

The Exotic Materia Medica of Chinese Medicine: A Survey of Its Resources and Medical Information in 1029 BC–1999 AD

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Research

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Abstract

Background

Traditional Chinese medicine (TCM) gives people an image of its medicinal resources all from within China. Nevertheless, the fact is that the Exotic Materia Medica (ECM) has been used in Chinese medicine from Zhou Dynasty (1029 BC-221 AD). However, no extensive studies have focused on it. Now, the high exchange speed of information and material brings TCM opportunities to apply exotic resources in clinics. So, surveying the historical ECM's resources and medical information is valuable.

Methods

We investigated the origin of 8980 *Chinese Materia Medica's* resources included in *Chinese Materia Medica* and compiled a species list of exotic Chinese medicines (ECM) used in China between 1029 BC–1999 AD and their medical information, introduction time, introduction routes, and place of origin.

Results

Consequently, we found information on 788 ECM and their clinical application. A total of 99% of ECM were found to be botanicals mainly belonging to Solanaceae, Amaranthaceae, Malvaceae, Myrtaceae, and Cruciferae. The exchange speed of these medicines between China and other regions peaked in the Han (206 BC–220 AD), Tang (618–907 AD), and Ming dynasties (1368–1644 AD), and increased sharply from 1912 onwards. The main registered efficacies of the ECM were "clear heat" and diuresis. The most efficient way to convert foreign medicine to TCM is to absorb drugs from foreign regions directly. Last but not least, about One-fifth of commonly used TCM in the clinic is ECM.

Conclusion

Chinese doctors are more concerned with the efficacy of the drug when using it in clinical settings than whether the drug comes from afar. The record of origin and source was to ensure the supply and quality of the drugs. The use of foreign resources as Chinese medicine is the fact that Chinese medicine objectively exists. The existence of ECM has enriched the resources of TCM. Furthermore, both foreign medicine and local medicine currently protect people's lives and health.

1. Background

Traditional Chinese medicine (TCM) or Traditional Chinese Materia Medica has provided medical knowledge and resources in China. While exploring and utilizing local medical resources, the Chinese doctor also applies effective foreign medicines to the clinical. The history of using exotic medicines in China can trace back to the Zhou dynasty (1029-221 BC). The Eastern Han philosopher Chong Wang's Lun Heng volume eight "Ruzeng Pian" said: "During the Zhou Dynasty, the world was peaceful, Vietnam sent white pheasants, and Japanese sent tulip grass[1]. " And then, in the Middle Ages, exotic medicines were introduced by the Persians from the Silk Road. Moreover, during the Tang dynasty (618-907 AD),

overseas medicines were introduced to China via the Maritime Silk Road due to the development of maritime trade[2]. In the Five Dynasties and Ten Kingdoms period(907-979 AD), the Persian businessman Xun Li's Marine Herbal Medicine systematically recorded the foreign medicines. Exotic medicines have been introduced in medical practice in China during each historical period.

Although the history of using exotic medicines in China can trace back to the Zhou dynasty, modern research on exotic medicines began with the Chinese pharmacist Professor Ling Yikui. He and his student first defined exotic Chinese medicine (ECM) in 1980. ECM refers to imported medicines or foreign medicines introduced in China. ECM should: 1) be produced outside the territory, relying solely on importers, such as frankincense, myrrh, benzoin, and storax; 2) be produced outside and inside the territory, imported from abroad, such as Korean ginseng, Dongyang ginseng, American ginseng; 3) firstly produced outside the territory but later introduced in China, such as white cardamom, pepper, cinchona, and coix seed[3]. Chinese pharmacists complied with this definition and inclusion criteria while exploring the ECM[2,4–8]. In this research, we followed the definition of Yikui Ling, except we emphasized that the **original resources** came from abroad. ECM covers plants, animals, and minerals or their processed products that have entered China through various methods, and have been used in the Chinese medicine. Which includes animals and plants originally distributed in China, but the **initial resources** were from abroad or naturalized in China, such as turmeric, coix seed, American ginseng, patchouli, winter melon seeds.

