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SECTION I

HISTORICAL ROOTS OF CHINESE HERBAL MEDICINE

This section:

- a) Outlines the developments of Chinese herbals from the first extant text to the present day.
- b) Considers the ramifications that modern developments in Chinese medicine have had on Chinese herbal medicine, in particular, and on Chinese medicine in general.
- c) Compares the historical roots of development of other Eurasian medical systems, such as Ayurveda and biomedicine, with those of Chinese medicine.
- d) Presents a summarial account of the contents of the BEN CAO GANG MU (Li Shi-zhen, 1596), the primary text upon which this study is based.

Historical Origins of Chinese Herbal Medicine

Origins in China

According to the dictionary, medicine is the art of restoring and preserving health. Based upon this definition, medicine in China can be considered to date from at least as early as the time of the shamanistic healers of the Shang dynasty (?16th – ?11th centuries BC¹). This early medicine was essentially demonological, ascribing illnesses to the unseen forces of ancestors and gods. It was not until the Spring and Autumn Period (770 – 476 BC) of the Zhou dynasty (*ca.* 11th century BC – 221 BC) that explanations of illness in terms of natural occurrences of the perceptible world came to the fore. The earliest extant Chinese text on a theoretically systematic medicine is the HUANG DI NEI JING² 黃帝內經 (*The Yellow Emperor's Classic of Internal Medicine*), which dates to the second or first century BC. However, frequent references in that text to numerous earlier medical works make it clear that there was an evolution of intellectual understanding throughout the latter half of the first millennium BC. The HUANG DI NEI JING discourses on the body in states of both health and illness, makes recommendations on lifestyle in harmony with the seasons, sets out the various ways by which illness may arise, explains diagnostic methods, describes a system of “meridians” carrying “energy”, or “subtle influence” around the body, and expounds upon the methods and applications of acupuncture. Although the medicinal use of herbs is mentioned, the work is primarily a text on general medicine and acupuncture. Dating to a similar period is the first extant Chinese herbal, the SHEN NONG BEN CAO JING 神農本草經 (*Shen Nong's Herbal Classic*).

Etymological Clues

The etymology of three terms: “Yao”, “Yi” and “Ben Cao” is of particular relevance to understanding the historical origins and development of Chinese medicine. As a preamble to the explanations of these terms, a short comment on Chinese characters is appropriate.

¹ 1766–1122 BC, according to some sources (e.g. THE WALLED KINGDOM, Rodzinski, 1984).

² Emperor Huang Di 黃帝 (real name Gong-sun Xuan-yuan 公孫軒轅) is thought to have lived approximately 2698 – 2589 BC. The HUANG DI NEI JING was not written by him. It is a compilation of earlier works which are set out as a discussion between Huang Di and Qi Bo 歧伯, one of his ministers.

Chinese characters can be “primitives” or “compounds”. Primitives are basic units that cannot be further reduced; for example, the characters 日 Ri, meaning sun, and 月 Yue, meaning moon, which are essentially pictographic. Compounds may be logical aggregates of primitives and have a cumulative meaning; for example, the characters for sun and moon in combination, 明 Ming, mean bright. Or, again, the character for woman, 女 Nü, in combination with that for child, 子 Zi, means good: 好 Hao. Compounds may also be phonetic complexes, comprising an element imparting meaning, called the radical, which is usually either a primitive or a derivative of one, and a phonetic component indicating pronunciation. An example of a phonetic complex is the character for mother, 媽 Ma, which comprises the primitive radical 女 Nü, meaning woman, with the character 馬 Ma, meaning horse. Here, Ma 馬 clearly carries no logical meaning to the compound character, but serves only to indicate its phonetic nature.

The character 藥 Yao, meaning medicinal herb, comprises the grass radical 艹 on the top and a partial-primitive image of a musical instrument 樂 underneath. The grass radical 艹 is a derivative of the primitive 艸 Cao, an image of two grass stalks with panicles (inflorescences), and indicates herbaceous plants. The partial primitive 樂 can be pronounced either “Yue” or “Le” and, either way, is an image of a wooden pole 木 (actually the character means “wood”) with bells 钹 and a drum 白 attached. Pronounced “Yue”, it means music; pronounced “Le”, it means happy/joyful. The association between music and joy is obvious. From shamanistic times, music and ritual were used to drive out illness; later, herbs were used for the same purpose. The character “Yao”, for medicinal herb, thus reflects the use of a herbaceous plant to promote a restoration of health and the associated state of joy.

The character meaning medicine was originally written as 醫 and later as 醫. Both characters are pronounced “Yi” and have, on the top, the images of a stylised arrow 矢 “Shi” in a receptacle 匚 “Fang” (in this case, representing a quiver), and an agitating hand 扌 “Shu” indicating defence against an enemy: the sending of arrows against such pernicious influences as cause illness. The bottom of the character, however, changed from the primitive 巫 “Wu”, meaning shaman or magician, to the character 酉 “You”, an image of an earthen crock with a stopper 酉, meaning liquor. The change in character reflects a transition from an essentially shamanistic medical system to one employing tinctures. A shift in emphasis from magical to herbal medicine. This transition, however, was not harmonious. The ZUO ZHUAN¹ 左傳 (*Zuo's Commentary*) contains pieces reflecting fierce competition between shamanistic and medical healers (William Dolby, pers. comm.).

The term “Ben Cao”, as occurs in the title of the first extant herbal, the SHEN NONG BEN CAO JING 神農本草經 (*Shen Nong's Herbal Classic*), includes the characters 本 Ben and 草 Cao. “Ben” comprises the primitive “Mu” 木, meaning ligneous plant or wood, with a horizontal line — through its base. A horizontal line is often used to represent the earth. In this case, it forms a logical aggregate indicating the place where the tree and the earth unite, namely the root. It could also be construed as an indicative symbol, drawing attention to the base or root of the tree: the foundation of something. Either way, the resulting composite character means root/origin/fundament. The character 草 Cao comprises the grass radical 艹 above, and the character 早, imparting the phonetic element “Cao”, beneath. The composite character is a logical-phonetic complex indicating herbaceous plants. “Ben Cao”, literally rendered, therefore, could be given either as “roots and herbaceous plants” or as “fundamental herbaceous plants”. In reality, the term “Ben Cao” has been

¹ The ZUO ZHUAN may have been written by Zuo Qiu-ming 左丘明 in the Warring States Period (475 – 221 BC). It is a commentary on the CHUN QIU 春秋 (*Annals of the Spring and Autumn Period*), which text is a chronological Chinese history from 722 – 481 BC. The commentary is a record of the principal political, social, and military affairs of the state of Lu 魯國 in the Spring and Autumn Period (770 – 476 BC).

The first two pages of Section II

SECTION II

AN INTRODUCTION TO THE CONCEPTS OF CHINESE HERBAL MEDICINE

Chinese medicine has its own particular language and way of expressing the characteristics of herbs. Without a knowledge of these, the entries of classical herbals are unintelligible. This section:

- a) Introduces important terms and concepts of classical Chinese herbal medicine.
- b) Describes parallelisms between the classical Chinese medical and biomedical systems.
- c) Discusses how the two medical systems may work to mutual advantage.

A Note on the Capitalisation of Organ Names

The concept of the organs and the blood, in Chinese medicine, is not restricted to the physical material indicated by the corresponding words in biomedicine. Instead, it embraces both functional and physical attributes. Thus, the “heart” presides over the blood vessels. The “liver” stores the blood and presides over the sinews. The “spleen” holds the blood in the pathways, presides over the muscles and stores the intellect. Classical reference to the “blood” also indicates more than just the fluid flowing through the vascular system. Deficient “heart blood” could manifest as poor memory, and a person can suffer from “heat in the blood”, which might present as a red skin rash. So as to differentiate between the Chinese and biomedical indications, the former are capitalised and the latter not. This puts representation of the Heart, Liver, Kidney, Blood etc. in line with Yin, Yang and Qi, in this book.

Key Concepts of Chinese Medicine in General

Qi

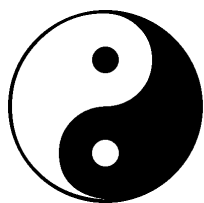
Qi 氣 is sometimes translated as “energy”, but can equally well be rendered as “influence”. It has function, but not form; it is insubstantial. It is that influence which causes or enables substantial, material things to move or change. In the body, the Qi flows through the meridians (channels), it also provides the dynamic impetus for food to move through the Intestines and for Blood to flow through the blood vessels. Outside of the body, there is also Qi. Externally contracted illness is regarded as being caused by Xie Qi 邪氣, pernicious Qi. If the body is replete with healthy Qi, it should not readily succumb to pernicious Qi.

Meridians

The body is traversed by a number of channels, Jing 經, through which flows the Qi. The etymology of Jing 經 is informative. To the left of the character is the radical 糸 Mi, itself comprising two primitives: the upper part, 夂 Yao, is two cocoons, 厶 Si, wound together to give the lightest of silk threads, and the lower part 丩 is an image of several small threads, which are to be twisted together to produce a stronger one. Thus, the radical indicates a strong, fine thread. The right side of the character 經 imparts the phonetic component Jing and at the same time is an image of a current of water 川 flowing under the ground. Thus, Jing 經 is a conduit, like a strong, fine, silk thread, carrying a flow, in this case, of Qi, beneath the surface of the body.

There are a number of different types of meridians, but this is not a book about acupuncture; it is not the place to go into these sub-categories in any detail. Very briefly and very simply:

- **MAIN MERIDIANS** run longitudinally over the surface of the body, but have internal branches which penetrate the organs from which they derive their names. Thus, although the Large Intestine meridian's superficial route runs from the tip of the index finger to the side of the nose, an internal branch separates at the collar-bone and passes down through the abdomen into the colon. Main meridians connect a series of related acupuncture points.
- **CONNECTING MERIDIANS** branch out from main meridians. Significantly, they run transversely between Yin/Yang pairs of main meridians.
- **EXTRAORDINARY MERIDIANS** do not connect directly with the organs, and are described in the classics as not comprising their own points. Instead, they each connect with a number of points on various main meridians. Because of this, they are able to serve as canals and reservoirs and, in acupuncture, it is possible to use them to adjust Qi imbalances between the main meridians.
- **MUSCLE MERIDIANS** do not enter the organs, but run only through the muscles.



Yin Yang Diagram

Yin and Yang

Many readers will have heard of Yin and Yang and be familiar with the Yin Yang diagram. The etymologies of Yin 陰 and Yang 陽 give clues as to their extended meanings in Chinese medicine. On the left of each character is the radical 阝 indicating “mound” or “hill”. On the right, Yin 陰 has 今 Jin, meaning “present” or “presence”, and 云 Yun, “clouds”. The whole character indicates the presence of clouds over a hill and, therefore, shady, cool conditions. In contrast, on its right, Yang 陽 has 旦 Dan, an image of the sun 日 rising above the horizon 一, with 勿¹ rays shining down from it. The whole character indicates sunshine and warmth on a hillside; the south side of the hill. In Chinese medicine these meanings are extended. For example:

Yin:	Dark	Night	Female	Cold	Descending	Substantial	Body
Yang:	Light	Day	Male	Hot	Ascending	Insubstantial	Spirit

The Five Elements

The Five Elements (Wu Xing 五行) model refers to a pentagonal arrangement of five “elements” interpreted in two cycles: a creative cycle:

- Metal→Water→Wood→Fire→Earth→(Metal),

and a controlling cycle:

- Water→Fire→Metal→Wood→Earth→(Water).

The model is based upon natural phenomena. For example, wood creates fire, because it serves as fuel; water creates wood, because trees need it to grow; but water controls fire, and earthen banks regulate water by confining it to rivers and lakes. The nature of controlling is regulatory rather than oppressive or extinguishing. As these examples show, the name Five Elements is a misnomer, because the concept relates to the relationships between pairs of elements, not the elements as phenomena in isolation. The Chinese term Wu Xing reflects this, in that Xing 行 means “action”.

¹ By itself, as a character, 勿 is pronounced Wu and means “not”. In this case, it is simply an image of rays emanating downwards. Hence, no phonetic element is indicated.

