminating the storage time of CMM.

Due to the colonial connections between the Netherlands and (South-) East Asia since the 17th century, and the keen interest of Dutch scholars and the public in exotic plants from the East, numerous plant specimens from these regions are preserved in Dutch museums or private collections. Consequently, historical Chinese *materia medica* specimens are likewise included in these collections. The historical CMM specimens preserved in the Netherlands, which have not undergone a thorough study, can offer valuable physical evidence for researching the evolution of Chinese *materia medica*. This thesis focuses on the historical CMM specimens preserved in the Netherlands. Through comparison with CMM literature records and modern CMM samples, the evolution of CMM is investigated. Additionally, several historical specimens were subjected to delayed luminescence (DL) to verify the feasibility of this technology in discriminating the storage time of Chinese *materia medica*.

In **Chapter 2**, we conducted a comprehensive study of a historical Chinese *materia medica* collection, the Westhoff collection, spanning approximately 140 years and consisting of around 400 specimens. Through identifying aspects such as taxonomic identity, medicinal parts, processing methods, and comparing them with corresponding literature and modern samples, we successfully uncovered evidence of dynamic changes in Chinese *materia medica*. These findings not only substantiate certain conclusions from textual research; some of them also reveal new evidence of dynamic changes in Chinese *materia medica*. Those historical specimens that did not change also demonstrated the continuity in the evolution of Chinese *materia medica* from a physical perspective.

In **Chapter 3**, an examination was conducted on a handwritten catalogue corresponding to the Westhoff collection. Apart from information like vernacular names and the medicinal parts, this catalogue presented the medical indications for symptoms or illnesses related to each Chinese *materia medica* specimen. This provided an unique opportunity to explore the evolution of CMM from a medical usage perspective. Our findings reveal that 78% of medicinal indications in the catalogue align with current reported Chinese *materia medica* indications. Additionally, the catalogue indicates the most frequently mentioned illnesses or symptoms that were treated at that time. The catalogue also sheds light on important aspects of Chinese *materia medica* circa 1870, including popular herbal medicines, their geographical origins, and the social aspects of traditional Chinese medicine.

Chapter 4 presents a comparative study of four historical collections of Chinese *materia medica* and includes a list of contemporary CMM available in both the Chinese and the EU market. The objective is to explore the evolution of Chinese medicinal materials by examining physical specimens. Specimens in these five collections, spanning over 300 years, illustrate that the core of CMM has experienced minimal changes in terms of medicinal plant

taxa and plant parts used throughout this extensive period. Furthermore, the persistent presence of shared CMM among collections of various ages confirms the continuity in the use of CMM. Dynamic changes in CMM are primarily related to the conservation of endangered species, the safe usage of CMM, and the exploration of new pharmacological applications for well-known species. Overall, the examination of historical CMM specimens reveals significant continuity and subtle changes in Chinese *materia medica* spanning 300 years.

Chapter 5 validates the delayed luminescence (DL) technique by employing historical CMM specimens from the 1900s to the 1920s, the 1950s, and recent samples. This technique measures the decaying ultra-weak luminescence displayed by materials after exposure to light and has previously proven successful in detecting variations in CMM arising from different growth conditions and processing methods. This chapter examines whether DL can discriminate differences attributed to storage time. The results showed that the DL technique can distinguish CMM based on age, but DL values of CMM depend on the particular species. The findings imply that DL technology could serve as a method for detecting storage time, but additional research and validation of this approach are still necessary.

The historical CMM specimens are the focus of this thesis, contributing to the comprehension of the historical, continuous, and dynamic changes in traditional Chinese medicine and Chinese *materia medica*. They offer an additional perspective to conclusions derived from textual records or present new viewpoints that may differ from literary data. Simultaneously, the advantages and characteristics of historical specimens, not found in textual records, further elucidate the significant value of historical CMM specimens. Unfortunately, in comparison to research on literary sources, the study of historical specimens remains inadequate. This is, of course, attributed to unavoidable objective factors, such as CMM's inability to be preserved and transmitted like written texts. Additionally, these medicinal substances are primarily intended for use by patients during their effective periods for treating diseases or maintaining health, rather than being stored in cabinets for extended periods as decorative items. Besides these objective factors, well-preserved ancient specimens may be overlooked and neglected by the public due to the limited understanding of their important research value and significance. For instance, collections such as the Westhoff Collection and Catlender Collection were hardly studied before this thesis. The aspiration is that this thesis will bring these historical specimens, which have been out of the public eye for many years, back into focus, enabling more researchers and the general public to comprehend the crucial research value and significance of historical specimens. Furthermore, this thesis aims to bring awareness to other ancient medicinal specimens scattered worldwide, unnoticed and unattended, offering a new and deeper understanding of the history and development of medicine, as well as humanity's history and development.