Now, the high exchange speed of information and material brings TCM opportunities to apply exotic resources in the clinic. So, surveying the historical ECM's resources and medical information is valuable. However, no extensive studies have focused on it. The existing research on ECM have focused on a classic pharmacy book or a certain dynasty[7–16]. Most of them focusing on a classic pharmacy book or a certain dynasty. Therefore, we compiled a list of ECM from the 8980 traditional Chinese medicines included in the *Chinese Materia Medica* [17]. which covers the drugs that are recorded in all the classic pharmacy books of TCM and still being used today. We then analyzed their place of origin, time of application, time of introduction, characteristics of the resources, drug efficacy, and clinical application. This study represents the first attempt at a compilation of the basic general list of ECM with comprehensive analysis of its efficacy, indications, and resources.

2. Methods

In this research, the definition of ECM refers to the part of TCM that its **initial resources** were from abroad, which covers plants, animals, and minerals or their processed products that have entered China through various methods and have been used in Chinese medicine. ECM should: 1) be produced outside the territory, relying solely on importers, such as frankincense, myrrh, benzoin, and storax; 2) be produced outside and inside the territory, the **initial resources** were from abroad, such as turmeric, coix seed, American ginseng, patchouli, winter melon seeds; 3) firstly produced outside the territory but later introduced in China, such as white cardamom, pepper, cinchona, and coix seed. Under the guidance of the

above three standards, we have assessed 8980 Chinese medicines recorded in *Chinese Materia Medica*[17], Withing the help of Guangyao's Xu research[18].

The scientific name of plants was determined according to The Plant List database (www.theplantlist.org) and the Chinese Flora database (www.iplant.cn/frps). The scientific name of the animal resources was determined using www.marinespecies.org/index.php and a-z-animals.com. According to the relevant appendix data of the "Exotic Plants from China" and the Plant Introduction and Conservation Database of the Xishuangbanna Tropical Botanical Garden of the Chinese Academy of Sciences (<http://sdb.xtbg.ac.cn>), we analyzes the introduction pathway, time, and origin. Additional information was collected from journal literature.

A database of ECM based on the aforementioned, including scientific name, taxonomy information, traditional efficacy, introduction route, introduction time, place of origin, the first application time (based on history literature), and first medical literature. The drug application time was mainly based on the first recording time of traditional Chinese medical literature. We have also referred to Chinese clinical pharmacies and diagnostics to determine the traditional efficacy of ECM. Due to the complex relationship between TCM and biological resources, this study used two standards for statistical analysis of medicinal resources and clinical information: 1) ECM's data of medicinal resource of the original place, family, introduction time, and introduction way were considered as statistic objects; 2) clinical information on efficacy, indication, application time, and the total number of ECM, were set as statistics objects.

3. Results

A total of 788 ECM among 8980 TCM were retrieved from the *Chinese Materia Medica*. The ECM's drug names, plant names, sources, effects, indications, medicinal properties, medicinal taste, meridian, medicinal parts, toxicity, introduction route, life type, family, genus, introduction time, first medical literature of loading, the first application time, and the place of origin, can be seen in **Supplement 1**.

3.1 Resources characteristics of ECM

3.1.1 The dominant family of ECM and its introduction route

The percentage of botanical ECM was 98.70%. The botanical ECM was distributed among 94 families, 316 genera, and 469 species (including subspecies, varieties, and hybrids). The top 10 families were Fabaceae, Asteraceae, Euphorbiaceae, Solanaceae, Amaranthaceae, Malvaceae, Lamiaceae, Myrtaceae, Brassicaceae, and Liliaceae. The percentage of animal ECM was 0.84%: *Corallium rubrum* of Coralliidae, *Cairina moschata* of Anatidae, *Capra aegagrus hircus* of Bovidae, and *Castor canadensis* of Castoridae. The percentage of mineral ECM was 0.42%: Agate of Oxide Quartz Group and the Manganite of oxide

rutile group. The most dominant family and its introduction route can be seen in **Fig.1**. The overall view on families and their introduction route in China can be seen in **Supplement 2**.