... and two further pages from Section II

Laboratory research shows that its main phytochemical component, the alkaloid berberine, has an antibacterial effect especially against intestinal bacteria. Also, it acts on the gastric mucosa in such a manner as to produce an antidiarrhoeal effect.

In looking through the monographs, readers can make comparisons between the Chinese and biomedical actions and applications. Correspondences are apparent.

The General Lack of a One-to-One Correspondence

Whereas biomedicine focuses on naming illnesses, Chinese medicine sometimes names them and other times describes them. As a result of this, a single Chinese medical condition may equate to several biomedical named diseases. Conversely, a single, named biomedical disease often equates to a range of Chinese medical descriptions. Thus:

- a) a damp-heat condition in the Spleen may be given a biomedical diagnosis of gastroenteritis, dysentery, or ulcerative colitis;
- b) Liver fire ascending may manifest as hypertension, Ménière's disease, migraines or glaucoma.

Conversely:

- a) dysentery may be due to a damp-heat or damp-cold attack on the Spleen;
- b) gastroenteritis may be due to an accumulation of a heat-cold conflict in the Stomach, accumulation of heat and water in the Stomach, accumulation of damp-heat in the Spleen, deficiency of the Spleen with cold attack etc.;
- c) hypertension may be due to excess Liver Yang ascending, deficient Yin failing to restrain the Yang, or accumulation of phlegm and dampness;
- d) coma, from the Chinese medical perspective, is principally divided into raging internal heat, which needs to be withdrawn from the body, and collapse of the Yang, which requires moxibustion¹ to put heat into the body.

In all cases where there are multiple possible causes of a named biomedical illness, a specific Chinese medical aetiology must be determined if a treatment prescription is to be devised. It follows that the assessment of the value of a certain herb or prescription in treating a named biomedical condition is meaningless unless it is based upon a Chinese diagnosis.

The Classification of Diseases in Classical Chinese Medicine

At the level of individual symptoms and illnesses, the preceding text demonstrates, notwithstanding the difference in terminology, parallels between the classical Chinese medical and biomedical systems. At the level of disease classification, the correspondence is still more evident.

At the time of the HUANG DI NEI JING 黃帝內經 (*The Yellow Emperor's Classic of Internal Medicine*) (Anon., ca. first century BC), diseases were classified in only a simple way. The orderly arrangement of this early text in the edition prepared by Yang Shang-shan 楊上善, the HUANG DI NEI JING TAI SU 黃帝內經太素 (*The Yellow Emperor's Classic of Internal Medicine: Absolute Essence*) (ca. 600 AD), reveals this neatly in the sequence of its contents. Conditions include:

- injuries caused by external cold, heat or wind (i.e. acute febrile disorders corresponding to biomedical illnesses such as upper respiratory tract infections, gastro-enteric disorders, malaria); along with
- miscellaneous illnesses, including headaches, eye pain, hearing difficulties, nosebleeds, knee pain, back pain, asthma, diabetes, epilepsy, insanity, boils and abscesses, and so on.

The primary distinction into acute infective illnesses and miscellaneous indicates the importance of the former as a particular cause of mortality in those times.

¹ The combustion of moxa (艾 艾 dried leaf of *Artemisia argyi* H. Lévl. & Vaniot, Compositae, ground into a woolly mass) over selected parts of the body.

By the time of the eminent Han dynasty physician Zhang Zhong-jing 張仲景 (142 – 222 AD), disease classification had not progressed greatly. His work, the SHANG HAN ZA BING LUN 傷寒雜病論 (*Discussion of Injury by Cold and Miscellaneous Illnesses*) (ca. 200 AD) devotes much, close attention to cold-induced febrile disorders, in particular the common cold, infectious gastrointestinal disorders and their potential complications if not treated early¹. The section on miscellaneous disorders conspicuously pares off three adjacent chapters on problems of gynaecology and pregnancy, thereby introducing a further level of classification.

The QIAN JIN YI FANG 千金翼方 (*Assisting Prescriptions Worth a Thousand Pieces of Gold*) (late seventh century), by the Tang dynasty physician Sun Si-miao 孫思邈, shows a considerable increase in the range of illnesses understood, and a further refinement of their classification. The book has sections on gynaecology; obstetrics (including the treatment of post-partum problems such as agalactia and mastitis); paediatrics; disorders of ears, nose, throat, eyes, teeth and mouth; injury by wind and cold (i.e. acute febrile disorders); illnesses arranged by organ: Heart, Lung, Liver, Kidney, Bladder, etc.; oedema; urinary disorders (e.g. the biomedical equivalents of urinary retention, cystitis, urolithiasis, haematuria); diabetes; infected cutaneous lesions (e.g. carbuncles, erysipelas); and so on.

By the time of the YI ZONG JIN JIAN 醫宗金鑒 (*Medical Ancestry's Golden Mirror*) (1742), by the Qing dynasty physician Wu Qian 吳謙, a further distinction had been introduced. In that work, the primary division is into “external medicine” and “internal medicine”. The external category is largely composed of dermatopathies (e.g. abscesses, ulcers, moles, and the Chinese medical equivalents of psoriasis, urticaria, vitiligo, scabies), but also includes scrofula, nasal polyps, oral and lingual neoplasms, breast carcinoma, frostbite, scalds and insect bites. Internal problems include the disorders noted for the QIAN JIN YI FANG (above), but with a section on traumatology and bone-setting. There is also a substantially differentiated consideration of ophthalmology showing recognition and treatment of biomedical problems such as nebulae, cataracts, conjunctivitis and conjunctival scars, keratitis, blepharitis, and nyctalopia (poor night-vision).

Aside from these named texts, introduced here to illustrate not only the breadth of understanding, but also its progressive expansion and increasing sophistication over the centuries, other works from the same periods include sections on:

- toxicology (e.g. the treatment of poisoning by contaminated or decaying foodstuffs, heavy metals, overdosing of toxic officinals);
- parasitology (intestinal, hepatic and cutaneous);
- cardiology, as indicated by “Heart and thorax disorders” (e.g. chest pain, tachycardia and palpitations), and
- dietetics.

A survey of classical texts reveals the steady evolution of an increasingly sophisticated, systematic and cohesive system of medical understanding. It is quite clear that, even by the Tang (618 – 906 AD) and Song (960 – 1279 AD) dynasties, classical Chinese medicine had direct equivalents of many, modern biomedical categories: dermatology, traumatology, gynaecology & obstetrics, paediatrics, ear nose & throat conditions, ophthalmology, genito-urinary medicine, acute infectious disease, toxicology, cardiology and parasitology. This categorisation and range of conditions is barely distinguishable from the array of departments to be found in modern, biomedical hospitals. The principal difference between classical Chinese medicine and biomedicine manifests in the

¹ His emphasis on the differentiation and treatment of acute febrile disorders reflects two things. First, their prevalence and seriousness as a threat to life at that time, and second, that he had himself lost many relatives to this category of illness. It was this latter fact that first inculcated his determination to study medicine.

The first page of Section III

SECTION III

AN INTRODUCTION TO BOTANY

Botany, like Chinese medicine, has its own particular language. A range of conventions and abbreviations pertains to nomenclature and taxonomy, and descriptions of plant morphology require specific, anatomical terminology. Unfamiliarity with botanical language may render botanical names and synonymies, and descriptions of plants inaccessible, or even unintelligible. This section:

- a) Introduces the uninitiated to the origins of botany and its systems of classification.
- b) Explains the language and conventions of botanical nomenclature.
- c) Introduces, by illustrated explanation, principal terms of basic plant morphology, with especial reference to the Umbelliferae.

A Historical Note on the Origins of Botany and the Role of Herbalists in Europe

The Beginnings of Botany and Its Language

The history of botany dates back over two thousand years. There is evidence that the Chaldeans¹, Egyptians and Greeks recognised botany as a subject of study. As noted above (pp. 29-30), the *HISTORIA PLANTARUM* (ca. 300 BC) of the Greek philosopher Theophrastus of Eresos (ca. 372 – 288 BC) essentially founded the study of botany. Indeed, he is known as the “Father of Botany”. Pliny the Elder (23 – 79 AD), a Roman writer and philosopher, wrote about plants in Latin. His *HISTORIA NATURALIS* (ca. 60 AD) included translations into Latin from the work of Theophrastus. From these roots, arose the Graeco-Latin botanical nomenclature of plants that is used today. Although, linguistically, the story is more complex, involving as it does divergences and evolutions from classical and mediaeval Latin into the modernised and extended Latin used by Linnaeus (1707 – 1778), Pliny and Theophrastus can, nevertheless, be regarded as its progenitors².

Following these early and seminal developments in botany, further progress in Europe was minimal until the sixteenth century, when the Swiss physician Otto Brunfels (1464 – 1534) rather restored it as a subject of merit. In Britain, William Turner (?1508 – 1568), a naturalist and theologian, known as the “Father of English Botany”, began to lay the foundations of classification. However, his book, *A NEW HERBALL*³ (in three parts: 1551 – 1568), arranged plants according to their medicinal values, not in the botanical fashion used today. Not long thereafter, the Flemish physician Rembert Dodoëns (1516 – 1585), having turned from his primary qualification in medicine towards botany, produced his *STIRPIUM HISTORIAE PEMPTADES SEX SIVE LIBRI XXX* (1583). Although this is considered to be one of the foremost botanical works of the late sixteenth century, it too arranges plants

¹ The Chaldeans originally occupied the area of the Persian Gulf and founded the New Babylonian Empire (625 – 539 BC). Their culture produced the famous Hanging Gardens of Babylon.

² Readers interested in a detailed, historical discussion of the developments of Graeco-Latin botanical nomenclature are referred to Stearn, 1992.

³ Full title: *A NEW HERBALL: WHEREIN ARE CONTEYNEDE THE NAMES OF HERBES IN GREKE, LATIN, ENGLISHE, DUTCH, FRENCH, AND IN THE POTECARIES AND HERBARIES LATIN, WITH THE PROPERTIES DEGREES AND NATURALL PLACES OF THE SAME.*

... and some samples from Section III

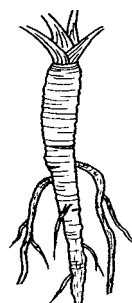
Underground Parts

Underground parts include roots, rhizomes, tubers, corms and bulbs. Corms and tubers do not feature in the species monographed in this work.

Roots are normally underground. They serve to anchor a plant, absorb water and minerals into the plant, and act as a food store. In monocotyledons¹, roots are often a mass of fine branches – a “fibrous root” (see illus.). In dicotyledons², there is usually a clear primary root, the “taproot” (see illus.), from which diverge smaller secondary rootlets. The carrot, root of *Daucus carota* subsp. *sativus* (Hu Luo Bo, Monograph 19), is an example of a taproot swollen with food reserves.



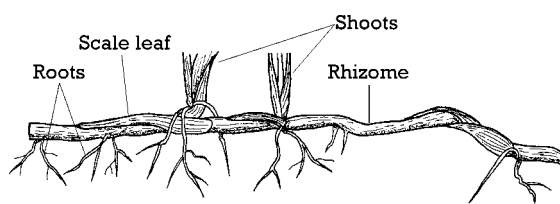
Fibrous root



Taproot

What is or is not a stem can cause confusion. To the layperson, the portion of a plant that is above ground, bears leaves and is vertical or climbing is usually thought of as a stem, whilst the portion that is underground is regarded as a root. In fact, stems are often underground. In the case of the banana (*Musa paradisiaca* L. var. *sapientum* Kuntze, Musaceae), for example, the apparently erect stem is nothing more than the loosely overlapping bases of enormous foliage leaves. The true stem is underground, but erect. In Chinese herbal medicine, underground organs that are, in fact, modified stems are encountered frequently. Some examples follow.

Rhizomes (see illus.) are specialised, horizontal, underground stems lasting for more than one growing season. They confer the possibility of vegetative propagation, by being able to grow along horizontally and producing the root and shoot systems of a new plant.



