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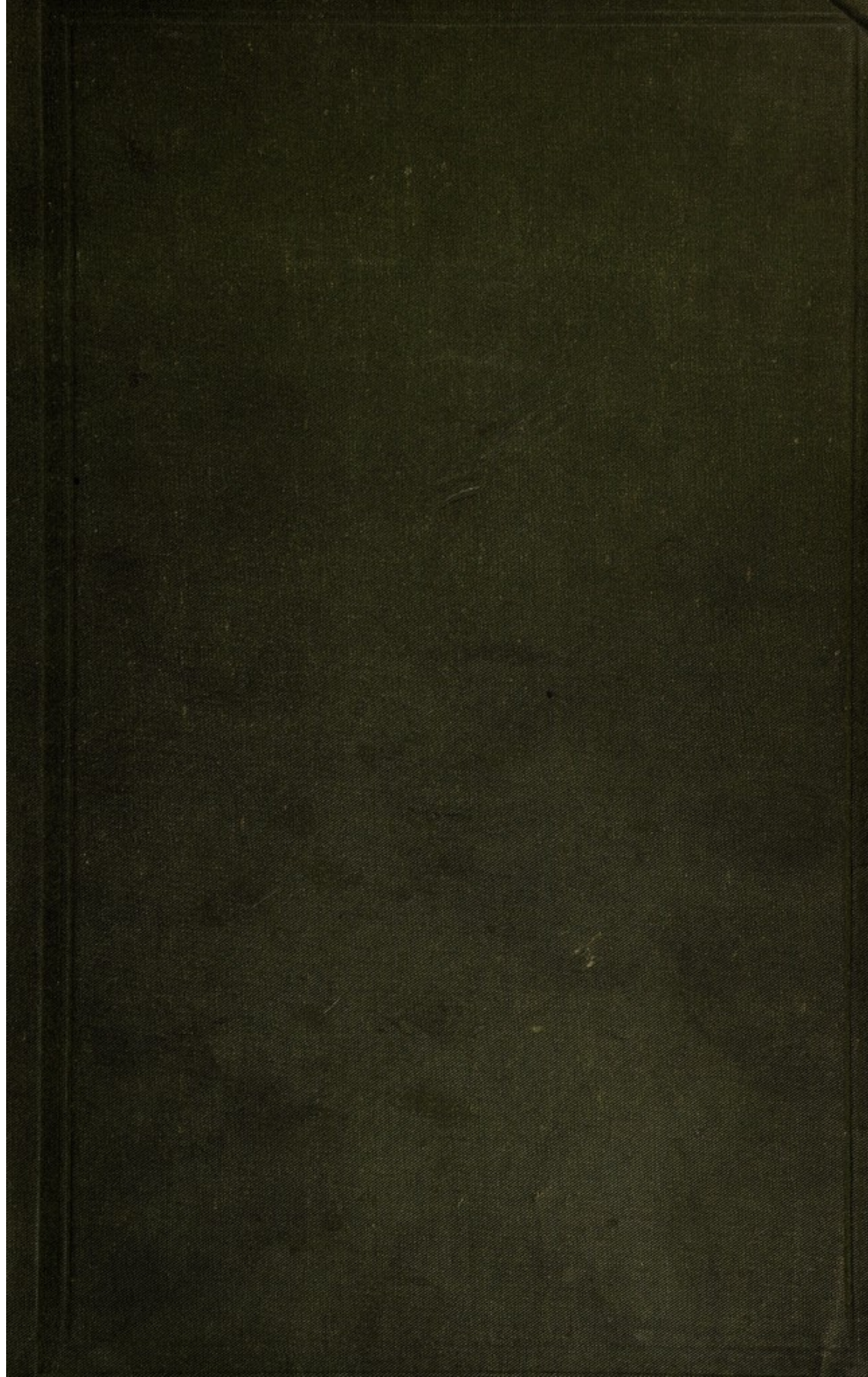
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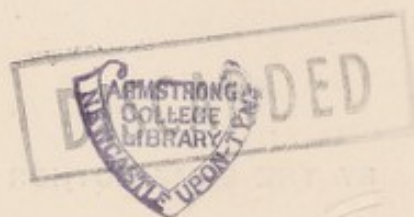


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A
TEXT BOOK
OF
MATERIA MEDICA

BY THE SAME AUTHOR

THE MICROSCOPICAL EXAMINATION OF FOODS
AND DRUGS, IN THE ENTIRE, CRUSHED AND
POWDERED STATES. With numerous Illustrations.
Second Edition. *In preparation.*

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A

TEXT BOOK
OF
MATERIA MEDICA

BEING AN ACCOUNT OF THE MORE IMPORTANT CRUDE
DRUGS OF VEGETABLE AND ANIMAL ORIGIN

DESIGNED for STUDENTS of PHARMACY and MEDICINE

BY

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DIRECTOR OF THE PHARMACY RESEARCH LABORATORY

LATE EXTERNAL EXAMINER IN MATERIA MEDICA AND PHARMACY

TO THE UNIVERSITY OF BIRMINGHAM

WITH 269 ILLUSTRATIONS

SECOND EDITION



LONDON

J. & A. CHURCHILL

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1909

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THE BOOK

MATTHEW MEDICAL

THE HISTORY OF THE MEDICAL ARTS
IN THE ROMAN EMPIRE AND AFRICA

BY WILLIAM SMITH, M.D.

REVISED BY WILLIAM SMITH, M.D.

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PREFACE

THE present volume, published under the title of a 'Text-Book of Materia Medica,' constitutes a second edition of the author's 'Introduction to the Study of Materia Medica' which appeared in 1899. This change in title has been rendered desirable by the numerous additions that have been made to the work with the view of broadening its scope. To this end a chapter on the history and commerce of drugs has been added. Each section has been prefaced by a short introduction, including, in the section dealing with 'Animals and Animal Glands and Secretions,' a brief outline of modern zoological classification. For the convenience of advanced students the microscopical characters of, and assay processes for, a number of important drugs have been added. The commercial varieties have been more fully dealt with, and considerably more attention has been paid to the chemistry of a number of the more important constituents. Several drugs not previously dealt with have also been included.

The general arrangement of the subject-matter has been retained, but in several cases sections have been united or divided. The correct pronunciation of a number of Latin plant-names has been indicated by marking the quantities of the syllables.

Many of the seventy-seven new figures have been reproduced from original photographs. For those illustrating the various forms of packages I am indebted to Messrs. Wright, Layman & Umney (Figs. 6, 7, 95, 117, 177, 179, 195, 204, 205, 255, 267), and to Dr. Weigel of Hamburg (Figs. 1 to 5). To the

Editor of the *Pharmaceutical Journal*, the Editor of the *Chemist and Druggist*, and to Messrs. Chas. Smith, Gowland & Son, who have given permission for the reproduction of illustrations that have appeared in their respective publications, and to the London and India Docks Company, and the proprietors of Bull Wharf who have kindly allowed me to reproduce photographs taken on their premises, my thanks are also due.

Much information respecting the commerce in drugs has been furnished by Messrs. Cæsar & Loretz (Halle a. S.), Messrs. Davy, Hill & Hodgkinson, Messrs. Hearon, Squire & Francis, Messrs. Potter & Clark, and Messrs. Wright, Layman & Umney. The current literature has also been freely laid under contribution. In the work of proof-reading I have been most efficiently aided by Mr. Reginald R. Bennett, B.Sc.

The student is again strongly advised to make the study of crude drugs as far as possible a practical one. Before commencing any one of the first ten sections the morphology and anatomy of the respective organs should be studied in a text-book of botany. Each drug should be carefully compared with the description given; differences should be noted, and an explanation sought either from a teacher or from other works. Sketches should be frequently made. In the case of seeds, fruits, barks, roots and rhizomes, the prominent features of the transverse section should also be delineated, if necessary on an enlarged scale. Flowers and leaves may be expanded by soaking them in hot water. The meaning of botanical technical terms, if not precisely known, should be ascertained at the time from a suitable glossary, and a geographical atlas should also be kept at hand for reference.

H. G. G.

May 1909.



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MATERIA MEDICA

Definition.—Materia Medica or Pharmacognosy, for the terms as used by pharmacists are synonymous, may be defined as that science which aims at a complete and systematic knowledge of crude drugs of animal or vegetable origin. The term drugs may be understood to include all parts of animals or vegetables used in medicine, or such of their products as have not undergone any material elaboration or separation into their constituents; it is, however, not susceptible of exact limitation, and hence substances may be included which are of dietetic or technical rather than medicinal use.

A complete knowledge of a drug must, however, include a knowledge of the morphological nature and the structure, both macroscopic and microscopic, of such as are organised, of the botanical or zoological source, of the constituents both active and inactive, their nature, the amount in which they are present, and the relation they bear to the constituents of other drugs. The geographical source, the trade route, the cultivation, mode of collection, preparation for the market, commercial varieties, history, uses, &c., must also be known. To attain this knowledge the aid of chemistry and of chemical methods of investigation, of botany and botanical methods, of physiology, geography, commerce, history, &c., must be sought, or at least the results of other investigators in these respects utilised, and the information thus obtained combined to form a complete knowledge of each drug, and these systematised to build up the science of pharmacognosy.