Fig.1: The most dominant family and its introduction route in China.

Notes: Introduction Way: Af, afforestation; Co, compound; CR, cotton ramie; Dy, dye; FAV, fruits and vegetables; FI, Food intake; Fo, forge; GM, green manure; Gr, grain; He, hedge; Me, medicinal; Na, natural; Oi, oil; Or, ornamental; Pe, perfume; SC, sugar crop; ST, street trees; UI, unintentional; Wo, wood.

3.1.2 The origin place of ECM

To assess the origin place of ECM, we used the continental division system of Biodiversity Information Standards (www.tdwg.org). For species already described in Guangyao's Xu research on naturalized plants in China, we have used these source information. The results are standardized according to the Biodiversity Information Standards. The place of origin for the ECM were: 144 from South America, 96 from tropical Asia, 69 from temperate Asia, 67 from Oceania, 62 from Africa, 56 from North America, 42 from Europe, six unknown, five from the Pacific, two Paleotropic, two with hybrid origin (especially refers to the hybrid plants of Chinese native plants and naturalized plants), one with origin of cultivation, and six non-verified specific origins.

3.1.3 Introduction time and routes of ECM

We confirmed the introduction time of the 410 species, and 65 species had not been verified. The annual introduction rate of each dynasty is shown in **Fig.2**. A total of 33 species were introduced during Zhou dynasty (1029–221BC) to Han dynasty (206 BC–220 AD), 24 species were introduced during Wei, Jin, Southern, and Northern Dynasties (220–581 AD), 25 species introduced during Sui and Tang Dynasties (581–907 AD), 26 species introduced during Song Jinyuan period (960–1368 AD), 35 species introduced during Ming dynasty (1368–1644 AD), 95 species introduced during Qing dynasty (1636–1911 AD), 80 species introduced during the Republic period, and 172 species introduced during 1912–1999 AD.

Fig.2: Annual average number of introduced species per dynasty.

A total of 29 routes for the introduction of ECM in China were found. The main ones(**Fig.3**) were ornamental (23.05%), fruit and vegetable (22.07%), unintentional introduction (13.41%), medicinal (10.61%), and spice (5.61%). The ECM introduced by these routes accounted for 74.76% of the total. A few species were found to be introduced in China in multiple ways (e.g., nutmeg through medicinal and spice routes).

Fig.3: Introduction routes of exotic Chinese medicines in China.

3.2 Medicinal information of ECM

3.2.1 The efficacy of ECM

The efficacy of TCM is recorded with a summary of diagnosis and treatment. The current Chinese clinical medicine usually divides the efficacy of Chinese medicines into 22 major categories. We classified the ECM based on efficacy and indication, Chinese medical diagnostics, and basic medical knowledge. And then, we get the frequency of exotic Chinese medicines with various functions in each dynasty (Table 1), which shows that the most introduced categories of ECM were "clear heat" and diuresis, suggesting that local ECM may lack resources in these two areas.

The efficacy of the 788 ECM here studied is distributed throughout the major of Chinese clinical medicine. The main efficacies found for the ECM were: "clearing heat," "promoting urination and draining," "promoting blood circulation and removing stasis," "hemostasis," "regulating Qi," "relieve cough and asthma," "resolving phlegm," "counteracting toxic substances and insecticides, remove rotting skin and muscle and convergence wet sores," "removing rheumatism," and "tonic."

Table 1: Frequency of exotic Chinese medicines with various functions in each dynasty.