Rhizome

Roots are different from rhizomes not only in that they are, essentially, vertical structures, but also in that, unlike rhizomes, they do not have the leaf-scars and buds which are typical of stems. Many plants have both roots and rhizomes, an example is *Ligusticum sinense* (Gao Ben, Monograph 11). Another example of a rhizome used in Chinese herbal medicine is Huang Jing 黃精 (Siberian Solomon's seal) rhizome of *Polygonatum sibiricum* Redouté, Liliaceae.

Tubers (see illus., facing page) are the swollen portion of a stem or root which, unlike rhizomes, last only one growing season. Those occurring in successive years neither arise from old ones, nor bear

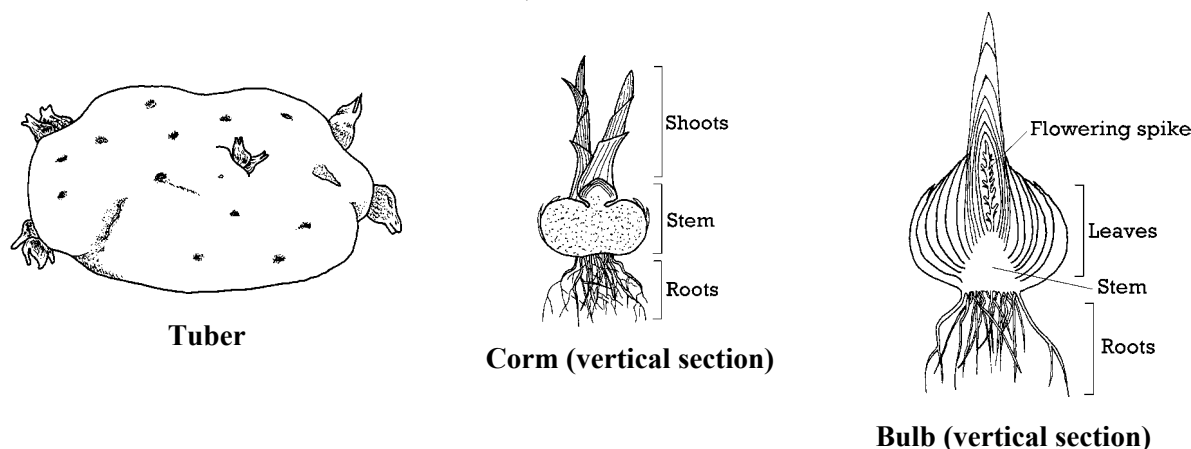
¹ Plants with only one cotyledon (i.e. seed-leaf) on the germinating shoot (e.g. grasses).

² Plants with two cotyledons on the germinating shoot (e.g. the majority of herbs, shrubs and deciduous trees).

any constant relation to them. A common example is the potato (tuber of *Solanum tuberosum* L., Solanaceae). An example of a tuber commonly used in Chinese herbal medicine is Ban Xia 半夏 tuber of *Pinellia ternata* (Thunb.) Breitenb., Araceae.

Corms (see illus.) like tubers, are short, underground swollen portions of a stem of one year's duration. Unlike tubers, those occurring in successive years arise at the top of and close to an old one. An example of a plant with a corm is the crocus, *Crocus sativus* L., Iridaceae. The stigmas (see illus.: "Stereotypical flower", p. 105) of this plant, under the name Fan Hong Hua 番紅花 (known in the West as "saffron") are used in Chinese herbal medicine.

Bulbs (see illus.) are underground organs consisting of a short stem bearing a number of swollen, fleshy leaf-bases, the sum of which encloses the next year's bud. A common, culinary example is garlic. An example of a bulb used in Chinese herbal medicine is Bai He 百合 bulb of *Lilium brownii* F.E. Brown var. *colchesteri* Wils., Liliaceae¹.

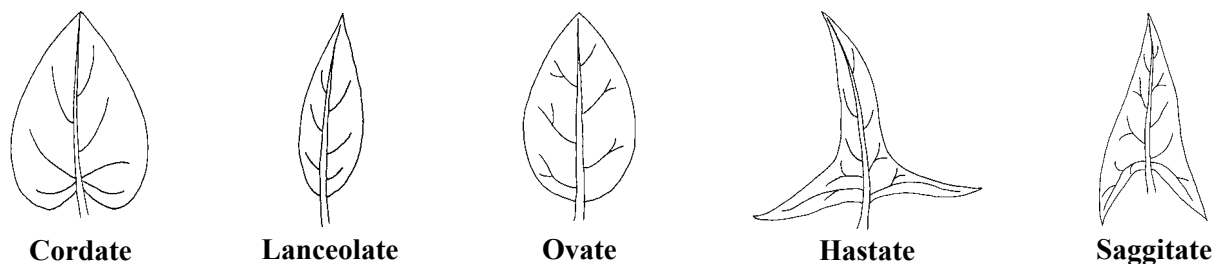


Above-ground Parts

Above-ground parts include stems, leaves, leaf-stalks, flowers and fruits.

Stems are usually the principal vertical axes of plants. They can, however, be horizontal and creeping, as in the case of *Centella asiatica* (Ji Xue Cao, Monograph 13), or climbing and entwining, as with *Trachelospermum jasminoides* (Lindl.) Lem., Apocynaceae, the leaf and stem of which constitute the herb Luo Shi Teng 絡石藤. They bear buds and leafy shoots.

Leaves (see illus.) diverge from stems at nodes and may do so singly, or in pairs or groups. They are often characterised according to their outline shape and the nature of their "margin". Historically, there have been many variations on categorisation by shape. A few examples serve to illustrate the idea. Cordate (*cor*, indicating a heart-shape), lanceolate (indicating a lance-shape), ovate (*ova*, indicating an egg-shape), hastate and saggitate (both terms referring to "arrow-heads").



¹ Brummitt & Powell (1992) do not list F.E. Brown and, although they list 38 authors with the surname Wilson, none of them is shown as taking the standard abbreviation "Wils." It is uncertain who is intended in this case.

The first page of Section IV

SECTION IV

AN INTRODUCTION TO PHYTOCHEMISTRY

Increasingly, books list the phytochemical constituents of herbs, and journals report on the effects of these various constituents. Suppliers of herbs use chromatographic assays of herbs as a means of quality control. Phytochemistry rather lies at the interface between botany, herbal medicine and the physiological and pharmacological interpretation of herbal effects. Yet, phytochemical names are often long and confusing; they can seem like an alien language, and herbalists might not always have qualifications in chemistry. In an attempt to bridge this gap this section:

- a) Considers the advantages that modern phytochemical analyses may confer upon an ancient tradition and concludes that, despite some shortcomings, there is potential for net benefit.
- b) Introduces the principal types of organic compounds and their nomenclature.
- c) Introduces the primary physical characteristics and pharmacological actions of principal phytochemical groups.
- d) Introduces chromatography and mass-spectrometry as means of producing phytochemical fingerprints.

[Information is predominantly derived from: Cooper & Johnson (1998), Harborne (1973), Heywood (1971), Housecroft & Constable (2002), McMurray (2000), Mills (1993), and Mills & Bone (2000).]

The Roles of Phytochemistry and Phytochemical Pharmacology in Herbal Medicine

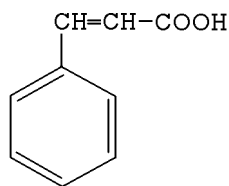
The complexity of multiple chemical interactions in herbal prescriptions may currently put a comprehensive understanding of phytopharmacology beyond the scope of scientific investigation. However, the production of lists of phytochemical constituents of parts of plants is not without value. It is, at least, a necessary first step. Even as a first step, it already offers some potential advantages. A consideration of some of these follows.

Quality Control

Throughout the history of Chinese medicine, herbs have been subject to bio-degradation, and to unwitting or deliberate substitution. Xu Da-chun 徐大春, in his *YI XUE YUAN LIU LUN* 醫學源流論 (*A Treatise on the Origins and Development of Medicine*) (1757), comments on the occurrence of substitution. He notes that whereas in ancient times, officinals were not sold in markets, but collected and prepared by individual physicians, in later times, less-skilled people sold them from shops. He further notes that such people might mistakenly supply a wrong herb, substitute an unsuitable or less effective variety, or even deliberately substitute a similar herb to cheat people. Hence, the ability to assess an officinal's quality and identify the presence of any substituted materials has long been important. The subject of herb recognition is known as "pharmacognosy". Previously, pharmacognostic skills relied upon visual characteristics and taste. In modern times, phytochemical profiling and the use of chromatographic "fingerprints" represent more reliable techniques for verification and quality control. A set of phytochemical fingerprints potentially offers several advantages:

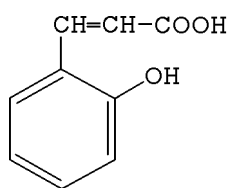
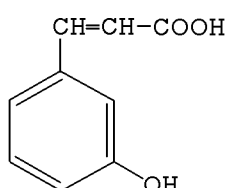
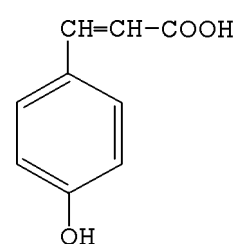
- 1/ An opportunity for quality control and the detection of adulterant herbs. Huang *et al.* (1999)

... and some samples from Section IV

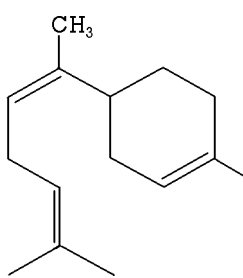
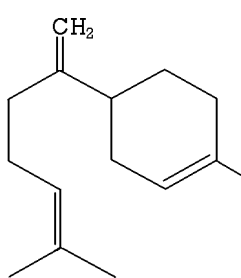
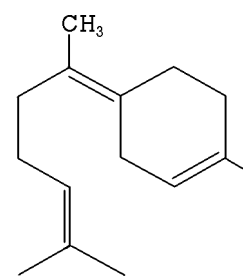
**Cinnamic acid**

By way of example, the stem & leaf of *Foeniculum vulgare* (Xiao Hui Xiang, Monograph 23) contains *o*-coumaric acid, whilst the root of *Anethum graveolens* (see Qin, Monograph 21) contains *p*-coumaric acid. These are both hydroxylated derivatives of cinnamic acid, which is itself recorded as being present in Xiao Hui Xiang. (See illus. left and below.)

Under the IUPAC system, the *ortho*-, *meta*- and *para*-forms of coumaric acid are named 2-hydroxycinnamic acid, 3-hydroxycinnamic acid and 4-hydroxycinnamic acid, respectively. Both forms of names may be encountered in texts. They are partial systematic names, as cinnamic acid itself is a trivial name.

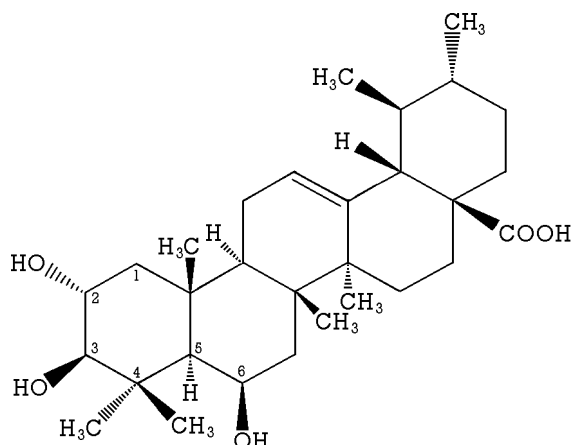
***o*-Coumaric acid
(2-Hydroxycinnamic acid)*****m*-Coumaric acid
(3-Hydroxycinnamic acid)*****p*-Coumaric acid
(4-Hydroxycinnamic acid)**

The Prefixes α -, β -, γ - and δ - Also commonly encountered in the context of constitutional isomers are α -, β -, γ - and δ - prefixes, as applied to isoprene compounds (monoterpenes, sesquiterpenes etc.). In isoprene compounds, double-bonds distribute differently between carbon pairs, with a resultant effect on the location of hydrogen atoms. The monoterpenes α -pinene and β -pinene (not illustrated), which occur in seven and four, respectively, of the monographs in this text (see Appendix 8 for details), and the sesquiterpene isomers α -, β - and γ -bisabolene provide suitable examples.