Pharmacognosy may be subdivided into Scientific Pharmacognosy, as above described, and Applied Pharmacognosy.

Applied Pharmacognosy is the application of scientific pharmacognosy to the solution of the pharmacognostical problems that are constantly arising in the daily work of the pharmacist. Thus Scientific Pharmacognosy includes an intimate knowledge of the structure of vegetable drugs; Applied Pharmacognosy utilises this knowledge to identify the drug entire or in powder and to determine its purity.¹ Scientific Pharmacognosy treats of the constituents of drugs. Applied pharmacognosy ascertains the relative quality of a drug by determining the proportion in which one or more of these constituents is present.

History.—Although it is only within very recent years that pharmacognosy has substantiated its claim to rank as a science, the collection of herbs for medicinal use is of the remotest antiquity. Ancient Egyptian papyri, of which that of Ebers written about B.C. 1600 is the most important and most complete, prove that even at this early period the physicians were in possession of a very considerable number of drugs, including aloes, acacia gum, myrrh, Indian hemp, hemlock, opium, frankincense, cassia, cummin, coriander, castor seed, and many others. But as far as Western nations are concerned Greece must be regarded as the cradle of medicine. About the middle of the twelfth century before the Christian era temples were built which served as centres for the exercise of the healing art. Most famous among these were the temples of the deified Æsculapius at Epidaurus, Cos, Trika, and Pergamos. At these temples, which were usually situated on high ground in pure air, cures were effected chiefly by hygienic means such as massage, baths, &c. Pythagoras (B.C. 580) added to this hygienic treatment the use of such drugs as squill and mustard. Hippocrates (B.C. 466), who placed the treatment of disease on a more rational basis, was familiar with numerous indigenous as well as exotic drugs, with many of which he doubtless became acquainted during his travels. Wormwood, acacia gum, chamomile, cinnamon, hemlock, gentian, henbane, myrrh, rhubarb, and many others were well known to him.

Theophrastus (about B.C. 370) was a pupil of Aristotle, after whose death he became chief of the Aristotelian school. He enumerates some 500 plants which were known to him, distinguished cinnamon from cassia and was acquainted with

¹ Tschirch, *Handbuch d. Pharmakog.* 1908, p. 7.

ergot. It was during this period (B.C. 335 to 325) that Alexander the Great undertook his expeditions to Persia, India, and Africa, as the result of which numerous treasures, and among them drugs, were brought back to Greece.

Alexander founded Alexandria, which he intended to become the seat of the learning and commerce of the world. Although science in Egypt had fallen so low that the Greeks learnt but little from the Egyptians, the Alexandrian school was invaluable in preserving and transmitting to posterity the writings of Greek and other authors.

After the death of Alexander the Roman Empire rose. During this period Dioscorides, who was a Greek by birth, travelled in Egypt, Africa, Spain, Italy, and Syria, where he became acquainted with a great variety of plants and drugs. His observations and knowledge he placed on record in a compendious work on pharmacognosy which served for many centuries as an inexhaustible source of information. This remarkable work contains classified descriptions of a great number of vegetable, animal, and mineral drugs, no less than 500 medicinal plants, including many exotic ones, being discussed. To Dioscorides belongs the credit of being the first to separate pharmacognosy from medicine.

Pliny, who lived about the same time as Dioscorides and evidently made use to some extent of the same sources of information, studied natural history; his work on this subject consisted of forty-seven books, many of which have been unfortunately lost, Pliny himself perishing in the eruption of Vesuvius (A.D. 79). His 'Natural History,' in addition to books dealing with zoology, meteorology, astrology, &c., treats of as many as 1,000 plants.

Galen (A.D. 131 to 200) was a physician and studied chiefly the production of various 'galenical' preparations, dealing only incidentally with drugs. He recognised the adulteration of cinnamon, pepper, saffron, and myrrh, and points out that exhausted rhubarb was sold in place of the genuine. He wrote twenty books containing a large number of receipts for various preparations.

With the subsequent decline of the Roman Empire, a long period of scientific inactivity or perhaps rather retrogression took place. The Arabian Empire then rose, and seats of learning were established and encouraged at Bagdad, Cordova,

Toledo, &c. The Arabians acted chiefly as the transmitters of Greek and Roman knowledge, adding comparatively little of their own. The most important of their writers were Geber, Rhazes, Avicenna, and Ibn Baitar.

Geber (A.D. 850 ?), who studied at Cordova, wrote chiefly concerning salts of which a considerable number were known to him.

Rhazes (A.D. 875 ?) studied medicine in Bagdad, and with him a period of independent investigation begins. He was acquainted with asafetida, aloes, dandelion, henbane, staves-acre, and numerous other drugs; he prepared extracts by evaporating infusions and made them into pills, which he coated with psyllium mucilage in order to render them less unpleasant to take.

Avicenna (A.D. 980) was perhaps the most gifted of the Arabian physicians and a very prolific writer. His 'Canon Medicinæ' served as the chief source of medical knowledge down to the fifteenth century.

Ibn Baitar (A.D. 1197-1248) devoted himself chiefly to botanical work in which he excelled, his 'Corpus Simplicium Medicamentorum,' containing descriptions of about 2,000 drugs, of which 1,700 were of vegetable origin.

The Arabian school was followed by that of Salerno, near Naples, where a school of medicine, established in the twelfth century or perhaps earlier, was instrumental in continuing scientific work until the dawn of science in Europe in the fifteenth century. During this period the knowledge at least of indigenous medicinal plants was kept alive and added to in the gardens attached to the convents and monasteries of Central Europe.

The beginning of the sixteenth century witnessed a revival in the study of drugs, which was stimulated by the discovery of America, of the West Indies, and of the sea route to India. Matthioli (1501-1577), who studied in Italy, published a commentary on Dioscorides, which enjoyed a great reputation; he also collected and dried plants for pharmacognostical purposes and prepared careful illustrations. Monardes (1493-1578) collected drugs and other products brought from America, forming thus what was probably the first museum of *materia medica*. Clusius (1526-1609) also collected drugs from drug merchants and examined them; his 'Rarium Plantarum

Historia (1601) contains no less than 1,146 illustrations, many of which are of great excellence.

After the lapse of a considerable time, during which little of note was published, Pomet wrote his excellent and well-illustrated '*Histoire Générale des Drogues*' (Paris, 1694), which was closely followed by Lémery's '*Traité Universel des Drogues Simples*' (Paris, 1697) and '*Dictionnaire des Drogues Simples*' (4th ed., Paris, 1727), and later by Geoffroy's '*Tractatus de Materia Medica*' (Paris, 1741).

The period of modern pharmacognosy may be said to open with Guibourt's admirable '*Histoire Abrégée des Drogues Simples*' (Paris, 1820), of which several editions were published. Guibourt relied largely on his own observations, and treated the subject from a purely pharmacognostical point of view. This was not the case with Pereira, whose classical '*Elements of Materia Medica and Therapeutics*' (London, 1839) embraced, as its title indicates, both pharmacognosy and therapeutics. Schleiden was the first to employ the microscope to distinguish drugs by differences in their structure, a departure which was rapidly advanced by Berg and Schmidt ('*Anatomischer Atlas*,' Berlin, 1865), Vogl, and Moeller. Hanbury studied chiefly the botany and commerce of drugs, while Flückiger devoted himself chiefly to the chemistry and history, the collaboration of these two celebrated pharmacognosists resulting in the publication of the classical '*Pharmacographia*' (London, 1874). Meyer ('*Wissenschaftliche Drogen-Kunde*,' Berlin, 1891) followed the morphological development of drugs, Tschirch ('*Anatomischer Atlas*,' Leipzig, 1900) their structural development, and E. M. Holmes their botanical origin.

By these and other workers a mass of material has been accumulated which is now being systematically arranged.

Commerce.—The oldest records of commercial intercourse between different peoples indicate that several thousand years before the Christian era a considerable trade existed in ancient Bactria, the modern Bokhara. At a very early period the Bactrians had undoubtedly made considerable progress in civilisation. The country was extremely fertile, and its position rendered it a convenient centre for the caravans that brought the spices and other products of India and China to Persia and Egypt. From Attock, near Peshawar, in the extreme

north-west of India, caravan tracks led through Kabul to Bactria, and from China a northerly track had the same objective. From Attock similar routes passed through Assyria to the Black Sea, through Syria to the Mediterranean, and through Palestine to Egypt. During this period commerce was carried on almost entirely by caravans, the courses of the various routes being determined partly by the physical nature of the country to be traversed and partly by the presence of populous cities at which intermediate markets might be found ; thus the routes from Bactria to Syria passed through Herat, Ecbatana, Nineveh, Babylon, and Palmyra.

During the rise of the Babylonian Empire (B.C. 2000 to 1000), at the time therefore at which the papyrus of Ebers was written, a considerable commerce existed between India, China, Syria (and the countries bordering on and even beyond the Mediterranean), and Egypt. In this commerce Arabia, favoured by its situation, took a very considerable part. Boats and rafts were used for descending the rivers, beasts of burden carrying the exchange back. Coasting vessels navigated the Persian Gulf, the Red Sea, and the coasts of Arabia and India. Probably it was by one of these routes that cassia and other spices travelled from China to Egypt and frankincense from Somaliland.