3.2.2 The indication of ECM

The indications of TCM refer to the main clinical adaptation of the drug, also called the main adaptation range. Ancient Chinese doctors obtain indications of Chinese medicine through clinical practice. The descriptions of ECM indications come from different documents, thus we have analyzed and standardized the treatment of the main treatment of each medicine. The detailed treatment process and results are shown in Supplement 3. A total of 826 indications were reported for ECM. The top 50 were: sore, carbuncle, fall injury, cough, dysentery, diarrhea, edema, rheumatic arthralgia, sore, boil, vomiting blood, eczema, respite, jaundice, vomiting, hot eyes, sore throat, metrorrhagia and metro taxis, scald, blood in stool, boil, difficulty in urination, stomach ache, hemoptysis, scabies, gangrene, headache, traumatic bleeding, malaria, irregular menstruation, stomachache, diarrhea, hemorrhoids, leukorrhea, sputum, leucorrhea, toothache, dysmenorrhea, lung fever, bloating, beriberi, blood, food accumulation, constipation, hypertension, scrofula, snakebite, fracture, amenorrhea, and malnutrition. The sum of the frequency of the top 50 accounts for 59% of all attending diseases. The top 10 frequencies were: 162, 151, 142, 129, 110, 80, 76, 63, 59, and 53. Half of the scope of the treatment of foreign Chinese medicine belongs to skin diseases, urinary system diseases, trauma, respiratory diseases, digestive system diseases, and gynecological diseases. This result is consistent with its main effects of clearing heat, diuresis, activating blood to remove blood stasis, hemostasis, relieving cough, relieving cough and asthma, and resolving phlegm.

4. Discussion

4.1 The dominant families of ECM

To clarify the unique superior families of ECM relative to TCM, we collected the family of 7812 non-animal and mineral medicine (i.e., algae, lichens, and plant) included in the *Chinese Materia Medica* (**Supplement 4**). The 7,812 non-animal Chinese medicine resources came from 8,394 species distributed between 353 families. The top 20 families of TCM were: Fabaceae, Asteraceae, Lamiaceae, Rosaceae, Ranunculaceae, Apiaceae, Liliaceae, Orchidaceae, Euphorbiaceae, Scrophulariaceae, Gramineae, Rubiaceae, Asclepiadaceae, Urticaceae, Polygonaceae, Saxifragaceae, Rutaceae, Araliaceae, Lauraceae, Polypodiaceae. The top 10 families of ECM were: Fabaceae, Asteraceae, Euphorbiaceae, Solanaceae, Amaranthaceae, Malvaceae, Lamiaceae, Myrtaceae, Brassicaceae, Liliaceae. Thus, the common dominant families of ECM and TCM were Fabaceae, Asteraceae, Euphorbiaceae, Lamiaceae, and Liliaceae; The unique dominant families of ECM were Solanaceae, Amaranthaceae, Malvaceae, Myrtaceae, and Cruciferae(**Fig.4**).

Fig.4: The common and unique dominant families of exotic Chinese medicines compared with traditional Chinese medicine.

4.2 Directly absorb and convert natural medicines from foreign regions into TCM is Commendable.

The top four introductory routes found were the ornamental route, the fruit and vegetable route, the medicinal route, and the spice route. The number of ECM introduced through the ornamental route was the highest. However, just 11 (pittosporum bark, elderberry, calendula, cassia, trumpet creeper, morning glory, green box, opium, digitalis, poppy, and poppy husk) had high-quality clinical efficacy and pharmacological effects. Although the number of ECM introduced through the fruit and vegetable route is relatively high, they all appear as fruits and vegetables in supermarkets and vegetable markets, rather than medicines in hospitals and pharmacies. The number of ECM introduced through medicinal routes ranks third. More than half of ECM introduced through medicinal routes is commonly used in clinics of Chinese medicine. They are used in hospitals and pharmacies as medicines. The 16 (asafoetida, benzoin, citrus sinensis, aloes, cloves, dried ginger, pepper, horseradish, myrrh, ginger, nutmeg, frankincense, ginger, sesame seeds, cumin, and cumin) items introduced through the spice route in Chinese clinical medicine have the effect of "warming the spleen" and "regulating the stomach," mainly treating digestive system diseases. This feature is consistent with the current application of spices. To sum up, directly absorb and convert natural medicines from foreign regions into TCM is Commendable(**Fig.5**).

Fig.5: Directly absorb and convert natural medicines from foreign Regions into traditional Chinese medicine is Commendable.