 **α -Bisabolene** **β -Bisabolene** **γ -Bisabolene**

In more recent times, notably since the CHEMICAL ABSTRACTS (Anon. 1907 – 2002) Ninth Collective Index period (1972 – 1976), the use of α - and β - has been used to denote the position of a substituent below or above the plane of a molecule. Substituents labelled α - are considered to be below the plane whilst those labelled β - are above. This application depends upon an agreed, standardised orientation of the parent molecule. An example of a compound in the current work exhibiting this nomenclatural feature is the triterpene madasiatic acid ($2\alpha,3\beta,6\beta$ -trihydroxy-12-ursen-28-oic acid), which is recorded in an unspecified part of *Centella asiatica* (see Ji Xue Cao, Monograph 13). “ $2\alpha,3\beta,6\beta$ -trihydroxy-” indicates that the hydroxyl substituent on the second

carbon is below the plane of the molecule (a hatched triangle goes into the page), whilst those at the third and sixth carbon atoms are above its plane (a solid triangle comes out of the page).



Madasiatic acid
($2\alpha,3\beta,6\beta$ -Trihydroxy-12-ursen-28-oic acid)

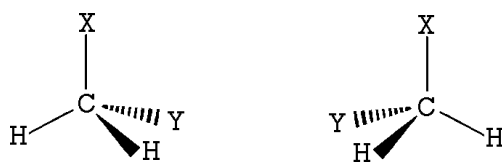
Although, at first, it may seem confusing to have like-terms indicating different phenomena in systematic names, what is intended is usually apparent from the context. In the foregoing examples, α -bisabolene clearly refers to an isomeric form of bisabolene, as neither carbon atom nor substituent is specified. Conversely, “ $2\alpha,3\beta,6\beta$ -trihydroxy-” is quite unambiguously referring to the orientation of hydroxyl groups at specified carbon atoms: C2, C3 and C6.

Stereoisomers

Stereoisomers are compounds with the same molecular formula, with atoms and functional groups connected in the same way, but with a different spatial arrangement. The phenomenon is represented by two categories: ENANTIOMERS, which are mirror-image stereoisomers, and GEOMETRIC ISOMERS, which are non-mirror-image stereoisomers. Each category has its own biochemical characteristics and pharmacological impact, and each is reflected in its own nomenclatural way. MESO-FORMS and DIASTEREOMERS are special cases of isomerism; they are also described in the following text.

ENANTIOMERS

Enantiomers are isomers that occur in mirror-image pairs. The term comes from the Greek *enantio* “opposite” and *meros* “sharing”, indicating that substituent groups are shared, but at opposite locations. The left and right hands of a person are an enantiomeric pair: same fingers, opposite spatial distribution. This left-hand/right-hand relationship is termed “chirality”, it comes from the Greek *kheir* “hand”. Compounds comprising molecules in enantiomeric pairs are “chiral”. An atom about which chirality manifests is a “chiral centre”. There can be more than one chiral centre in a molecule (for a simple example, see the illustrations of tartaric acid, p. 139). The most common cause of chirality in a molecule is the presence of a carbon atom that is bonded to four different substituents; however, even three different substituents can confer the property.



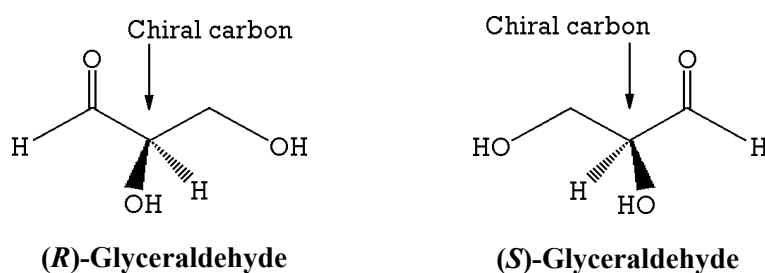
An enantiomeric pair of molecules

Different Chemical Properties – The two forms of an enantiomeric pair are indicated by the use of (*R*)- and (*S*)- prefixes to (or within, if there are multiple chiral centres) its chemical name¹. The means of determining which to apply are explained below. Although enantiomers have the same physical properties, they have different chemical properties. Pharmacologically, this can be critically important. For many chiral drugs only one enantiomer has the desired therapeutic properties. The second enantiomer may be inactive, beneficially active in a different way, or produce undesired side-effects. Three pharmaceutical examples follow.

- Regarding the drug ibuprofen, the *S* form is analgesic and anti-inflammatory, whilst the *R* form is inactive in the human body. Further, the presence of (*R*)-ibuprofen in the mixture substantially slows the rate at which (*S*)-ibuprofen takes effect in the body: from 12 minutes to 38 minutes.
- In the drug fluoxetine (trade name Prozac), when the *R* and *S* forms are present in equal amounts (a phenomenon known as a “racemate” or a “racemic mixture”) the drug is effective as an anti-depressant, but has no action against migraines. As a pure *S* enantiomer, however, the drug works well in preventing migraine.
- In the case of thalidomide, the *S* enantiomer is sedative and has antinausea properties, whilst the *R* form has teratogenic side-effects on foetuses. (*R* and *S* forms of thalidomide are depicted on the facing page.)

Whereas, in the natural world, chiral compounds are usually only produced in one enantiomeric form, in the laboratory, such compounds have generally been produced as racemic mixtures. Although stereo-selective methods for the production of single enantiomers are now being devised, this does not always offer a solution. A stereo-selective sample of (*S*)-thalidomide, introduced to the pH conditions of the human body, spontaneously racemises and therefore leads to the same teratogenic problems as occur if the original racemate is administered.

Determination of *R* and *S* Forms – In order to convey information about the structural configuration of chiral carbon atoms, three men, Robert Sidney Cahn², Sir Christopher Kelk Ingold³ and Vladimir Prelog⁴, devised a notational system: the so-called “Cahn-Ingold-Prelog notation”. Glyceraldehyde, the simplest monosaccharide, lends itself to an explanation of the system.



The rules are:

- 1/ Prioritise substituents or atoms according to atomic number⁵.

¹ *R* and *S* descriptors refer to the sequential arrangement of groups around a chiral carbon. *R* means *rectus*, indicating a clockwise arrangement, and *S* means *sinister*, indicating an anticlockwise arrangement.

² Robert Sidney Cahn (1899 – 1981) was born in England and received a doctoral degree in France. He became editor of the British JOURNAL OF THE CHEMICAL SOCIETY.

³ Sir Christopher Kelk Ingold (1893 – 1970) was born in Ilford, England and received his D.Sc. at the University of London. He spent most of his career at University College, London.

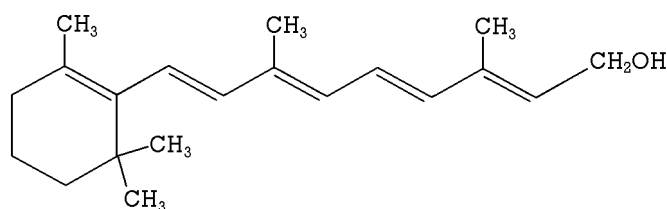
⁴ Vladimir Prelog (1906 – 1998) was born in Sarajevo, Bosnia. He was professor at the Swiss Federal Institute of Technology in Zurich (1941 – 1976). In 1975, he received the Nobel prize in chemistry for his achievements on the stereochemistry of alkaloids, antibiotics and enzymes.

⁵ The atomic number is the number of protons in an atomic nucleus. For a fuller note of atomic composition and element notation, see p. 199*m*1.

... and a little more from Section IV

have irritant properties to mucosal surfaces and can cause contact allergic reactions such as oral ulceration and dermatitis. Kletter & Kriechbaum (2001) report the daphnane diterpenes found in *Stellera chamaejasme* L., Thymelaeaceae, as having piscicidal, antitumour, antileukaemia and antiviral effects. Diterpenes also occur as alkaloids. Examples are the proto-alkaloids¹ mesaconitine and hyaconitine in Fu Zi 附子 lateral root of *Aconitum carmichaeli* Debeaux, Ranunculaceae.

The only diterpene recorded in the current work is vitamin A (retinol), which is noted as being present in the root of *Angelica sinensis* (Dang Gui, Monograph 7). The carotenes, which are tetraterpenes and have a base structure of C₄₀H₆₄, are present in almost all green plants. They are, in effect, two diterpenes linked tail-to-tail, (compare the illustration of vitamin A, below, with that of β-Carotene, p. 154). As such, carotenes serve as precursors for vitamin A, to which they can be converted by enzymes in the liver. It is not clear, therefore, whether vitamin A is considered to exist in free-form in Dang Gui, or whether it appeared following the fission of carotenes in a sample.



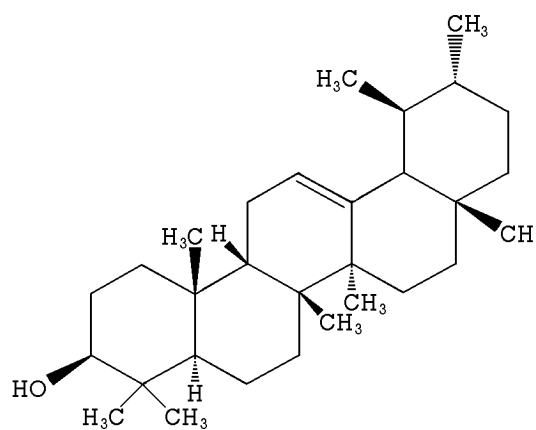
Vitamin A (retinol)

Triterpenes

Triterpenes have a C₃₀H₄₈ base structure. The class comprises the TRUE TRITERPENES and the STEROID TRITERPENES. Both groups occur in isolation and as glycosides.

TRUE TRITERPENES

Although many true triterpenes are known, only a few are of widespread distribution. In particular, triterpenes occur in the waxy coatings of leaves and on fruits. Like diterpenes, they also occur in the resins of barks and trees, and in latex. An example of a widespread triterpene is α-amyrin, which is present in the ripe fruit of *Foeniculum vulgare* (Xiao Hui Xiang, Monograph 23). There are over one dozen sub-types of triterpene; they often take their names from a particular plant or group of plants: meliacane triterpenes, occur in *Melia azedarach*² L., Meliaceae; cucurbitacin triterpenes, are notably present in species of the Cucurbitaceae (the gourd family); fernane triterpenes, are present in a number of ferns, and so on. Sub-types are generally not restricted only to one plant group, but probably took their names from the plant group in which they were first identified.



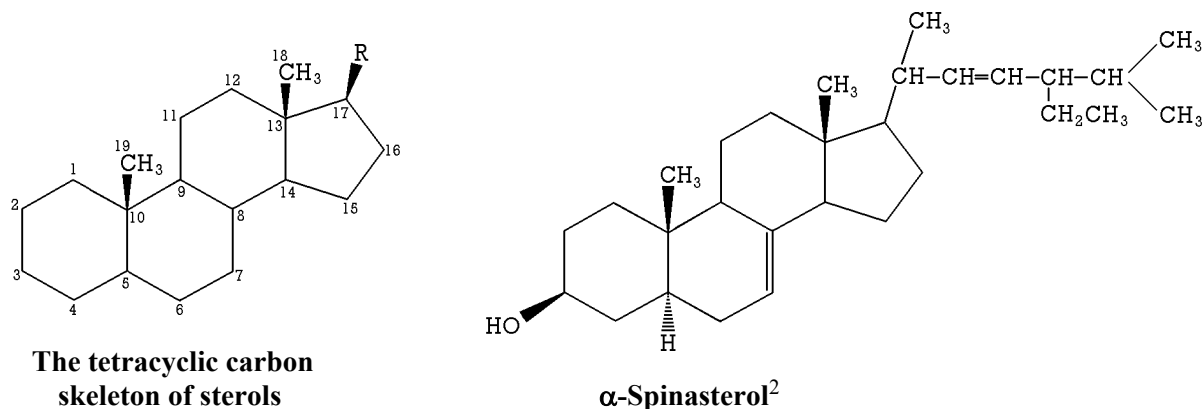
α-Amyrin

¹ Proto-alkaloids are so called because, although they are nitrogenous, the nitrogen atom is not in an aromatic heterocycle, as it is in the true alkaloids.