Towards the end of this period the Phœnicians developed their maritime commerce in the Mediterranean. Established at Tylos and Arados on the Bahrein Islands (near the western shore of the Persian Gulf) and navigating the Red Sea, the Persian Gulf, and the Indian Ocean, they practically controlled the trade between the East and the West, the outlets to the latter being their ports of Tyre and Sidon. Much of the extensive *materia medica* of the Greeks reached them through the Phœnicians, such as, for instance, gum acacia, cinnamon, cassia, indigo, &c. Rhubarb, on the other hand, probably travelled by caravan from Western China, passing south of the Caspian Sea to the Black Sea and the Bosphorus.

During the Persian Empire (B.C. 600 to 400) the caravan routes were carefully tended and repaired, and every effort made to divert the traffic through Persian territory. About this time Greece had risen to be an important country and carried on an extensive maritime commerce with the Black Sea countries, with Chios, Lesbos, and other islands of the

Grecian Archipelago as well as with Egypt. The conquests of Alexander the Great gave a great impulse to this trade, as they brought the East into contact with the West. The foundation of Alexandria was destined to produce far-reaching results. Its situation made it the natural emporium for this trade, and it rapidly drained the life-blood from Tyre and Sidon.

Shortly after the death of Alexander, Greece declined in importance, and the Romans, having overthrown the Carthaginians, who had succeeded the Phœnicians as the chief traders of the Western Mediterranean, rapidly extended their influence, which reached its zenith during the first two centuries of the Christian era. Rome became the centre of the world. The enormous wealth accumulated there attracted foreign merchants, who employed it as a central market for the distribution of the products from India, China, and other countries.

A trade had now sprung up between the seaports of Arabia and of the Persian Gulf with Ceylon, the Malay Archipelago, China, and Japan. Drugs and spices were landed in Arabia, and found their way thence by caravan to Alexandria, those reaching the Persian Gulf being conveyed by similar means to Syria. From Northern China the old caravan route passing south of the Caspian Sea and through Persia and Syria was still followed.

As Rome fell the Byzantine Empire rose. Byzantium, rebuilt by Constantine A.D. 330 and renamed after himself, occupied a most favoured site. When Alexandria fell to the Arabs (A.D. 640) the Alexandrian route was closed owing to the unwillingness of the Arabs to deal with Christians. The Indian trade was consequently diverted to the caravan routes to Greek colonies on the Black Sea, and thence to Constantinople. Drugs and spices from India and the East were then distributed from Constantinople, either by sea to the Mediterranean or by land to Germany.

Wars with the Mohammedans led, however, to the decline of Byzantine commerce. The Arabs established colonies on the African coast and obtained control of the Mediterranean coast traffic. Their empire rapidly spread from the Indus to the Pyrenees. The caravan routes were revived. At first Damascus and subsequently Bagdad became the centre of this trade and amassed enormous wealth. Their merchants penetrated to Nigeria, Madagascar, Siberia, India, and China.

Canton was connected with the West by a caravan route which in northern Tibet divided into three branches, the most northern reaching the Black Sea, the middle Bagdad, and the most southern Daybal at the mouth of the Indus. Daybal was also the centre of the sea-trade from India, Ceylon, the East Indies, China, and Japan, to Bussorah and Bagdad, to Aden, Cairo, and Alexandria. Cairo received caravans from all parts of Africa bringing both African and Asiatic goods, and it soon rivalled Bagdad in magnificence. Centres of learning were simultaneously established in Bagdad, Cordova, Toledo, &c.

The Arabs became enervated and were gradually driven out of Europe during the fifteenth century. Towards the end of this period the carrying and distributing trade passed into the hands of the Italians. The Pisanese wrested Sardinia, Corsica, and the Balearic Islands from the Arabs, and, assisted by the Crusades, secured for Pisa a lucrative trade, which passed to Genoa and finally to Venice, the latter becoming the chief carrier of the world. She reopened the sea-trade of the Red Sea and Alexandria, which was safer and cheaper than the caravan routes; she received and distributed all the drugs and spices of the East, and thus acquired great power and great wealth, the zenith of her prosperity being reached towards the end of the fifteenth century.

About this time, however, Henry the Navigator, son of King John I. of Portugal, eager to annex the Indian trade, and convinced by information obtained from the Arabs of the possibility of reaching India by sea, explored the west coast of Africa, discovering Madeira and establishing colonies on the mainland. The way was thus paved for Vasco da Gama, who in 1498 discovered the sea route to India, and landed on the Malabar Coast. The Portuguese established ports on the coasts of India, Goa being the chief, colonised Mozambique, the Spice Islands (1511), Ceylon (1518), Java, Sumatra, and Celebes. About the same time Spain became a colonial power. In 1492 Columbus discovered San Salvador, and on his subsequent voyage the West Indies. In 1519-1521 Mexico was conquered by Cortes, and immediately afterwards (1529-1535) Peru and Chili by Pizarro. The cities of Vera Cruz, Cartagena, and Caracas on the east, and of Acapulco, Panama, and Lima on the west, were founded.

The rich commerce of India was now soon diverted to

Portugal, and Lisbon succeeded Venice as the emporium for Europe, a position which it occupied for nearly a century. To Lisbon or to Portuguese merchants in Antwerp the Dutch and English repaired to obtain their supplies of spices. Antwerp became the emporium of the north. When, however, in 1580 Philip II. of Spain united Portugal with Spain, and soon afterwards declared war against England, he closed the ports of his empire to English merchants. This act was followed by the revolt of the Netherlands from Spanish dominion, and both the Dutch and the English found themselves compelled to engage in a direct trade with India.

They thus became rivals of the Portuguese and of one another. The Dutch were at first the more successful. They established themselves in India, in the East Indian Islands, the Moluccas and the Sunda Islands; they drove the Portuguese out, and took possession of the entire trade with India, the East Indies, Japan, and China. They also established colonies in the Cape, and in 1658 took Ceylon from the Portuguese. Several of the West Indian Islands, and part of the north-east of South America, fell into their hands. The commerce of all these colonies and countries flowed into Amsterdam, which thus supplanted Antwerp and Lisbon as the European emporium of Indian trade.

Meanwhile the English, who had met with less success, had nevertheless founded colonies in Calicut, Madras, Masulipatam, Calcutta, and Bencoolen, and had driven the Spaniards from Jamaica, Barbados, and other of the West Indian Islands. In 1600 the first English East Indian Company was formed which built forts in Java, Amboyna, and Banda. At first this company shared the spice trade, but eventually it was driven from the islands by the Dutch, who destroyed all spice trees but those on the island of Amboyna. The English were thus restricted to the coasts of India, where they competed successfully with the Portuguese. After the cessation of the company's charter in 1833 trade rapidly increased. Cotton, sugar, tobacco, tea, coffee, and cinchona were introduced. Singapore, which had become a British possession in 1819, became and still remains the centre of East Indian trade. North America had already been colonised; here and in the West Indian Islands tobacco, allspice, cocoa, indigo, &c., had been introduced, and their cultivation had rapidly extended.

Drug Routes.—At the present time drugs reach the London market chiefly by the following routes :

I. *Central European.*—From Reval and Riga (Russian) ; from Hamburg and Bremen (German) ; from Amsterdam and Rotterdam (Dutch and German) ; from Antwerp (Belgian and Dutch) ; from Dieppe, Boulogne, Havre, and Bordeaux (French) ; in all cases direct to London.

II. *Mediterranean.*—From Lisbon (Portuguese) ; from Vigo, Seville, Malaga, Valencia, and Barcelona (Spanish) ; from Marseilles (French) ; from Genoa, Leghorn, and Bari (Italian) ; from Messina, Palermo, and Catania (Sicilian) ; from Malta ; from Salonica, Constantinople, Smyrna, Alexandretta, Jaffa, Beyrout (Turkish) ; from Suez, Tripoli, Tangiers, Algiers (African) ; either direct to London or often (from the Eastern Mediterranean) viâ Trieste or viâ Marseilles.

III. *North-West African.*—From Rabat, Mazagan, Saffi, Mogadore, Bathurst to London, Liverpool, or Southampton.

IV. *West-Central African.*—From Sierra Leone, Bonny, Lagos, San Thomé, and Benguela to Liverpool.

V. *South African.*—From Cape Town, Mossel Bay, Port Elizabeth, East London, Natal, and Delagoa Bay to Southampton and Liverpool.

VI. *East-Central African.*—From Beira, Chinde, Quilimane, Mozambique, Zanzibar, Mombasa to London (often viâ Hamburg) ; from Mauritius, Réunion, Madagascar, and Seychelles to Liverpool.

VII. *Red Sea, Arabian, and Persian.*—From Suakin, Massowah, Aden, Bunder-Abbas, Bushire, Bussorah, and Bagdad to London.

VIII. *Indian.*—From Karachi, Bombay, Mangalore, Calicut, Cochin, Aleppy, Colombo, Tuticorin, Madras, Calcutta, and Rangoon to London.