4.3 Trends in the exchange of medical information between China and other regions

Because the time of different dynasties existed and the number of ECM that were introduced during that dynasty were different, we have use 1000 times OF the annual average number of ECM in each dynasty to analyze the tendency (**Fig.6**). The introduction rate of ECM with different efficacies generally peaked during the Han (206 BC–220 AD), Tang (618–907 AD), and Ming dynasties (1368–1644 AD). In the late Qing dynasty, most types of ECM began to accelerate sharply, in line with the rapid acceleration of the material and information exchange between the East and the West. The exchange speed of medical resources and information between China and other regions increased sharply from 1912 onwards.

Fig.6: The annual average*1000 of exotic Chinese medicines introduced with different efficacies in each dynasty.

4.4 About One-fifth of commonly used TCM in the clinic is ECM.

According to Chinese Materia Medica, the total resources of TCM is 8980. Based on our result, the total resources of ECM are 788. So the percentage of ECM accounts for TCM in its total resources is 8.8%. But the key point is the percentage of commonly used exotic Materia Medica in clinics (CECM) accounts for the commonly used traditional Chinese medicine (CTCM). Now, the current official standards of CTCM have not yet been established[19–23]. To obtain the percentage of the CECM accounts for the CTCM, we chose the drugs recorded in The Identification of Traditional Chinese Medicine as the CTCM. The Identification of Traditional Chinese Medicine is a book of great reference value, which recorded 240 botanical CTCM[24]. With the help of this book, we analyzed the characteristic of different medicinal parts that the CECM accounts for the CTCM(**Table 2**). Among them, the more prominent is the resin medicinal herbs that account for 100%, which means all of the resin TCM clinically commonly used in clinics belongs to ECM. They are storax, frankincense, myrrh, Asafoetida, benzoin, and dragon's blood. Then it is worth noting that the most frequently used medicinal sites are fruits and seeds. The frequency of clinically commonly used in clinic ECM in fruits and seeds is as high as 13(nutmeg, semen cassiae, boat-fruited scaphium seed, medicine terminalia fruit, fennel fruit, semen strychni, Semen Pharbitidis, henbane, common carpesium fruit, Areca catechu, fructus amomi, fructus amomi rotundus, galanga galangal seed). Last but not least, the percentage of the CECM accounts for the CTCM is 17.1%.

Table 2: The characteristic of different medicinal parts that the CECM accounts for the CTCM

5. Conclusion

Although the percentage of ECM accounts for TCM in its total resources is 8.8%, the percentage of the CECM accounts for the CTCM is 17.1%. This suggests that Chinese doctors are more concerned with the efficacy of the drug when using it in clinical settings than whether the drug comes from afar. Although in the past, the use of distant drugs meant more money to spend. The famous American Orientalist Laufer said: "The Chinese are a well-thought-out, sensible, and open-minded nation. They have always been

willing to accept good things from outsiders[25]" Chinese medicine uses foreign medicine resources for its effectiveness in treatment. Therefore, proactive absorption is the main attitude of Chinese pharmacists when facing effective foreign drugs. The record of origin and source was to ensure the supply and quality of the drugs. Both the accumulation of effective drugs and edible food play an important role in evolution. The use of foreign resources as Chinese medicine is the fact that Chinese medicine objectively exists. The existence of ECM has enriched the resources of TCM. Furthermore, both foreign medicine and local medicine currently protect people's lives and health.

Abbreviations

ECM	Exotic Chinese medicine.
TCM	Traditional Chinese medicine.
CECM	Commonly used Exotic Materia Medica in clinics.
CTCM	Commonly used Traditional Chinese medicine in clinics.

Declarations

Ethics approval and consent to participate

Not applicable

Consent to publish

Not applicable

Availability of data and materials

All data generated or analyzed during this study are included in this published article.

Competing interests

The authors declare that they have no competing interests.

Funding

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Authors' Contributions

Zhuyun Yan: Conceptualization, Methodology, Writing- Review & Editing, and Supervision.

Qingqing Cai: Investigation, Writing-Original Draft.