² Ku Lian Pi 苦楝皮, the bark of the root and tree, was first recorded in the SHEN NONG BEN CAO JING 神農本草經 (*Shen Nong's Herbal Classic*) (Anon., ca. first century BC).

STEROID TRITERPENES

Steroid triterpenes are lipids with a common tetracyclic carbon skeleton. The illustration shows the standard numbering of the tetracycle. The “angular methyl groups”, C18 and C19, bonded at C10 and C13, respectively, are an almost constant feature of steroids; a notable exception is the estrane group (i.e. that on which the oestrogens are based), which has H, not CH₃ at C10. C3 often has a hydroxyl group, and that molecule forms the basis of the “sterols”, (steroid alcohols). R represents various side chains¹. By way of example, α -spinasterol exhibits the steroid tetracycle, both angular methyl groups, a hydroxyl at C3, and an R substituent of a form that places it in the “cholestane group” – the group into which cholesterol falls.



The phytosterols, naturally occurring plant sterols, are almost ubiquitous in their occurrence in higher plants. They can occur in free or compound forms. Examples of free-form sterols are:

- α -spinasterol, in the root of *Bupleurum chinense* (Chai Hu, Monograph 1);
- β -sitosterol, in Chai Hu; the root of *Saposhnikovia divaricata* (Fang Feng, Monograph 3) and the root of *Angelica sinensis* (Dang Gui, Monograph 7), and root & rhizome of *Notopterygium incisum* (Qiang Huo, Monograph 5);
- stigmasterol, in unspecified parts of *Oenanthe javanica* (see Shui Qin, Monograph 20) and the ripe fruit of *Foeniculum vulgare* (Xiao Hui Xiang, Monograph 23); and
- spongesterol, in unspecified parts of *Angelica decursiva* (see Qian Hu, Monograph 2).

The hydroxyl group at C3, in the sterols, is vulnerable to attack by other groups. Attack by sugars leads to the formation of glycosides. Attack by carboxylic acids leads to the formation of esters. Examples of compound sterols are:

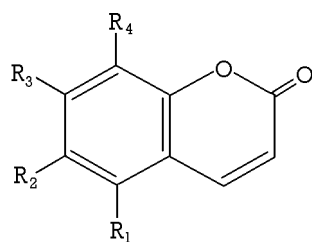
- daucosterol, a β -sitosterol glucoside, in the fruit of the *Daucus carota*, the wild carrot, (see Monograph 19);
- stigmasteryl palmitate, an ester of stigmasterol and hexadecanoic acid, in the root of *Foeniculum vulgare*.

Broadly speaking, phytosterols seem to be most useful as dietary components in the prevention of cholesterol-related diseases, rather than in specific medical interventions. Wong (2001) shows that phytosterols have a general effect of the lowering of serum cholesterol. Awad *et al.* (2001) show,

¹ For example: R = H \rightarrow androstane steroids (e.g. testosterone). R = CH₂CH₃ \rightarrow pregnane steroids (e.g. progesterone). R = H, and C10 bonded to H instead of CH₃ \rightarrow estrane steroids (e.g. oestradiol).

² A note on nomenclature: In systematic nomenclature, the nature of the R group at C17 primarily determines the base name of an individual sterol. In α -spinasterol: there is an ethyl group at C24 (**24-ethyl-**); the hydrogen at C5 is below the plane of the molecule, so is α - (**-5 α -**); R carries the “cholestane” group (**-cholesta-**); there are alkene bonds at C7 and C22 (**-7,22,-dien-**); the hydroxyl group at C3 is above the plane of the molecule, so is designated β - (**-3 β -ol**). Hence, α -spinasterol’s systematic name is 24-ethyl-5 α -cholesta-7,22-dien-3 β -ol.

... and a last sample from Section IV



Coumarins

R ₁	R ₂	R ₃	R ₄	Coumarin
H	H	H	H	Coumarin ¹
H	H	OH	H	Umbelliferone
H	OCH ₃	OH	H	Scopoletin
H	CHO	OCH ₃	H	Angelical
H	H	OCH ₃	CO-CH=CH(CH ₃) ₂	Osthol(e)
OCH ₃	H	OCH ₃	CO-CH=CH(CH ₃) ₂	Angelicone

Scopoletin and umbelliferone are particularly common and widespread in higher plants.

With regard to the correspondence between classical claims and modern research findings, the coumarins present a mixed picture:

- Scopoletin, present in the roots of *Angelica biserrata* and *A. dahurica* cvs. Qibaizhi & Yubaizhi, is indicated pharmacologically as having spasmolytic effects. Although Du Huo is recognised by both classical Chinese medicine and biomedicine as treating various kinds of seizures, spasms and joint spasticity, the source texts used do not attribute these effects to *A. dahurica* cultivars. Perhaps their use in this regard might be considered.
- Umbelliferone is recorded as having antifungal properties, though the umbellifers listed above as containing it are not ascribed antifungal applications, either classically or biomedically.
- Coumarin is ascribed antioedema, anti-inflammatory and immune-enhancing, anticancer activities. Although it occurs in *Hydrocotyle sibthorpioides*, of this list of actions, only the anti-inflammatory effect is attributed to the herb by the source texts used in compiling the monographs.

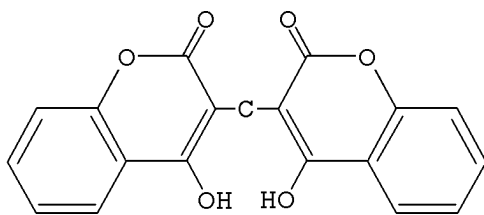
Coumarins as Anticoagulants – In recent times, coumarins have received attention in respect of their having anticoagulant properties and, therefore, of being contra-indicated for concurrent use with the anticoagulant pharmaceutical drug warfarin. However, the literature on the subject shows much conflict of opinion. The following text attempts to summarise the current position.

Dicoumarol² is a potent anticoagulant. Its discovery led to the development of the modern anticoagulant drug warfarin. Botanically, it is associated with the Leguminosae; in fact, a search of the phytochemical source texts used in researching the current book suggests it as being present only in the Leguminosae. Certainly, it is not recorded for any of the herbs monographed in this book. This is significant because, although dicoumarol is a coumarin, and coumarins are widespread in the Umbelliferae and Rutaceae, dicoumarol's undoubted anticoagulant property seems to be atypical of coumarins in general.

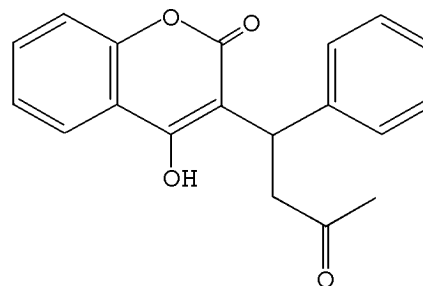
¹ A systematic name for coumarin is 2H-1-benzopyran-2-one (9CI). It reflects the fusion of 2[H]-pyran with a benzene ring and the presence of a ketone substituent at C2.

² Dicoumarol occurs in Mu Xu 苜蓿 above-ground parts of *Medicago sativa* L., Leguminosae, which was first recorded in the MING YI BIE LU 名醫別錄 (*Famous Physicians' Additional Records*) (ca. 500 AD) of Tao Hong-jing 陶弘景, but only upon its decomposition (Anon., 1984). Mu Xu is a diuretic and a lithagogue, but is not documented as having applications related to the vascular system or bleeding; this may reflect that it is not the decomposing herb that is indicated for use by classical Chinese herbals. The roots of the same plant, Mu Xu Gen 苜蓿根, which were first documented for medical use in the XIN XIU BEN CAO 新修本草 (*Newly Revised Herbal*) (659 AD) of Su Jing 蘇敬, according to source texts, do not contain dicoumarol. A further example of a plant containing dicoumarol is clover *Trifolium pratense* L., Leguminosae, the leaves and flowers of which, in both the fresh and dried state, contain dicoumarol (Anon., 1984). *T. pratense* is not documented in classical Chinese herbals, but the flowers are used in Western medical herbalism.

What sets dicoumarol apart from the coumarins recorded in the monographs of the current work (e.g. osthol(e), scopoletin, umbelliferone etc., see illus. on facing page), and what is mimicked by warfarin, is the presence of a hydroxyl group at C4. Mills & Bone (2000) say that this group is “an essential requirement (among others) for [dicoumarol’s] powerful anticoagulant activity”, and add that its absence accounts for the lack of such activity, to any significant clinical degree, in those coumarins which do not have it. As described below in greater detail (pp. 183-184), Mann (1992) explains that for a “lock and key” mechanism to work, allowing one molecule to mimic another, the presence of only two atoms in an appropriate spatial arrangement can suffice¹. The observation of Mills & Bone is certainly not without precedent.



Dicoumarol



Warfarin²

In apparent conflict with the suggestion of the criticality of the hydroxyl group at C4 is the report of Page & Lawrence (1999) that osthol(e), which has no substituent at C4, has strong antithrombotic activity and may potentially increase the risk of bleeding with anticoagulants. The authors go on to say that some coumarin derivatives (unspecified) have strong inhibitory effects on human platelets. They conclude that the true mechanism of the interaction of coumarins with blood-clotting is unknown.

Different again is the suggestion of Chan & Cheung (2000) who suggest that although “coumarins” do not by themselves have anticoagulant properties, they do potentiate the anticoagulant actions of warfarin, by increasing the affinity of the warfarin receptor site to the drug. The authors make no reference to a C4 hydroxyl group and direct their comment at “coumarins” in the generic sense.

It is possible that Mills & Bone (2000), Page & Lawrence (1999) and Chan & Cheung (2000) are all correct: coumarins with a hydroxyl substituent at C4 could be directly anticoagulant, whilst those without it (e.g. osthol(e), umbelliferone) might affect affinity of warfarin receptor sites as suggested by Chan & Cheung. However, if this were so, then fennel fruits (Monograph 23) and especially the widely and frequently eaten carrot (Monograph 19), both recorded by the source texts used in preparing the current work as containing the coumarin umbelliferone, might by now have attracted attention.

Vagueness in the Literature in the use of the Word Coumarins – To complicate the picture, in consulting the literature, considerable vagueness in the use of the term “coumarins” was encountered. Page & Lawrence (1999), for example, say of Dang Gui root of *Angelica sinensis* (Monograph 7) that “the root contains several natural coumarin derivatives, including oxypeucedanine, osthol(e), psoralen, and bergapten and two furocoumarin derivatives, sen-byak-angelicole

¹ Readers are also referred to the discussion of the flavonol thunberginol, below (p. 172), for another example involving the criticality of the presence and precise location of hydroxyl groups to a phytochemical’s pharmacological activity.

² A systematic name for warfarin is 4-Hydroxy-3-(3-oxo-1-phenylbutyl)-2H-1-benzopyran-2-one.

The first page of Section V

SECTION V

AN INTRODUCTION TO PHARMACOKINETICS

Medications, whether pharmaceutical or herbal, contain chemicals; the study of the pathways and effects of such chemicals in the body is known as pharmacokinetics. It may provide means both of promoting an understanding of classical Chinese herbal medical lore, and of reducing unnecessary risks arising from the co-administration of medicinal materials from different traditions. This section:

- a) Considers the brief history of pharmacokinetics and defines it.
- b) Introduces the salient features of pharmacokinetic processes.
- c) Examines the implications of the subject both within Chinese herbal medicine and between various medical systems, such as Chinese herbal medicine, biomedicine, Western medical herbalism and Ayurvedic medicine.

[Information is predominantly derived from: Curry (1980), Duffus (1980), Jack (1992) and Woolf (1999).]