IX. *Malayan.*—From the various islands viâ Singapore and Penang to London ; from Batavia viâ Amsterdam to London ; from Saigon viâ Marseilles to London.

X. *Chinese.*—From Shanghai and Hong-Kong, often viâ Havre or Hamburg, to London.

XI. *Japanese.*—From Nagasaki, Kobé, Hiogo, and Yokohama to London.

XII. *North American.*—From Quebec, Montreal, Boston, New York, Baltimore, Newport, New Orleans, and San Fran-

cisco to Liverpool, London, and Southampton, sometimes viâ Havre and Cherbourg.

XIII. *Central American*.—From Greytown and Belize to Liverpool and London, sometimes viâ Hamburg.

XIV. *West Indian*.—From the British islands to Liverpool, Bristol, and Southampton; from the Dutch islands to London viâ Amsterdam.

XV. *South American*.—From La Guayra, Savanilla, Cartagena, and Maranham to Liverpool; from Pernambuco, Bahia, Rio Janeiro, and Buenos Ayres to London and Liverpool; from Montevideo to Southampton; from Valparaiso, Santiago, Mollendo, Truxillo, and Guayaquil to Liverpool.



FIG. 1.—Original packages of drugs (Weigel). A, gourd aloes; B, cassia fistula; C, China root.

XVI. *Australian*.—From Brisbane, Sydney, Melbourne, Adelaide, and Perth to London; from Tasmania viâ Melbourne.

XVII. *New Zealand*.—From Auckland and Wellington to London.

Drug Packages.—The various ways of packing drugs for exportation form an extremely interesting study, as may be gathered from the following examples:—

Aloes is exported from the West Indies, from East Africa, and from Cape Colony. That from the Dutch West Indian Islands usually arrives in wooden cases in which bottled spirits have been exported (compare 'Aloes'), but formerly West

Indian aloes was frequently poured while still soft into empty gourds (fig. 1, A), which were then closed with a piece of cloth and packed in barrels; such gourd aloes is still occasionally seen. Socotrine aloes is commonly sent from East Africa in a pasty or semi-solid condition in kegs (fig. 10) or barrels. Zanzibar aloes is filled while soft into goat-skins, which are afterwards packed in cases.

Cassia fistula is exported from Java in baskets made of plaited split cane (fig. 1, B). China root, much used in China, but now almost obsolete in Europe, and galangal root (fig. 2, E) arrive in mats made of plaited bast (fig. 1, C); a similar



FIG. 2.—Original packages of drugs (Weigel). A and F, seron of Calisaya bark; B, Honduras sarsaparilla; C, dragon's blood; D, compressed lobelia; E, galangal root; G, euphorbium.

covering protects the cases of cassia bark and cassia buds (fig. 3, A, B, C), all of which are exported from China. Cloves are usually sent from Zanzibar in mats made from interlaced strips of cocoanut leaves (fig. 3, D).

'Seron' is the name generally given to packages made of raw hide, such as those in which Calisaya cinchona bark is still occasionally imported (fig. 2, A, F); a similar protection is afforded to bales of Honduras sarsaparilla (fig. 2, B), the ends of which are covered with raw hide laced with strips of the same material. Jamaica and Lima sarsaparilla are made into large disc-shaped bales bound round with iron wire, while the native Jamaica drug is packed loose in bales.

Euphorbium (fig. 2, g) is exported in bales made of plaited reeds and provided with curious handles. Mogadore orris root

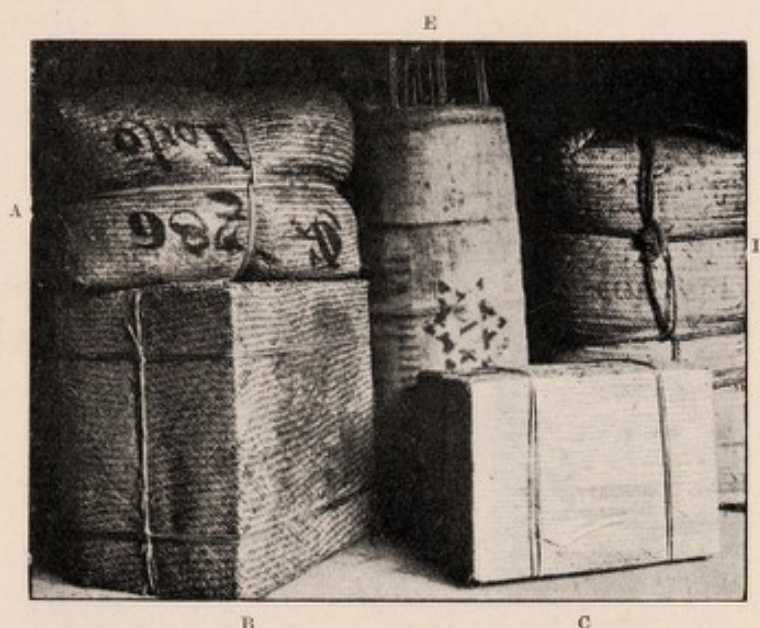


FIG. 3.—Original packages of drugs (Weigel). A, small cassia bark; B, cassia bark in bundles; C, cassia buds; D, Zanzibar cloves; E, cinnamon bark.

arrives in somewhat similar packages. Dragon's blood is exported from Sumatra in lumps (fig. 2, c), which usually bear



FIG. 4.—Original packages of drugs (Weigel). A, Turkey opium; B, balsam of Peru; C, stick liquorice; D, musk; E, isinglass; F, lycopodium; G, vanilla.

the impress of matting, or in sticks, each of which is wrapped in palm leaf and secured by bands of flexible grass. Lobelia

herb is sent either loose in bales (compare 'Lobelia') or in compressed packets (fig. 2, D). Cinnamon bark comes in very carefully made cylindrical bales consisting of sticks of the same length bound together and covered with sacking (fig. 3, E; fig. 12, A). Opium from Turkey (fig. 4, A) is packed in 'chests' with the fruits of a *Rumex* shaken between the cakes to prevent them adhering, while stick liquorice (fig. 4, C) is packed with bay leaves. Vanilla (fig. 4, G) comes in small bundles, several of which are enclosed in a tin, balsam of Peru and copaiba in old oil-canisters. Musk pods (fig. 4, D;

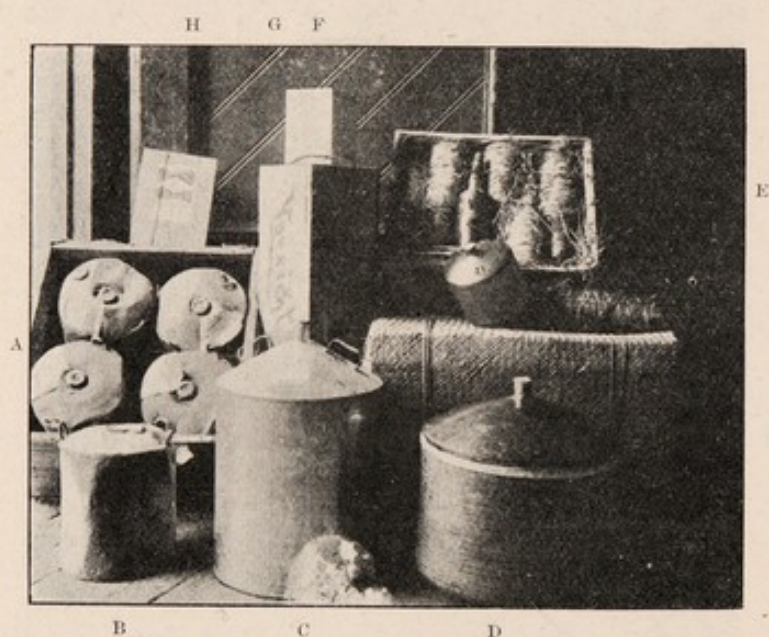


FIG. 5.—Original packages of drugs (Weigel). A, cassia oil; B, star-anise oil; C, lavender oil; D, lemon oil; E, lemongrass oil; F, Japanese peppermint oil; G, American peppermint oil; H, Japanese menthol.

compare also 'Musk') are wrapped singly in thin paper and packed in tins, which are enclosed in silk-covered 'caddies.'

Menthol is exported in tins, oils of cassia and star-anise (fig. 7) in leaden canisters, oil of lavender in tins, oils of lemongrass and cajeput in wine-bottles, oils of lemon and bergamot in coppers of varying size (fig. 5, D), while otto of rose arrives in metal 'vases' covered with felt (fig. 6).

Sale of Drugs.—The bulk of the drugs sold in London arrive by sea. From the steamers bringing them they are conveyed either by lighters or by railway to the wharves that line the river bank or to the extensive warehouses of the London and India (or other) Dock Company.

Most foreign drug growers or drug merchants have no offices in London in which to sell their goods ; they therefore



FIG. 6.—Vase of otto of rose.