Correspondence to Zhuyun Yan.

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Tables

Due to technical limitations, table 1 and 2 is only available as a download in the Supplemental Files section.

Annual average number of introduced species per dynasty.

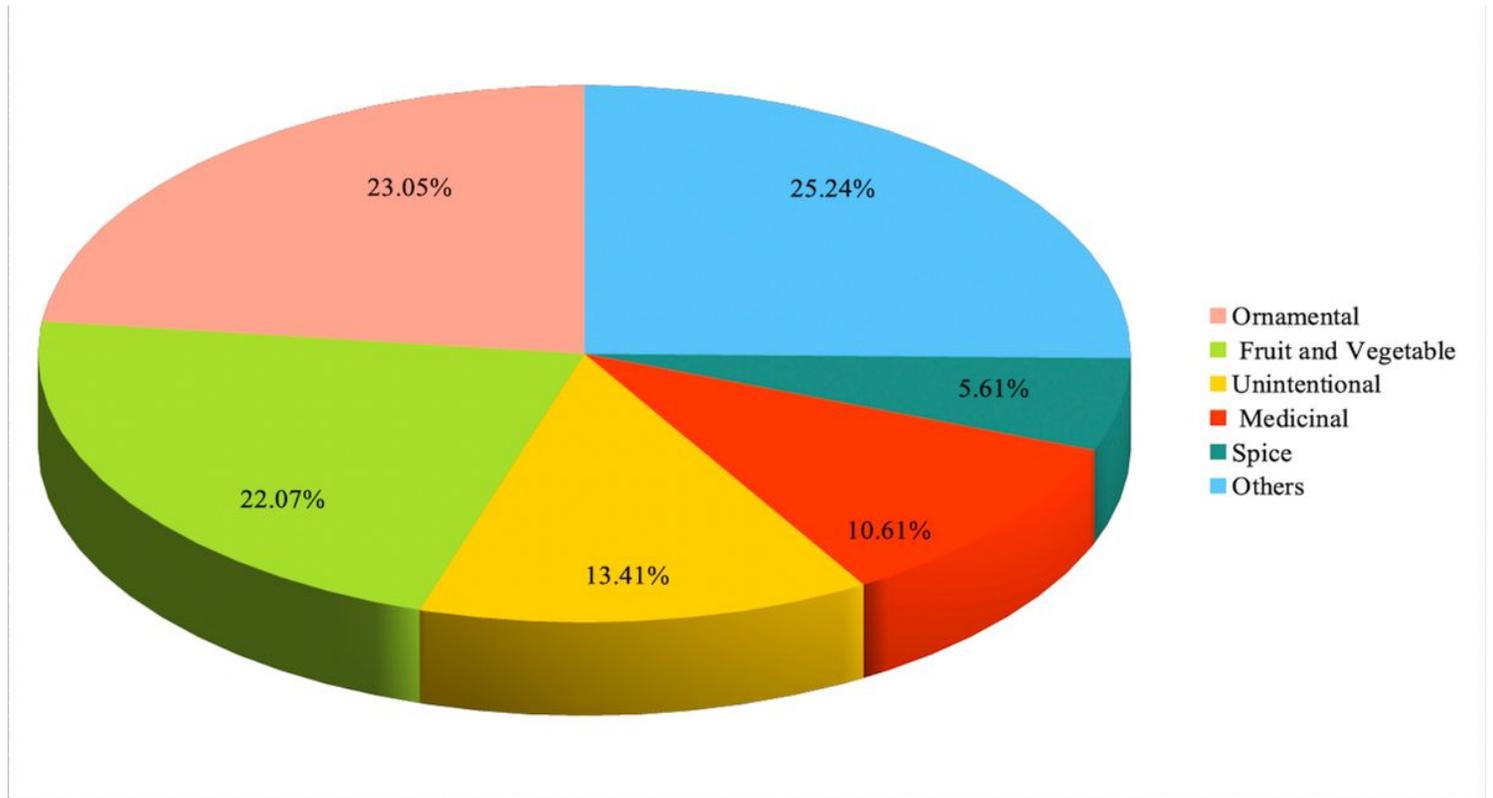


Figure 3

Introduction routes of exotic Chinese medicines in China.