Introductory Notes

Apology

The section may seem deficient in some regards. Specifically, it may seem lacking in information about herbs, with many of its explanations being met by tea, nicotine, coffee (the leaves and seeds of plants) and alcohol (a fermentation product of plants). This reflects the dearth of information found on the subject of phytopharmacokinetics (the pharmacokinetics of herbs). It reflects that the information that was found in connection with herbs did not show much connection with Chinese herbal medicine, as a logically coherent and organised system. Most research encountered concerned isolated chemical extracts from herbs, there is no reason to suppose that this will transfer reliably to herbal medicine. As explained below, the subject of phytopharmacokinetics is in its neonatal phase. A co-ordinated, multidisciplinary effort is needed if meaningful research is to be conducted. In a way, therefore, this is not an apology, but an acknowledgment of things as they are. The ethos of the current book is to facilitate the building of bridges between currently rather discrete disciplines, in the hope of promoting a more even continuum of information exchange.

Rationale for Study: Understanding the Interface

Because Chinese medicine is based upon an energetic rather than chemical model, it construes the passage through, and activity of herbs in, the body in energetic terms. For example, Gao Ben root & rhizome of *Ligusticum sinense* (Monograph 11) is pungent in flavour, warm in nature and is said to have a propensity to manifest its effects in the Bladder meridian. According to Chinese herbal medical theory, its pungent nature bestows upon it an ability to “scatter and disperse”. Similarly, its warm nature means it will tend to “oppose coldness and to dry dampness”¹. Its propensity to manifest its effects in the Bladder meridian² means that it will be more likely to “scatter and warm cold,

¹ For an introduction to the effects of the Five Flavours and the “nature” of herbs, see p. 51 and p. 52, respectively.

² For a discussion of “meridian tropism”, see pp. 57-60.

... and a sample from Section V

people died from heart-failure occurring as an abreaction between the drug and grapefruit juice. It is now known that grapefruit (*Citrus paradisi* Macfad., Rutaceae) and its juice inhibit both CYP3A4 (e.g. Bailey *et al.*, 2003) and CYP1A2 (e.g. Lown *et al.*, 1997). The effect is due to a number of phytochemicals: the flavone naringenin, and its glucoside, naringin; various furanocoumarins (e.g. bergamottin, 6',7'-dihydroxybergamottin, 6',7'-epoxybergamottin, geranyloxy coumarin); and the sesquiterpene nootkatone. Precisely which of these chemicals is most implicated is not yet understood. Early thoughts focussed upon naringenin and naringin. Later, attention shifted to bergamottin, but Bailey *et al.* (2003) note that this is not the primary substance, and Greenblatt *et al.* (2003) point to the CYP3A4 inhibitory potency of bergamottin as being much less than that of 6',7'-dihydroxybergamottin. Although conclusions have not been reached on the precise cause of cytochrome P450 inhibition, a number of summarial points can be made:

- Naringin is currently believed not to be a potent inhibitor of cytochrome P450 enzymes. However, upon bacterial hydrolysis, in the bowel, naringenin is released and this markedly inhibits CYP3A4 activity (Bailey *et al.*, 2000).
- Several furanocoumarins, notably bergamottin and its derivatives, are implicated to varying degrees (e.g. Bailey *et al.*, 2000; Greenblatt *et al.*, 2003).
- Most authors (e.g. Lown *et al.*, 1997; Lohezic-Le Devehat *et al.*, 2002; Greenblatt *et al.*, 2003) are in agreement that the cytochrome P450 inhibition reaction takes place in the intestines and impairs first-pass metabolism.
- Recovery time, following consumption of the compounds, is approximately three days (Greenblatt *et al.*, 2003).

In addition to these comments, information on two, more specific aspects of interaction between xenobiotics is documented: **the effect of timing of administration and the frequency of interactions.**

The Effect of Timing of Administration of Xenobiotics on Interactions – Of particular interest with regard to the timing of the administration of grapefruit juice and other xenobiotics is the work of Lilja *et al.* (2000). The study examined the effects of taking grapefruit juice on pharmacokinetic parameters of the drugs simvastatin and simvastatin acid:

- a) when the drug was taken at the same time as the juice,
- b) when the drug was taken 24 hours after the juice and
- c) when the drug was taken three days after the juice.

The following two tables show the results.

Timing of simvastatin	Increase in mean C_{max}	Increase in mean AUC
Same time	12-fold (P < .001)	13.5-fold (P < .001)
24 hours later	2.4-fold (P < .01)	2.1-fold (P < .001)
3 days later	1.5-fold (P = .12)	1.4-fold (P = .09)
7 days later	no change	no change

Timing of simvastatin acid	Increase in mean C_{max}	Increase in mean AUC
Same time	5.0-fold (P < .001)	4.5-fold (P < .001)
24 hours later	1.7-fold (P < .01)	1.7-fold (P < .01)
3 days later	nil	nil
7 days later	nil	nil

Notes to Tables:

C_{max} (concentration max.) is the mean peak serum concentration.

AUC (area under curve) is the mean area under the serum concentration/time curve [$AUC(0-\infty)$]

In addition to the changes shown in the tables, T_{max} (time to peak concentration) was also prolonged from 2 hours to 4 hours (a 100% increase), when grapefruit juice was taken with simvastatin. The paper concludes:

When simvastatin is taken 24 hours after ingestion of “high-dose” grapefruit juice, the effect of grapefruit juice on the *AUC* of simvastatin is only about 10% of the effect observed during concomitant intake of grapefruit juice and simvastatin. The interaction potential of even high amounts of grapefruit juice with CYP3A4 substrates dissipates within 3 to 7 days after ingestion of the last dose of grapefruit juice.

The magnitude of interaction between xenobiotics when they are co-administered, in this case, is many times greater than when they are administered apart in time.

The Frequency of Interactions – Lohezic-Le Devehat *et al.* (2002) investigated the interactions between grapefruit juice and 42 drugs; only 12 drugs (28%) showed no interaction. Ortiz de Montellano (1999) records that, in humans, of the spectroscopically detectable cytochrome P450 in the liver, CYP3A4 is the most abundant isoform, representing approximately 30%¹, whilst CYP1A2 represents 13%. In view of this, the observations of Lohezic-Le Devehat *et al.* are not surprising. Interactions between implicated phytochemicals, such as naringenin, furanocoumarins and nootkatone, and other pharmacologically active xenobiotics appears not to be a restricted phenomenon.

The Extrapolation of Grapefruit Investigations to Chinese Herbal Medicine – Although the furanocoumarins are restricted in their distribution to a relative few plant families, they are highly characteristic of some; notably, the Rutaceae and Umbelliferae. Members of the Rutaceae and Umbelliferae are used frequently in Chinese herbal prescriptions. Considering the flavonoids naringenin and naringin alone, a brief inspection of the XIN BIAN ZHONG YAO DA CI DIAN 新編中藥大辭典 (*Newly Compiled Chinese Official Dictionary*) (Anon., 1984), reveals their presence in a number of Chinese herbs.

Naringenin is present in:

- Zhi Ke 枳殼 and Zhi Shi 枳實 mature and immature fruit, respectively, of *Citrus aurantium* L.;
- Zhi Ke Hua 枳殼花 flower of *Citrus aurantium* L.;
- You 柚 (the pomelo, or shaddock) ripe fruit of *Citrus grandis* (L.) Osbeck;
- Gou Ju 枸橘 unripe fruit of *Poncirus trifoliata* (L.) Raf.;
- Gou Ju Ye 枸橘葉 leaf of *Poncirus trifoliata* (L.) Raf.;
- Tian Chen 甜橙 ripe fruit of *Citrus chinensis* (L.) Osbeck;

all Rutaceae, and

- Gu Sui Bu 骨碎補 rhizome of *Drynaria fortunei* (Kunze) J. Sm., Polypodiaceae,

whilst naringin, which metabolises to naringenin in the bowel, is present in:

- Tao Zhi 桃枝, Tao Hua 桃花, Tao Ye 桃葉 and Tao Bai Pi 桃白皮 twig, flower, leaf, and stem-bark, respectively, of *Prunus persica* (L.) Batsch, Rosaceae.

The idiosyncratic nature of phytochemical occurrence in plants is apparent from this list. In the main, there is a strong connection between *Citrus* species and these two compounds. However, some *Citrus* species (e.g. Chen Pi 陳皮 *Citrus reticulata* Blanco and Gou Yuan 枸櫞 *Citrus medica* L.) appear not to contain them, whilst other species, from the outwith the Rutaceae (e.g. the fern *Drynaria fortunei* and various parts of the peach tree, *Prunus persica*) do². The opportunity for

¹ Ronis & Ingelman-Sundberg (1999) note this as varying in the range of 10-60%, stating also that it is expressed at higher levels in women than in men, that it occurs at high levels in the intestine and that it is induced by alcohol.

² For further information on the poor correspondence between the relatedness of species and therapeutic effect, and, by

interactions, and therefore also abreactions, arising from novel, xenobiotic combinations appears to be considerable. Mills & Bone (2000), following their discussion of the grapefruit issue, conclude: “This phenomenon raises the question of how other plants and their phytochemicals influence the bio-availability of both drugs and herbal constituents.”

EXAMPLE 2: CRANBERRY JUICE AND WARFARIN

In recent years, the juice of the cranberry (fruit of *Vaccinium macrocarpon* Aiton, and *V. oxycoccus* L. Ericaceae¹) has become very popular in the West, as a self-help means of preventing cystitis. In September, 2003, the British Committee on Safety of Medicines (CSM) said it had received five reports of increased INR² in patients taking warfarin and associated with cranberry juice. In one of the cases, six weeks after starting to drink cranberry juice, the INR showed a dramatic increase rising to over 50; the man died of gastrointestinal and pericardial haemorrhage. In another case, the INR increased less dramatically, and returned to within the normal range, after cranberry juice was discontinued. An interaction between cranberry juice and warfarin is suggested. Although a mechanism is not currently known, the elements necessary for an interaction via inhibition of the cytochrome P450 system are present: Warfarin is predominantly metabolised by CYP2C9 (Rettie *et al.*, 1992), and cranberry juice contains various flavonoids known to inhibit cytochrome P450 enzyme activity (Hodek *et al.*, 2002). In view of this, CSM advice is that “until this possible interaction has been investigated further, it would be prudent for patients taking warfarin to be advised to limit or avoid drinking” cranberry juice or taking cranberry capsules.

As noted above (pp. 166-167), warfarin is a synthetic mimic of dicoumarol, a phytochemical occurring naturally in the leaves and flowers of red clover (*Trifolium pratense* L., Leguminosae) in both the fresh and dried states (Anon., 1984). It follows that abreactions associated with warfarin might apply in similar fashion to its natural counterpart. *T. pratense* features in Western medical herbalism as an antispasmodic, diuretic and expectorant (Grieve, 1931; Lust, 1974), and in more recent times has attracted attention as a source of phytoestrogens (see p. 177, for further comment). The findings of the CSM imply a possible risk of elevated INR in people taking both red clover preparations and cranberry juice.

To date, the documentation of adverse xenobiotic/xenobiotic interactions, seems essentially to have been restricted to biomedical journals and to involve biomedical xenobiotics. Whether this reflects that such reactions do not occur between other distinct medical systems, or merely that the biomedical reporting system is more highly organised and has a more prolific network in this regard is uncertain.

A Need for Prudence at the Interfaces of Established Medical Systems

For 2,000 years, there was no large-scale cross-fertilisation between different medical systems using potent, pharmacologically active materials. However, in the space of only a few decades, the potential for the mixing of medicinal materials in unprecedented combinations has grown rapidly. The examples noted by Ang-Lee *et al.* (2001) (ginkgo, ginseng, perforate St. John’s wort, valerian etc.) (see above, p. 241) relate to the interface of biomedicine with herbal medical systems, but there is no reason to suppose that interactions should be any less prevalent between different herbal systems. Herbs contain pharmacologically active xenobiotics which, on the one hand, are prone to

extension, phytochemical constituents, see pp. 115-116.

¹ *V. oxycoccus* and *V. macrocarpon* are not documented in classical Chinese herbals.