FIG. 7.—Leaden canisters of star-anise oil.

effect this through a drug broker as intermediary. In and around Mincing Lane a number of firms conduct the business of selling on commission not only drugs but also a great variety of other produce. To one of these the foreign drug merchant consigns his goods, advising the firm of their dispatch. On their arrival in London the broker procures samples from the various packages and exhibits these at intervals on counters in his office. This exhibition constitutes what is known as a 'drug show' and is held on alternate Wednesdays. The

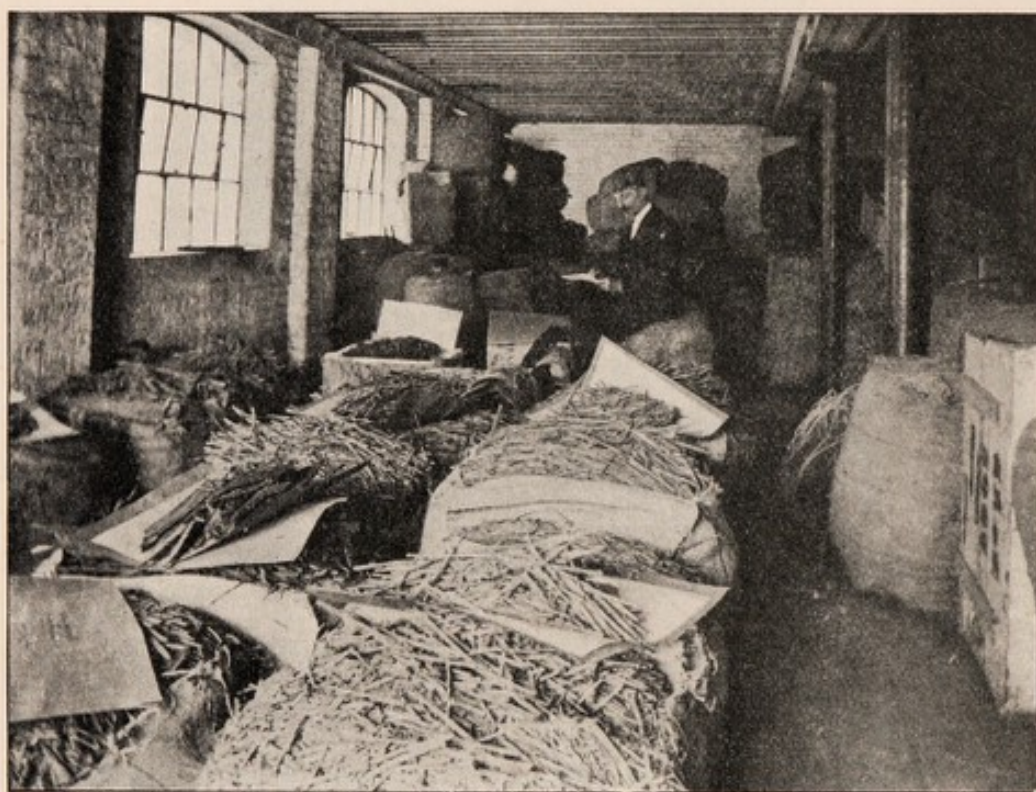


FIG. 8.—Sampling a few bales of bark. (Heap.)

show is attended by representatives of such drug merchants as desire to purchase, who note the parcels they wish to buy and the price they are prepared to give. On the day following the show the goods are sold by auction and this constitutes a 'drug sale.'

Sometimes the broker sells direct to a customer at a price previously agreed upon; this is sale by private treaty. Not unfrequently the drug producer sells his produce to an agent in the same district or country, who, in his turn, deals direct

with the drug merchant in London; such purchases are then shipped direct to the purchaser.

Although most drugs are sold by sample, in a number of instances the original packages are exhibited so as to allow of the inspection of the contents. These are shown in a well-lighted, lofty top-floor of the Crutched Friars warehouse of the London and India Dock Company, and also at the warehouses



Fig. 9.—Sale room of Messrs. Hale & Son. On the centre and window-tables various drugs; on the table to the left chiefly bristles; on the floor sample-bags of drugs. (Heap.)

of the London and other docks, &c. Original packages of the following drugs are usually shown: aloes (excepting Cape aloes), benzoin, dragon's blood, elemi, gamboge, guaiacum resin, ipecacuanha, myrrh, sarsaparilla, scammony gum-resin, jalap, rhubarb, musk, castor, balsam of tolu, vanilla, &c. Other floors in the same warehouse serve for the storage of a variety of drugs pending their sale or removal; among these the following may be noted: aloes, aniseed, areca nuts,

alkanet root, buchu leaves, calumba root, canella bark, cantharides, cardamoms, cascara sagrada, cassia fistula, castor seeds, chamomile flowers, chiretta, cocculus indicus, colocynth,



FIG. 10.—Drug-show at Crutched Friars warehouse.
(By permission of Messrs. Chas. Smith, Son and Gowland.)

croton seeds, cubebs, fennel fruits, galls, gentian, grains of paradise, Indian hemp, kola seeds, nux vomica, opium, orris root, quassia, saffron, sandal-wood, senna, squill, turmeric,



FIG. 11.—A drug and gum show at London Docks. (Heap.)

valerian, &c. Sometimes drugs are 'worked' before they are sold; they are then usually emptied on to the floor of the warehouse, mixed or sorted as required, and repacked in the

cases. Spices such as pepper, cloves, ginger, nutmeg, cassia, pimento, and chillies, together with tapioca and arrowroot,



FIG. 12.—Show of drugs at London docks; A, cinnamon bark; B, cinchona bark; C, Zanzibar cloves; D, various bales of drugs. (Heap.)

are included in the spice sales. Cinnamon auctions are held once a month.



FIG. 13.—Bales of drugs in London Docks. (Heap.)

After arrival in the drug merchants' warehouse the drugs have to undergo further treatment before they are sold to the

pharmacist. They are examined, freed from dust and dirt by sifting, and graded either by sifting or hand-picking ; they have



FIG. 14.—Working tragacanth. (Heap.)

frequently to be further tested by assay. Few drugs, therefore, reach the pharmacist in the condition in which they are imported.

SECTION I

LEAVES

Leaves may be defined as appendages borne upon an axis but differing from it in structure and organisation. They usually exhibit three regions, viz. a leaf-base, a stalk or petiole, and a lamina or blade. Each of these regions may offer characters that are useful in identifying the leaf. The following schedule of points to be observed may assist the student in examining leaves.

i. *Size and Shape*.—These must be carefully observed, although they may vary within certain, sometimes rather wide, limits. Should the leaf have shrivelled so much as to render them undeterminable it should be soaked in warm water and gently spread out on a white tile.

ii. *Venation*.—The shape of the leaf being to some extent determined by the venation this should be carefully examined. Not only the mode of branching of the midrib, but the angle at which the branches (lateral veins) leave it, the course they pursue, and their elevation above or depression below the surface of the leaf should be noted.

iii. *Margin*.—This should next be scrutinised ; it may be entire, serrate, crenate, dentate, sinuate, &c.

iv. *Apex*.—This may be rounded, pointed, notched, &c.

v. *Base*.—The appearance of the base should also be noted.

vi. *Surface*.—The surface should be examined with a lens, and the presence or absence of external hairs, as well as the character of the latter, glandular or otherwise, be determined ; this particular is of very great importance.

vii. *Glands*.—Many leaves contain internal oil-glands or oil-cells which can usually be seen as translucent points when the leaf is examined with the lens by transmitted light. In very thick leaves they may be difficult to see, and it may be necessary to examine a section under the microscope.

viii. *Texture*.—This may be papery, leathery, fleshy, &c.

ix. *Colour*.—This may be greyish green, dark green, brownish, etc.

x. *Odour*.—This is best determined by crushing the leaf between the fingers and smelling it.

xi. *Taste*.—Often very characteristic.

xii. *Petiole*.—Presence or absence of a petiole; its length and nature if present should be observed.

TEA

(*Folia Theæ*)

Source &c.—The tea shrub, *Camellia Thea*,¹ Link (N.O. *Ternstræmiaceæ*), from the leaf-buds and young leaves of which the black and green teas of commerce are prepared, has been cultivated from time immemorial in China and Japan, and more recently in Assam, Ceylon, Java, and other countries in which the climate is suitable.

In the manufacture of black tea the leaves are subjected to processes that vary somewhat in the different countries. In Assam, where much of the tea consumed in England is produced, the leaf-buds together with two or three of the youngest leaves are collected and spread upon trays until they have lost their turgidity. The 'withered' leaves are then rolled between two flat surfaces worked by machinery, during which many of the cells of the mesophyll are broken, and their sap squeezed out and allowed to come into contact with the air; at the same time the leaves acquire the twist characteristic of ordinary tea. They are next 'fermented' by exposing them on mats to the air; during this process, which is conducted at a temperature of 35°–40° C., the colour changes from green to yellow and finally to coppery red, and the tea acquires its well-known odour. The fermented leaves are dried in special drying-machines by a current of hot air, and are finally sifted through

¹ Specific names are written with a small initial letter, except in the following cases:

- (a) When the specific name was formerly a generic name, e.g. *Camellia Thea*.
- (b) When the specific name is the vernacular name, e.g. *Pilocarpus Jaborandi*.
- (c) When the specific name is the proper name of a person used as a noun or as an adjective, e.g. *Garcinia Hanburyi*; *Aloe Hanburiana*.
- (d) When the specific name is a noun, e.g. *Eucalyptus Globulus*.

sieves of varying size. These separate the leaf-buds, the small and the larger leaves, and in this way the various qualities are produced.