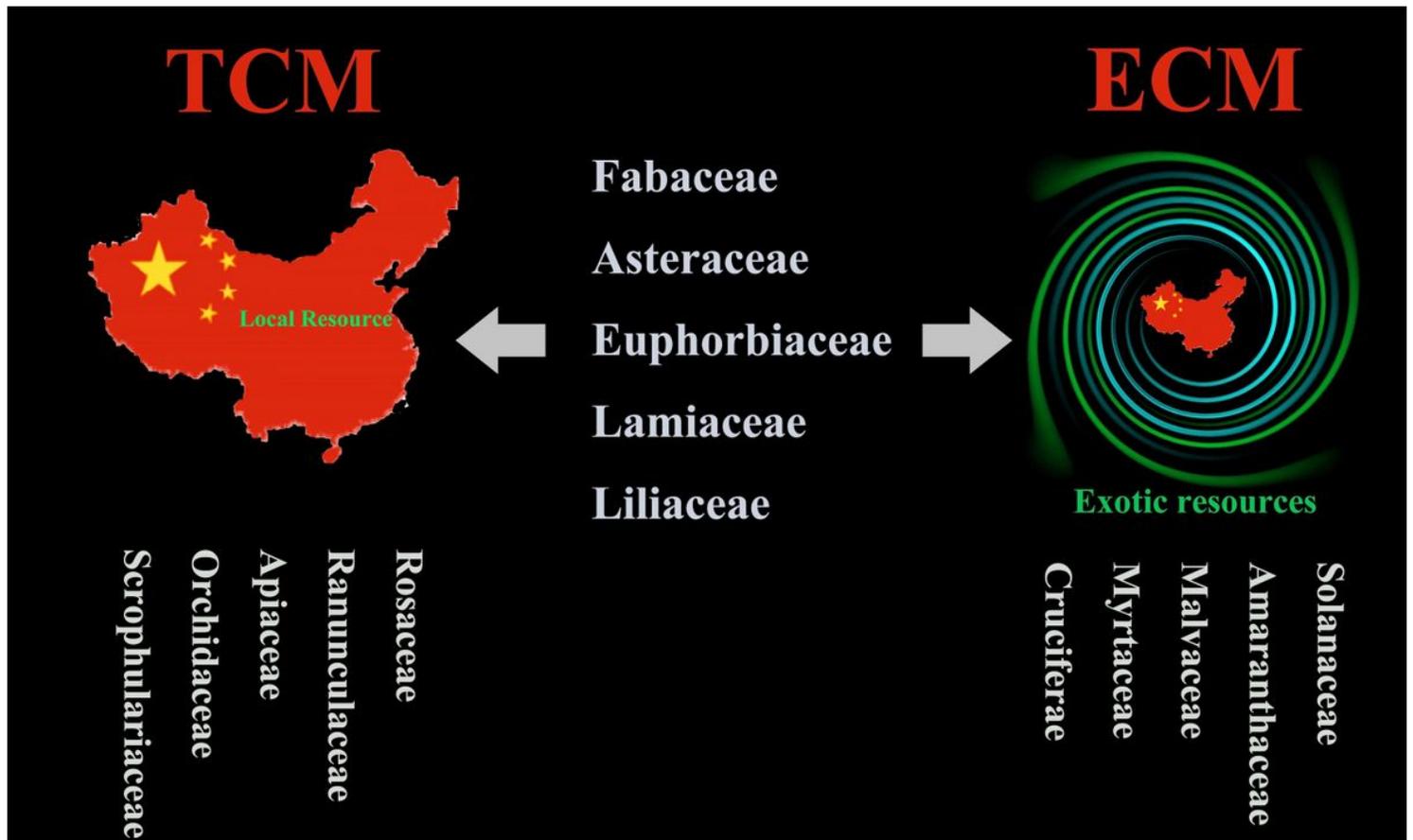


Figure 4

The common and unique dominant families of exotic Chinese medicines compared with traditional Chinese medicine.