² INR: international normalised ratio. The INR is a measure of the propensity of blood to clot. It is based upon a World Health Organisation standard reagent. INR for normal blood is 1.0, with an upper normal limit of 1.2. People receiving warfarin therapy in treatment of deep vein thrombosis (DVT) generally have a target value INR of 2.5. Because of the high risk of life-threatening haemorrhage, during treatment, INR is regularly monitored – values in excess of 8.0 merit immediate cessation of warfarin until INR falls below 5.0.

A complete monograph

23. Xiao Hui Xiang 小茴香 (either fruit, or stem & leaf of *Foeniculum vulgare*)



懷香 Huai Xiang¹

Historical Documentation

Precisely when Xiao Hui Xiang was first documented in a herbal is unclear. The SHI ZHI 食治 (*Dietary Treatment*) section of the BEI JI QIAN JIN YAO FANG 備急千金要方 (*Essential Prescriptions for Emergencies Worth a Thousand Pieces of Gold*) (ca. 652 AD) of Sun Si-miao 孫思邈, which is still extant, clearly refers to Hui Xiang Cai 茴香菜 stem & leaf of the species, and has an appended comment on the fruit. The BEN CAO GANG MU recounts comments from the YAO XING LUN 藥性論 (*Treatise on the Intrinsic Nature of Medicinals*) (seventh century AD) of Zhen Quan 甄權, which discussed medicinal uses of both the fruits and the stem & leaf. Both of these texts date to the seventh century AD, and, although it is uncertain which was published first, it is clear that the medicinal uses of Xiao Hui Xiang were documented in herbals by around the middle of that century. All modern works consulted by the author point either to the YAO XING LUN or the XIN XIU BEN CAO 新修本草 (*Newly Revised Herbal*) (659 AD) of Su Jing 蘇敬, as being the first herbal documentation. There appears to be general agreement on the matter. However, a query arises because the BEN CAO GANG MU quotes the SHEN NONG BEN CAO JING JI ZHU 神農本草經集注 (*Shen Nong's Herbal Classic [with] Collected Commentaries*) (ca. 500 AD) of Tao Hong-jing 陶弘景 on the derivation of the name: “[When] boiling offensive-smelling meat, [one should] add a little [Xiao Hui Xiang, in consequence of which, the meat will] not have the offensive smell.” The quote is given in explanation of the name Hui Xiang 茴香, which is a word-play on Hui Xiang 回香: “return of fragrance”. In the plant name, Hui 回, meaning return, has the grass radical 艹 above. Evidently, the herb was known to Tao Hong-jing, yet the BEN CAO GANG MU provides no quotations on its medical uses from Tao’s herbal works. This is entirely out of character with Li Shi-zhen’s usual style: gener-

¹ The main title of the illustration is Huai Xiang 懷香, which is the name used for the herb in the XIN XIU BEN CAO. The text within the picture says: Hui Xiang 茴香.

ally, he places his quotations in chronological sequence. The implication is that Xiao Hui Xiang was known at the time of Tao Hong-jing, but not accorded any medicinal applications and only used as a condiment for offensive-smelling meat. It seems a further 150 years had to pass before it was recruited to use as a medicinal herb.

Prior to mention in these herbals, no documentary evidence was found for Xiao Hui Xiang. However, like *Coriandrum sativum* (Hu Sui, Monograph 18), *Foeniculum vulgare* is not native to China, but to the Mediterranean. The first herbal in which Hu Sui appeared seems, like Xiao Hui Xiang, to have been the SHI ZHI section of the BEI JI QIAN JIN YAO FANG, but Hu Sui is documented in the SHUO WEN JIE ZI 說文解字 (*Explanation of Strokes and Elucidation of Characters*) (ca. 100 AD) of Xu Shen 許慎. With both species sharing a native distribution in the Mediterranean, both first appearing in the same herbal text, both having culinary as well as medicinal uses, and both almost certainly having arrived along trade routes, it is possible that Xiao Hui Xiang arrived in China at around the same time as Hu Sui.

Names and Synonyms

Botanical

Current name: *Foeniculum vulgare* Mill.

Synonymy: *Foeniculum officinale* All.

Anethum foeniculum L.

Ligusticum foeniculum (L.) Crantz

Chinese

Principal current name: **Xiao Hui Xiang**¹ 小茴香

Originally, the names Hui Xiang 茴香 and Huai Xiang 懷香 prevailed, and the former evidently won the battle for eminence in use. However, in more recent times, the plant took the name Xiao Hui Xiang (literally, “little” Hui Xiang). This may have been to avoid confusion with the fruit of *Illicium verum* Hook. f., Illiciaceae, which is known as both Da Hui Xiang 大茴香 (literally, “big” Hui Xiang) and Ba Jiao Hui Xiang² 八角茴香 (“Eight-Horned” Hui Xiang).

Although the names Huai Xiang and Hui Xiang are ubiquitous throughout the classical literature, certainly until the Ben Cao Bei Yao (1682), in current times, the name Xiao Hui Xiang seems to have become well-established. Since there is no perceptible merit in using the older names, and the newer name is less ambiguous, it is used throughout the current book.

Synonyms listed in the BEN CAO GANG MU: Hui Xiang Ba Jiao Zhu 茴香八角珠

Other synonyms:

Gu Hui Xiang 谷茴香 (JX)

Xiang Si Cai 香絲菜

Ye Hui Xiang 野茴香

Gu Xiang 谷香 (JX)

Xiang Zi 香子

Tu Hui Xiang 土茴香

Xiao Xiang 小香

¹ Xiao Hui Xiang refers to the fennel plant, the fruits of which are used certainly medicinally and perhaps dietarily, and the shoots of which are used dietarily. Strictly, Xiao Hui Xiang Zi 小茴香子 means fennel fruit, whilst Xiao Hui Xiang Miao 小茴香苗 or Xiao Hui Xiang Cai 小茴香菜 mean fennel shoots and vegetable respectively. In practice, “Xiao Hui Xiang” is often used to indicate the fruits with the expectation that Miao or Cai would be appended if the stem & leaf were required.

² The star-anise of culinary use.

N.B. Xiao Hui Xiang 小茴香 and Tu Hui Xiang 土茴香 are also listed as synonyms for Shi Luo (*Anethum graveolens*, Monograph 24).

English: Fennel

[Pharmaceutical: Fructus Foeniculi and Caulis et Folium Foeniculi]

Botanical Description

A glaucous, glabrous perennial or biennial, often forming stout clumps, strongly anise-scented when crushed. *Rootstock* a taproot. *Stem* erect, 0.5-1.5-(2.5) m high, branching, solid, but developing a small hollow when old, finely striate. *Leaves* 3- to 4-pinnate into filiform ultimate segments <1 mm broad, widely spaced and not in the same plane; whole leaf triangular-ovate in outline, to 30 x 40 cm; petiole with a broad sheath along its length, base clasping the stem. *Umbels* compound, terminal and lateral, with 10-40 smooth, but rather unequal rays 1.5-10 cm long; peduncles usually longer than the rays. *Bracts* and bracteoles absent. *Flowers* yellow; calyx-teeth obsolete; outer petals not radiating, styles with enlarged base forming the stylopodium. *Fruit* ovoid-oblong, slightly dorsally compressed, 4-10 x 1.5-2.5 mm, with conspicuous narrow ribs; vittae 1 per furrow, 2 on commissure.

Flowers May to September, fruits July to October.

Wild Distribution and Habitats

Fennel is native to the Mediterranean, but has been introduced to many parts of the world and is widely cultivated. It is an opportunist coloniser of disturbed ground, such as waste ground and roadsides.

Cultivation and Harvesting

Chinese texts record that the plant is readily grown from seed, prefers a humid atmosphere and is tolerant of many kinds of soil, but is not resistant to cold. Instructions on cultivation follow.

In northern regions, sow the seed in April, but in southern regions sow in September. Sow seed into drills 2.5 cm deep, leaving 45-60 cm between rows. Cover it with earth and firm in. Large-scale operations use a sowing rate of 22.5-30 kg/ha. Shoots appear after about 15 days; when they reach 7-10 cm tall, thin them, leaving 7-12 cm between plants. Protection against ash-spot disease can be achieved either by pre-treating the seeds in water at 50°C for 3-5 seconds and air-drying them before planting, or by chemical treatment.

Collect the fruits in the autumn, after ripening, and sun-dry them. The whole herb (?) can be harvested in the summer and autumn, the root can be collected throughout the four seasons, these products should all be washed clean and sun-dried.

In the British Isles – the plant is naturalised. Its distribution is predominantly coastal, on cliffs, along roadsides and on waste ground, notably in England and Wales; it is markedly less frequent in Scotland. It is commonly grown in kitchen gardens, preferring dry sunny situations, but will thrive in most conditions and last for several years. Fennel is easily grown from seed, sown in April and using the same techniques as described for China.

Classical Chinese Medical Lore

BEN CAO GANG MU Classification: Vegetables Division, Section I: Strong-smelling and Pungent Class, (Chapter 26).

SHEN NONG BEN CAO JING Category: Not included.

FRUIT

Flavour: Pungent

Nature: Neutral (some texts give this as warm; after stir-frying, it would be). Not toxic.

Meridian/Organ: Enters hand and leg Shao Yin and Tai Yang meridians (i.e. Kidney, Pericardium, Small Intestine and Bladder). The BEN CAO BEI YAO says “Kidney and Bladder”.

Actions: Regulates the Qi, adjusts the Centre (i.e. the Spleen and Stomach), strengthens and opens the Stomach and promotes descent of the Stomach Qi, stops pain, tonifies Ming Men¹ and warms the Dan Tian², expels cold and promotes milk flow.

Principal Applications: Vomiting and diarrhoea, cold lodging in the space between the Bladder and the Stomach, snake-bites, flatulence, cold Shan illness³, gastro-intestinal distension, painful menses (where this is due to coldness).

Syndrome Prohibitions and Restrictions: People with Yin deficiency and empty heat⁴ should not take it (unless prescribed with suitably modifying herbs). People with excess Stomach and Kidney fire or vomiting due to heat should not take it.

Seven Relationships & Toxicology: None given.

Modification for Prescription

- It should be stir-fried until yellow (Chao Huang 炒黃) before use⁵.
- Its actions benefit from use with liquor (which, like the herb itself, is also pungent and warm).
- Prepared with salt⁶, it enters the Kidneys and thereby better treats cold Shan conditions.

STEM & LEAF

Flavour: Pungent

Nature: Neutral. Not toxic.

Actions: Not stated.

¹ The Kidney’s Life Gate (Ming Men 命門) relates to the Kidney’s Yang aspect.

² Dan Tian 丹田 is often translated as “cinnabar field” or “elixir field”, both of these translations merit explanation. Dan 丹 alludes to Dan Sha 丹砂 (literally, “red sand”), which is cinnabar (naturally occurring red mercuric sulphide, HgS). Tian 田 means field. Daoist alchemists were particularly interested in the pursuit of longevity and considered Dan Sha perhaps to be an elixir of immortality. In the body, the Dan Tian is located a little way below the navel and a little way inside the abdomen; different sources disagree over precise distances. It corresponds approximately to the acupuncture point Qi Hai 氣海 or “Sea of Qi”, and is very much in the domain of the Kidneys – the root of Yin and Yang, and of human life force. Thus, the Dan Tian is a field (or area of the body) associated with the root of life and longevity, and therefore alluded to by reference to cinnabar, a potential elixir of immortality.

³ Shan 疝 is a mass in the lower abdomen. It is caused by an attack of external wind-cold-damp pernicious Qi, usually on the Liver meridian, which stagnates in the abdomen. The character is an image of a mountain 山 inside the “illness” radical; and reflects an illness characterised by a lump. In biomedicine, Shan is often equated with lower abdominal hernias.

⁴ Empty heat (Xu Re 虛熱): When a person’s Yin (cool, moist and descending) influences are deficient (not full, but somewhat empty), they fail to balance Yang (warm, dry and ascending) influences adequately, and a person feels too hot. Empty heat is relative. In contrast, solid heat (Shi Re 實熱) is due to the presence of excessive hot energy of external origin (e.g. during a fever, working in direct summer sunshine), such that even normal levels of bodily Yin are overwhelmed. Solid heat is absolute.