The change that takes place during the fermentation is due to the action of an enzyme ferment or more probably mixture of ferments to which the name of thease has been given. This ferment, which is very active at 54°C ., but is destroyed by a temperature of 76° – 77°C ., oxidises part of the tannin, converting it into a reddish brown, insoluble substance, while at the same time traces of volatile oil are produced and a bitter principle present in the fresh leaves is rendered insoluble. The quality of the tea produced depends largely upon the skill with which this process is conducted.

Green tea is prepared in a different manner. The leaves, which at most are only slightly withered, are subjected to a process of roasting in pans heated by direct fire, in which they are kept continually moving; they are then cooled, rolled into balls, and allowed to ferment. After fermentation, during which the leaf retains its green colour, the leaves are rolled (by hand singly into small balls for the variety known as gunpowder tea), dried, and thrown into rotating drums, in which by the friction of leaf against leaf the final characteristic colour of green tea is produced.

In this case the preliminary roasting probably destroys some at least of the various ferments of which the thease is composed, the tannin is not oxidised, and the leaves retain their green colour more or less unchanged.

Description.—The full-grown tea leaf is from 5 to 10 cm. long, dark green in colour, lanceolate or elliptical in outline, blunt at the apex, and tapering at the base into a short stalk; the margin is distantly and shortly serrate, the serrations terminating in characteristic, shrunken glandular teeth which readily break off and are often absent from mature leaves. When quite young the leaves are covered with silky hairs, but as they mature these are lost, and the surface becomes glabrous. This difference is readily observed in commercial tea, the bud still bearing numerous hairs ('flowery' Pekoe), while the larger leaves are glabrous or nearly so (Congou).

Microscopical characters.—Fragments of the leaves may be readily recognised under the microscope by the small cells of the upper epidermis, those of the lower epidermis being rather larger

and accompanied by numerous large stomata and long, thick-walled, one-celled simple hairs bent near the base; in the mesophyll, especially of older leaves, large, elongated, branching, thick-walled, sclerenchymatous idioblasts occur.¹

Constituents.—The principal constituents of tea are caffeine and tannin. It contains in addition traces of theobromine and theophylline, as well as of a volatile oil, to which its agreeable odour is due.

Caffeine or trimethyl-xanthine, $C_5H(CH_3)_3N_4O_2 \cdot H_2O$, an alkaloid obtainable in colourless silky crystals melting at $237^\circ C.$, was first discovered in coffee by Runge in 1820. In 1827 Oudry extracted a crystalline substance from tea, which was considered to be distinct from caffeine and termed theine, but the identity of these two alkaloids has, however, now been satisfactorily demonstrated. Caffeine occurs also in maté (the leaves of *Ilex paraguayensis*, Lambert, which are largely used in the Argentine Republic as tea is in this country), in cola seeds, and in guarana; it is present in tea in proportions varying from 1 to 5 per cent., Ceylon and Assam tea showing little variation from an average of about 4 per cent. (Paul and Cownley, 1887; Koch, 1900). The tannin varies from 10 to 24 per cent. in the same two varieties of tea (Hooper, 1889). But the commercial value of tea is not determined by the percentage of caffeine or of tannin contained in it, but by a combined consideration of several factors, such as appearance, which counts to a considerable degree, the size of the leaves as indicating their age, the presence of 'tip' (unexpanded leaf-bud), and the taste of the infusion (Paul and Cownley).

Theobromine, or dimethyl-xanthine, $C_5H_2(CH_3)_2N_4O_2$, and the isomeric theophylline are closely allied to caffeine, but occur in small proportion only.

Caffeine, theobromine, and theophylline are all derivatives of xanthin, $C_5H_4N_4O_2$, which, with a number of other substances, is regarded as containing the purin group, $C_5H_4N_4$. Tea, coffee, and other drugs containing caffeine, theobromine, or a similar purin derivative form therefore a natural group the members of which are allied by the similarity of their chief constituents.

The following are the most important drugs belonging to the purin group:

Tea, the leaves of *C. Thea*, containing caffeine (1 to 5 per cent.), theobromine, and theophylline.

Coffee, the seeds of *Coffea arabica*, Linné (N.O. *Rubiaceæ*), containing caffeine.

¹ Compare Greenish, *Foods and Drugs*, p. 117; Greenish and Collin, *Anatomical Atlas*, p. 89.

Cola Seeds, the seeds of *Cola vera*, Schumann (N.O. *Sterculiaceæ*), containing caffeine (2 to 2.5 per cent.) and traces of theobromine.

Maté, the leaves of *Ilex paraguayensis* (N.O. *Ilicineæ*), containing caffeine (1 per cent.).

Guarana, the crushed seeds of *Paullinia Cupana*, Humboldt, Bonpland, and Kunth (N.O. *Sapindaceæ*), containing caffeine (2.5 to 5 per cent.).

Cocoa, the seeds of *Theobroma Cacao*, Linné (N.O. *Sterculiaceæ*), containing theobromine (2 per cent.).

Assay.—Shake 6 gm. of the dried but not powdered tea with 120 gm. of chloroform for 15 minutes, add 6 c.c. of solution of ammonia, shake frequently for half-an-hour and set aside till clear. Filter 100 gm. (= 5 gm. of tea) into a flask, distil off the chloroform, add 3 c.c. of absolute alcohol, and dry on a water-bath. To the residue add 10 c.c. of 60 per cent. alcohol in which the caffeine is readily soluble, then 20 c.c. of water; shake vigorously, filter through a small filter, wash the residue and filter, evaporate, dry at 95° C., and weigh. The weight of the residue multiplied by 20 gives the percentage of total caffeine.

Adulterations.—Tea has been largely adulterated with foreign leaves, as well as with exhausted tea leaves that have been rolled and dried. For details concerning the detection of adulterations in tea, the student should refer to Allen's 'Commercial Organic Analysis,' Vol. III., Part II.

Uses.—The chief pharmaceutical use of tea is as a source of caffeine which has a marked stimulant action on the nervous system and heart, and is also diuretic but less powerfully so than theobromine.

COCA LEAVES

(Folia Cocæ)

Source &c.—In Peru and Bolivia the coca shrub has been cultivated for so many centuries that the plant is no longer known in the wild state. It certainly occurs in several distinct forms, which, according to the British Pharmacopœia, are to be considered as varieties of one species, viz. *Erythroxylum Coca*, Lamarck (N.O. *Lineæ*). The dried leaves of the plant are in daily use by the Indians, to whom they have become an almost indispensable nerve-stimulant; mixed with lime or with the ashes of a species of *Chenopodium* and chewed they

impart unusual powers of endurance, allaying the cravings of hunger and the feeling of fatigue. On the steep sides of the valleys in the spurs of the Andes the coca is cultivated in large quantities. The leaves are picked twice in the year, or sometimes oftener, and dried. Only a very small proportion of the coca produced is exported; by far the greater part is consumed by the natives, whilst a considerable quantity is used in Callao for the manufacture of cocaine, the crude alkaloid being exported instead of the leaves.



FIG. 15.—Bolivian coca leaf. A, upper surface, showing the prominent veinlets; B, under surface, showing the lines on each side of the midrib. Natural size.

There are two well-marked varieties of coca leaves, commercially known as *Bolivian* or *Huanuco*, and *Truxillo* or *Peruvian*, these names indicating their geographical sources.

Description.—*Bolivian* coca leaves usually reach the English market in a fairly good state of preservation. They have a characteristic brownish green colour, and are oval in outline, varying usually from 4 to 8 cm. in length and from 2.5 to 4 cm. in breadth, although it is possible to find

leaves that are much smaller. Both surfaces of the leaf are glabrous, and the lateral veins and veinlets are distinctly prominent. The margin is entire, and the lamina tapers towards both base and apex; the latter is acute, the midrib projecting in the form of a minute horny point (apiculus), which, however, is frequently broken off. When the upper surface of the leaf is examined with a lens the midrib is usually seen to lie in a slight depression; above it, and following its course, a raised ridge may be observed. On the under surface near to the reddish brown midrib, and on either side of it, a distinct curved line runs from the base to the apex of the leaf. This line is slightly raised above the surface of



FIG. 16.—A, under surface of Bolivian coca leaf; B, of Peruvian coca leaf, showing the difference in the veinlets. Magnified.

the lamina and consists of narrow, elongated cells; it is formed in the young leaf, each half of which is inrolled (involute) in the bud and forms a ridge closely applied to a similar ridge on the other half. Although the leaf is not thick it is by no means fragile, the lateral veins and veinlets being comparatively strong, and hence prominent on the upper surface (fig. 16). When a transverse section is examined under the microscope most of the epidermal cells of the under surface will be seen to project in the form of small papillæ; in surface view these appear as circular rings.¹ This peculiarity, although exhibited by other species of *Erythroxylum*,

¹ Compare Greenish and Collin, *Anatomical Atlas*, p. 63.

is so unusual as to render it of considerable diagnostic importance; hence its introduction into the British Pharmacopœia. This variety of coca is cultivated in Ceylon, whence considerable quantities are now exported.