1.Ornamental Route



2.Fruit and Vegetable Route



3.Medicinal Route



4.Spice Route



Figure 5

Directly absorb and convert natural medicines from foreign Regions into traditional Chinese medicine is Commendable.

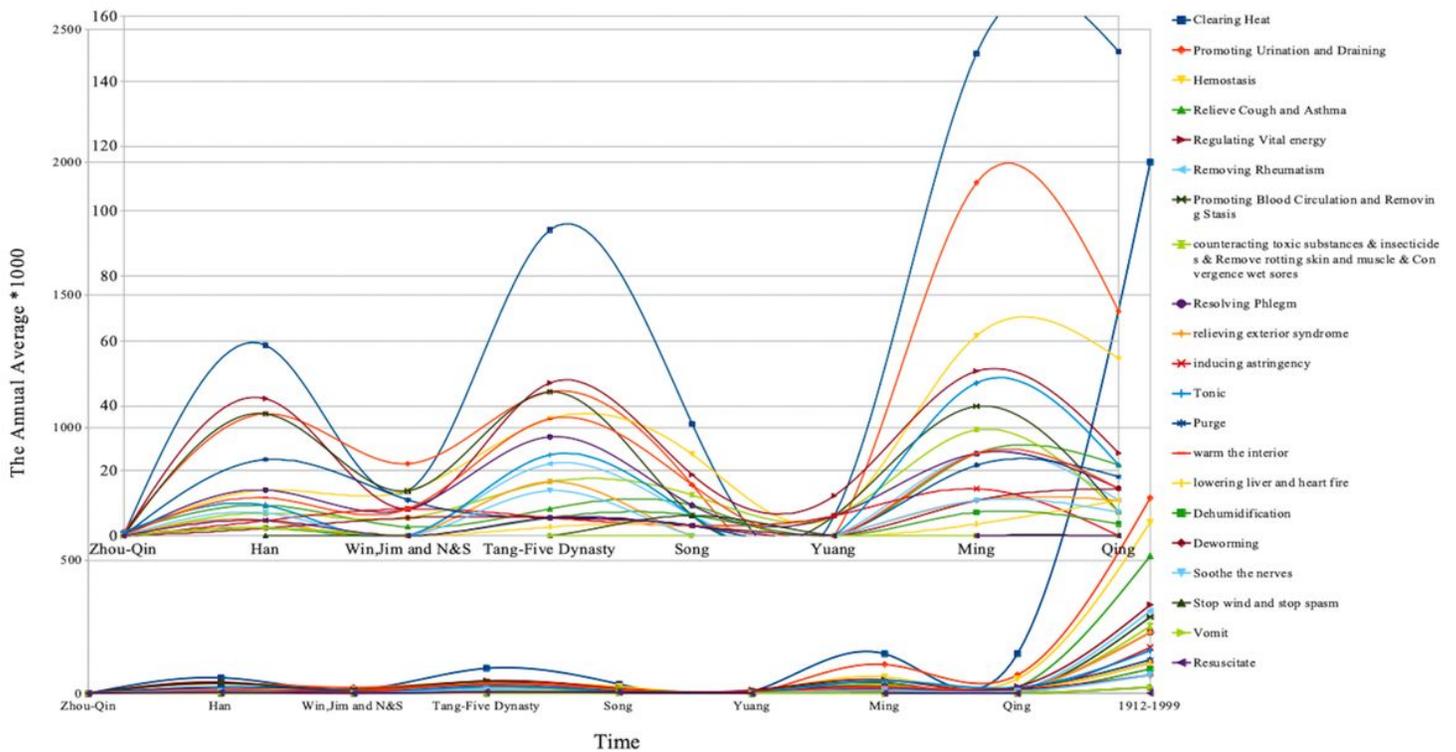


Figure 6

The annual average*1000 of exotic Chinese medicines introduced with different efficacies in each dynasty.

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