⁵ Aromatic herbs are often stir-fried until yellow before use in order to potentiate their warming and aromatic nature.

⁶ Each of the Five Zang organs, Wu Zang 五臟 (Heart, Spleen, Lung, Kidney, Liver) has its own flavour. That flavour can be used as an envoy to guide an officinal to its target organ. Salt is the envoy for the Kidney. In this case, the fennel fruit is prepared with salt, specifically to guide it to the Kidney.

Principal Applications: It can be boiled and eaten to treat sudden discomfort in the cardiac [region] or abdomen, wind in the Small Intestine, or up-rushing of the Kidney Qi to the flanks giving rise to stabbing pain¹. It can also be used in cases of asthmatic wheeze.

Syndrome Prohibitions and Restrictions: None stated.

Seven Relationships & Toxicology: None stated.

Notes

One way of preparing it is to pound the plant to extract its juice, which should be mixed in equal measure with warm liquor and drunk.

Other Parts Used

ROOT: The BEN CAO GANG MU mentions that, in winter, the root can be used, that this is a foreign practice, and that it is good. The NEWLY COMPILED CHINESE OFFICINAL DICTIONARY (Anon., 1984) says that the use was documented in the TU JING BEN CAO 圖經本草 (*Illustrated Classic Herbal*), (1062), of Su Song 蘇頌. The root is pungent, sweet and warm. It warms the Kidneys, harmonises the Centre (i.e. the Spleen and Stomach), moves Qi and stops pain. It treats cold Shan conditions (see p. 381ⁿ³), Stomach cold with vomiting, abdominal pain (due to cold) and wind-damp arthralgia.

Harvesting

Fruits should be collected in the eighth and ninth lunar months and dried in the shade. No direction is given on the gathering of the leaf & stem, though the text says that leaves appear in the third lunar month.

Dose

Anon. (1984): Fruit, 3-9 g. Roots 20-60 g, fresh-weight.

Hsu *et al.* (1986): Fruit, 1.5-5.0 g.

Xie Zong-wan (1997): No distinction is made between fruit, stem & leaf, and root. They are all given at 3-9 g.

Biomedical Information

Biomedical Actions

FRUIT: Analgesic, stomachic, emmenagogue, antispasmodic.

STEM & LEAF: Carminative, analgesic.

Biomedical Applications

FRUIT: Gastroenteralgia and dysmenorrhoea (where these are due to cold); hernial pain, testicular swelling, scrotal hydrocele and early to middle-stage schistosomiasis.

STEM & LEAF: Carbuncular swellings, hernia.

Phytochemistry

RIPE FRUIT

Monoterpene glycosides – foeniculosides V, VI, VII, VIII, IX

True triterpene – α -amyrin

¹ This group of applications appears to refer to general manifestations of gastro-intestinal wind with discomfort or colic in the areas of the epigastrium (just below the heart), small intestines (around the navel) and large intestine (the left and right colic flexures, which are at the lower margins of the flanks).

Steroid triterpenes – β -sitosterol, stigmasterol

Phenol glycoside – syringin

Coumarin – umbelliferone

Alkaloid glycoside – adenosine

Unclassified glycosides – zizybeoside I, leaveside A

Volatile oils¹ (3-8%) – of which the *ether*: *cis*-anethole is 50-60% and the *monoterpene ketone*: *d*-fenchone is 18-20%, along with:

Monoterpenes – *d*-camphene, *d*-limonene, *l*-limonene, *dl*-limonene, (–)- α -phellandrene, α -pinene, *d*-pinene

Aromatic hydrocarbon – *p*-cymene

Aromatic ether – estragole

Aromatic acid – anisic acid

Aromatic aldehyde – anisaldehyde

Non-volatile oils (18%) – of which *aliphatic acids*: petroselinic acid is 60%, oleic acid is 22%, linoleic acid is 14%, palmitic acid is 4%, along with arachidic acid, behenic acid and various waxes.

Unclassified – threo-anethole glycol, erythro-anethole glycol

UNRIPE FRUIT

Monoterpene ketone – *d*-fenchone

STEM & LEAF

Aliphatic acids – citric acid, fumaric acid, shikimic acid, tartaric acid, vitamin C

Aromatic acids – anisic acid, benzoic acid, caffeic acid, cinnamic acid, *o*-coumaric acid, ferulic acid, gentisic acid, protocatechuic acid, quinic acid, sinapic acid, syringic acid, *o*-vanillic acid

Aromatic ether – foeniculin

Flavonol glycosides – fencularin, juglanin, kaempferol-3-glucuronide, nelumboside, querciturone

Alkaloid glycoside – vitamin B₂

ROOT

Monoterpenes – limonene, β -myrcene, α -phellandrene, α -pinene, β -pinene, α -terpinene, γ -terpinene, terpinolene

Steroid triterpene – stigmasterol

Steroid triterpene ester – stigmasteryl palmitate

Aromatic hydrocarbon – *p*-cymene

Aromatic ether – dill-apiol(e)

Coumarin – umbelliferone

Furanocoumarin – bergapten

Regional Substitutes

The ENCYCLOPAEDIA OF CHINESE MEDICINAL PLANTS (Xie Zong-wan, 1997) states that in many regions of China, the fruits of two other species are erroneously used in place of Xiao Hui Xiang:

***Anethum graveolens* L.** – Shi Luo Zi 蒔蘿子 (see Monograph 24)

Erroneously used in the NE and NW.

¹ Volatile oils may be extracted by the steam distillation of crushed fruits. Many varieties of fennel oil are known, such as common, Florence, Saxon and Indian. It is used in the manufacture of soap and in the preparation of some medicines.

***Carum buriaticum* Turcz.** – Tian Ge Lu Zi 田葛縷子

Erroneously used in the Shanxi province region, where it is known as Shan Xiao Hui 山小茴.

Short Notes on Associated Lore in Other Herbal Medical Traditions

European

References by Theophrastus and Dioscorides indicate that the cultivation of fennel as a vegetable and medicinal plant dates back to antiquity. Both the fruit and root can be put to similar use in relieving colic, abdominal cramps and flatulence; and for expelling mucous accumulations. However, the roots are inferior in value to the fruits and now only the latter are recognised in the pharmacopoeias.

The fruits are antispasmodic, aromatic, carminative, diuretic, expectorant, galactagogue, stimulant and stomachic. They are chiefly used medicinally with purgatives to allay their griping tendencies. For example, fennel water, or the water of anise and dill, can be used with sodium bicarbonate and syrup to make “gripe water” as used in the correction of flatulence in infants.

The herb is said to be disliked by fleas and powdered fennel has the effect of driving away fleas from kennels and stables.

Culpeper has:

One good old fashion is not yet left off, viz. to boil fennel with fish: for it consumes that phlegmatic humour which fish most plentifully afford and annoy the body with, though few that use it know wherefore they do it. ... Fennel is good to break wind, to provoke urine and ease the pains of the stone, and helps to break it. The leaves or seed, boiled in barley-water, and drank, are good for nurses, to increase their milk, and make it more wholesome for the child. The leaves, or rather the seeds, boiled in water, stays the hiccough, and takes away the loathings, which oftentimes happen to the stomachs of sick and feverish persons, and allays the heat thereof. The seed boiled in wine¹, and drank, is good for those that are bit with serpents², or have eat poisonous herbs or mushrooms. ... The seed is of good use in medicines, to help shortness of breath and wheezing, by stopping of the lungs. It assists also to bring down the courses, and to cleanse the parts after delivery. ... Both leaves, seeds and roots thereof, are much used in drink or broth, to make people lean that are too fat.

Indo-Tibetan

It is regarded as sweet and pungent in taste, hot in potency, and light. It alleviates *kapha* and *vata*³, and is an appetiser.

Ayurvedic

The root, seed and oil are used in treating cardiac diseases, blood disorders, cough, dyspnoea, amenorrhoea, skin disorders, fevers, deformity of breast and general debility. They are carminative.

Ancient Egyptian

Egyptian and Coptic herbals recommend its use powdered for the treatment of eye ailments.

¹ This makes for comparison with the Chinese statement that “its actions benefit from use with liquor”.

² Coincident with classical Chinese use.

³ In pathology, Indo-Tibetan medicine identifies three factors as corrupting the body. They are known as the “Tri-dosa”, often rendered as the “three humours” or “three defects”. They are *vata*, *pitta* and *kapha*: wind, bile and phlegm, respectively.

First pages of Appendix 7 & Appendix 8

Appendix 8

TECHNICAL DATA FOR PHYTOCHEMICALS RECORDED IN THE MONOGRAPHS

The purpose of this appendix is two-fold: On the one hand, it presents basic technical data for phytochemicals recorded in the monographs; on the other, it enables readers interested in investigating particular compounds to see, at a glance, in which monographs they are recorded.

NOTES

- 1/ Under **Common name** is recorded those names appearing regularly in the source texts used. They are often trivial names. No attempt is made to list all known synonyms, but synonyms encountered in compiling the current work are listed beneath the principal name. (For an example, see adonitol.)
- 2/ Regarding **Chemical Category**, "*unclassified*" is used when the precise category of compound was not found, but its broad category is apparent. Thus, *d*-copinene is clearly a terpene, but since neither a systematic name nor a molecular formula was found, it is uncertain whether it is a mono-, sesqui-, tri-, or tetraterpene. Hence, it is shown as an *unclassified terpene*. "*Unidentified*" is used when even the broad chemical category of a substance was not found; angelicotoxin is an example of such a compound.
- 3/ Under **Monograph** is recorded the monograph number and Pinyin name of the herbs for which a chemical is recorded.
- 4/ **Systematic name**: nomenclatural practice varies somewhat; only one systematic name is given.
- 5/ Sometimes the entry under **Common Name** is the same as that under **Systematic Name**. In such cases, a systematic name is followed by (9CI), indicating that the trivial name is the one still used in the Chemical Abstracts Service 9th Collective Index and onwards. (For examples, see daucine and pectin.)
- 6/ **Mp** (melting point) and **Bp** (boiling point) are given in degrees centigrade.
- 7/ Empty cells in the table reflect information which could not be found.

Common Name	Chemical Category	Monograph	Systematic Name	Molecular Formula	Mp/Bp
6"- <i>O</i> -acetyl-saikosaponin <i>a</i>	oleanane triterpene glycoside (saponin)	1. Chai Hu		C ₄₄ H ₇₀ O ₁₄ ·H ₂ O	Mp 217-224
6"- <i>O</i> -acetyl-saikosaponin <i>d</i>	oleanane triterpene glycoside (saponin)	1. Chai Hu		C ₄₄ H ₇₀ O ₁₄ ·H ₂ O	Mp 196-205
AD I	pyranocoumarin	2. Qian Hu	a mixture of (3' <i>S</i>)-angeloyloxy-(4' <i>R</i>)-isovaleryloxy-3',4'-dihydroxanthyletin and (3' <i>S</i>)-angeloyloxy-(4' <i>S</i>)-isovaleryloxy-3',4'-dihydroxanthyletin		
AD II	pyranocoumarin	2. Qian Hu	(3' <i>S</i>)-angeloyloxy-(4' <i>R</i>)-seneciolyoxy-3',4'-dihydroxanthyletin	C ₂₄ H ₂₆ O ₇	
adenine	purine alkaloid (volatile oil)	7. Dang Gui, 8. Xiong Qiong	6-aminopurine	C ₅ H ₅ N ₅	Mp 360-365
adenosine	purine alkaloid glycoside (volatile oil)	8. Xiong Qiong 23. Xiao Hui Xiang	6-amino-9-β-D-ribofuranosyl-9 <i>H</i> -purine	C ₁₀ H ₁₃ N ₅ O ₄	Mp 235-236
adonitol (ribitol)	monosaccharide	1. Chai Hu	1,2,3,4,5-pentanepentol	C ₅ H ₁₂ O ₅	Mp 101-102

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