Coca leaves have a faint but characteristic odour. The taste is slightly bitter, the leaves producing, when chewed, a feeling of numbness in the mouth and throat. The small, oblong-ovoid, dark brown, pointed fruits are occasionally found in the drug.

Truxillo or *Peruvian* coca leaves are rather smaller than the Bolivian; they are pale green in colour and are more fragile, hence they are usually more or less broken. On the under surface the two curved lines are much less distinct; on



FIG. 17.—Java coca leaf.
(Burck.)

the upper surface the ridge above the midrib is less marked; on the under surface the veinlets are less prominent and the midrib green in colour. These leaves frequently contain an admixture of the carefully picked and dried flowers of a species of *Inga*; this is an intentional addition, made apparently with the view of improving the coca, and is not an adulteration. The *Inga* flowers are about 2 cm. long, and are easily recognised by their yellowish brown, tubular, hairy calyx and numerous deep red filaments forming

a plume. The pale, reddish brown fruits of the coca are also occasionally to be found.

The plant that yields this variety of coca has been distinguished as *E. truxillense*, Rusby.

In addition to these two varieties some quantity of coca is also exported from Java, usually in the form of coarse powder. The botanical source of this variety appears to be *E. truxillense*. It does not reach the English market, but is imported into Germany viâ Amsterdam for the extraction of cocaine.

The student should observe in both Bolivian and Truxillo coca leaves

- (a) The curved lines on the under surface of the leaf,
- (b) The minute horny apiculus,
- (c) The characteristic odour and taste;

in the Bolivian leaves :

- (d) The *brownish green colour, prominent veinlets, and less broken appearance,*
- (e) The *ridge above the midrib;*

in the Truxillo leaves :

- (f) The *pale green colour, broken appearance, and less prominent veinlets,*
- (g) The *absence of a distinct ridge over the midrib.*

Constituents.—Coca leaves contain several alkaloids, the most important of which is cocaine, $C_{17}H_{21}NO_4$, which forms colourless monoclinic prisms with a bitter benumbing taste. Bolivian leaves contain more of this alkaloid than the Peruvian, but the quantity is usually less than 1 per cent. Other alkaloids of less importance are cinnamyl-cocaine and truxilline; these are frequently present in Peruvian leaves in larger quantity than cocaine. All these alkaloids are easily hydrolysed, and they all yield, together with other products, a crystalline alkaloid, ecgonine, from which by suitable treatment cocaine can be regenerated. Thus cocaine, when hydrolysed by heating to $100^{\circ}C.$ with hydrochloric acid, yields methyl alcohol, benzoic acid, and ecgonine; cinnamyl-cocaine yields methyl alcohol, cinnamic acid, and ecgonine; and truxilline yields methyl alcohol, truxillic acid, and ecgonine. Ecgonine is very closely allied to tropine. (See under 'Belladonna Leaves'.)

In leaves imported from Java benzoyl-pseudotropine or tropacocaine has been found; this alkaloid yields, when hydrolysed, benzoic acid and pseudotropine; the latter is isomeric with tropine. This variety of coca contains about 0.7 per cent. of total alkaloid; it also contains four yellow, crystalline glucosides.

Coca leaves contain, in addition, cocatannic acid.

Assay.—Shake 12 gm. of the finely powdered leaves with 120 gm. of ether frequently during 10 minutes; add 5 c.c. of solution of ammonia and 5 c.c. of water, shake frequently and vigorously during half-an-hour and set aside. Filter 80 gm. of the ethereal solution (= 8 gm. of leaves) through cotton wool into a separating funnel and shake out with 0.5 per cent. hydrochloric acid till

exhausted. Mix the acid solutions, make alkaline with ammonia, and shake out with ether. Filter the mixed ethereal solutions through wool, recover the ether, evaporate, dry at 100°, and weigh.

Uses.—Coca is a stimulant tonic and restorative, and is used during convalescence. Cocaine hydrochloride, when administered hypodermically, or applied to an exposed mucous surface, rapidly paralyses the sensory nerves and thus produces local anæsthesia. It is therefore of great value and much used in minor surgical operations of the eye, nose, ear, &c.

BUCHU LEAVES

(Folia Buchu)

Source &c.—The official buchu leaves are obtained from *Barosma betulina*, Bartling & Wendland (N.O. *Rutaceæ*), a small shrubby plant indigenous to Cape Colony. The drug, the use of which appears to have been learnt from the Hottentots, was introduced in 1821, but this was probably not derived from the species now official. The leaves are collected while the plant is flowering and fruiting, dried, and exported from Cape Town.

Description.—The leaves of *Barosma betulina*, commercially known as 'short' buchu, average from 1 to



FIG. 18.—Buchu leaves (*B. betulina*), showing the shape, margin, and recurved apex. Natural size.

2 cm. in length, and are of a pale green colour. They have a very characteristic, rhomboid-obovate outline, and a blunt, strongly recurved apex. They are rigid and brittle when quite dry, but become cartilaginous when moist. The surface is glabrous or very nearly so, the upper presenting small wart-like prominences due to the elevation of the epidermis by subjacent oil-glands; the lower surface is finely wrinkled. The margin is provided with numerous, minute, sharp teeth.

When examined with a lens by transmitted light the lamina exhibits oil-glands distributed throughout it, but especially near the margin, one being situated at the base of each indentation. Not unfrequently the small flowers with five whitish petals and the brownish fruits with five carpels may be found in the drug.

The leaves have a characteristic odour recalling peppermint, readily perceptible when they are crushed, and a strong aromatic taste.

The student should carefully observe

- (a) The *rhomboidal outline and recurved apex*,
- (b) The *oil-glands* and their distribution,
- (c) The *characteristic odour and taste*;

and should compare the official variety with the other commercial buchu leaves mentioned below, as well as with

Bearberry leaves, which are rounded at the apex, spatulate in outline, and destitute of oil-glands.

Constituents.—The principal constituents of buchu leaves are volatile oil and mucilage, the former being contained in the oil-glands, whilst the latter is deposited on the inner walls of the epidermal cells. They contain in addition a yellow crystalline substance, hesperidin, which is found in several other Rutaceous plants, but does not markedly contribute to the physiological action of the drug; this substance forms spherocrystals in the epidermal cells. The volatile oil, of which short buchu yields from 1·3 to 2 per cent., deposits about 30 per cent. of crystalline diosphenol, $C_{10}H_{16}O_2$, when it is cooled. Diosphenol has antiseptic properties, and is considered by some to be the most important constituent of buchu; its absence from the variety known as long buchu has led to the exclusion of the latter leaves from the British Pharmacopœia. The oil also contains a ketone, probably identical with menthone, to which the peppermint-like odour is due.

Buchu also contains traces of a crystalline, therapeutically unimportant substance, diosmin, which is probably a glucoside.

Varieties.—*Barosma serratifolia*, Willdenow.—The leaves of this plant, which, like *B. betulina*, is also a native of South Africa, are imported in considerable quantity, and known

commercially as 'long buchu.' They are long narrow leaves, about 2.5 to 4 cm. long and linear-lanceolate in outline. The margin is serrate, and the apex distinctly truncate. The leaves contain oil-glands similar to those of short buchu, one being distinctly visible in the truncate apex when examined with a lens. In odour and taste they resemble short buchu;



FIG. 19.—Buchu leaves (*B. serratifolia*). Natural size.

they contain mucilage and about 1 per cent. of volatile oil, which, however, as previously mentioned, does not yield diosphenol when cooled.

The leaves of *Empleurum serrulatum*, Aiton (N.O. *Rutaceæ*), were formerly occasionally imported and offered as 'long buchu.' They closely resemble the leaves of *B. serratifolia* in appearance, and, like them, contain oil-glands, but may be dis-



FIG. 20.—Buchu leaves (*B. crenulata*). Natural size.

tinguished by the following characters: the leaves taper gradually to an acute apex in which no oil-gland is visible, the odour is different, the taste bitterish, and the colour usually yellowish green.

Barosma crenulata, Hooker.—The leaves of this plant are also imported from the Cape of Good Hope, but in smaller

quantity than either of the preceding varieties of the drug. They are rather broader than the long buchu, varying in outline from lanceolate to oval-oblong. The margin is minutely serrate, and the apex is blunt but not recurved (as in *B. betulina*). In odour and taste they resemble the official leaves; they yield about 1·6 per cent. of volatile oil, which also contains diosphenol.

The leaves of other species of *Barosma* are occasionally imported; the three varieties described are the only important ones and are readily identified by the characters given.

Uses.—Buchu is regarded as possessing a tonic and diuretic action; it is used in inflammatory conditions of the urinary tract.

JABORANDI LEAVES

(Folia Jaborandi)

Source &c.—The name jaborandi is applied in South America, especially in Brazil, to a number of plants belonging chiefly to the natural orders Piperaceæ and Rutaceæ. The official description in the British Pharmacopœia limits the drug to the leaflets of a Brazilian shrub, *Pilocarpus Jaborandi*, Holmes (N.O. Rutaceæ).

Although the various jaborandis have long been used in South America, the sudorific and salivatory properties of the official drug were unknown in Europe till 1873, when the leaves were sent from Pernambuco to Paris. The demand that quickly arose for the drug was so large that the supply of the Pernambuco leaves was soon exhausted, and other varieties of jaborandi were exported in their place. To a certain extent these conditions still obtain. The supply of the official leaves is limited, and other varieties of jaborandi are from time to time exported, either in the place of, or mixed with, the official variety. This being the case, the attention of the student should be carefully directed to the diagnostic characters of the official drug.

The plant produces large, imparipinnate, compound leaves, with from two to four pairs of leaflets. These are collected, dried, and exported chiefly from Pernambuco and Ceara. The drug, as it arrives in this country, consists principally of the leaflets mixed with the petioles and occasional small fruits. The leaflets

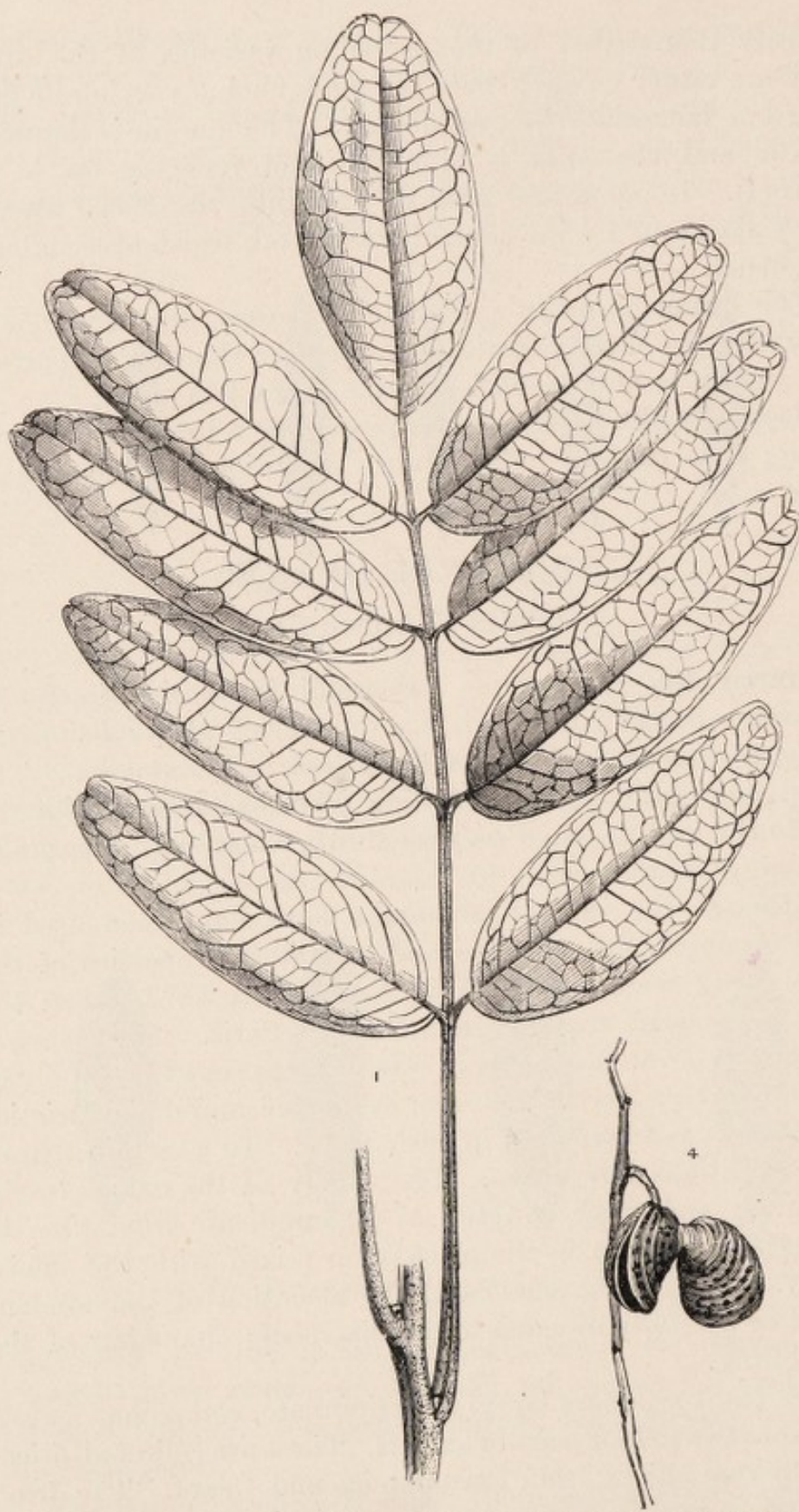


FIG. 21.—1, An entire leaf of Jaborandi, reduced ; 4, fruit of the same, natural size. (Holmes.)

alone are official, and they are described and commonly known as jaborandi leaves, although this designation is not strictly correct.

Description.—Jaborandi leaves are usually dull brownish green in colour, coriaceous in texture, and oblong-lanceolate in shape, varying in length from 6 to 10 cm. The margin is entire and revolute; the apex is blunt and emarginate. The leaf is attached to a short stalk, and is rounded at the base and usually unequal, but the terminal leaflet in each compound leaf is equal at the base. On the upper surface, which is quite glabrous, the lateral veinlets are distinctly prominent the under surface is generally glabrous, but sometimes bears a few scattered hairs.

Examined by transmitted light, large oil-glands are easily visible in the mesophyll of the leaf. The crushed leaves exhale a characteristic but not powerful odour; they possess an aromatic pungent taste, and, when chewed, produce a copious flow of saliva.

The student should carefully observe

- (a) The *presence of oil-glands*,
- (b) The *entire margin*,
- (c) The *emarginate apex*,
- (d) The *inequality at the base*,
- (e) The *prominence of the veinlets on the upper surface*
which is *brownish green* in colour,
- (f) The *glabrous or almost glabrous* under surface;

and should compare these leaves with

- (i) *Cherry-laurel leaves*, which have a serrated margin, pointed apex, and no oil-glands,
- (ii) *Bay leaves*, which are pointed at the apex, equal at the base, and have wavy margins,
- (iii) Other varieties of *jaborandi leaves*, from all of which they are distinguished by their brownish green colour, prominent veinlets, and glabrous surface.

Constituents.—Jaborandi contains three alkaloids—pilocarpine, isopilocarpine, and pilocarpidine, the total quantity varying from 0.5 to nearly 1 per cent. Of these alkaloids pilocarpine is the most important and occurs in the largest pro-

portion, seldom, however, exceeding 0.5 per cent. (Jowett, 1900). It has been obtained in the form of a colourless, amorphous, semi-solid mass of the formula $C_{11}H_{16}N_2O_2$, yielding crystalline salts, the nitrate being characterised by its melting point ($178^\circ C.$) and slight solubility in 95 per cent. alcohol (1 in 146).

Isopilocarpine is isomeric with pilocarpine, from which it is easily produced by the action of heat or alkalies; it is much less active than pilocarpine.

Pilocarpidine occurs in small amount only.

Jaborandi also contains about 0.5 per cent. of volatile oil consisting chiefly of terpenes.

Assay.—The total quantity of alkaloid in jaborandi may be determined by the following process: Moisten 10 gm. of the leaves in fine powder with 2 c.c. of solution of ammonia and 3 c.c. of chloroform, pack in a small percolator and percolate to exhaustion with ammoniacal chloroform. Shake out with diluted sulphuric acid, make alkaline, and shake out again with chloroform. Evaporate the chloroformic solution to dryness, dissolve the residue in 7 c.c. $\frac{N}{10}$ sulphuric acid and titrate back with $\frac{N}{50}$ solution of potassium hydroxide, using cochineal as indicator. Each c.c. of the acid indicates 0.02 gm. of alkaloid.

Uses.—Jaborandi stimulates the nerve endings to the salivary, sweat, gastric, and other secreting glands, and induces therefore profuse salivation and perspiration. It is chiefly given as a powerful and rapid diaphoretic, and appears to be of most service in renal disease, eliminating both water and urea. Pilocarpine is used in ophthalmic surgery to contract the pupil of the eye; it is antagonistic to atropine.

Substitutes &c.—Several substitutes for the official leaves have appeared from time to time in the English market. As the majority contain little or no pilocarpine, their absence from the official drug should be carefully ensured. The following are the chief substitutes and their distinguishing characters:

P. pennatifolius, Lemaire.—The leaflets of this species closely resemble the official leaves, but are paler, being usually of a greyish green colour and less coriaceous in texture. The veinlets are not prominent on the upper surface, and the leaflets are usually equal and taper at the base. They have been imported from Paraguay, and hence are sometimes designated

'Paraguay Jaborandi.' They contain but little alkaloid (0.2 to 0.3 per cent.).

P. selloanus, Engler.—The leaflets are imported from Rio Janeiro and closely resemble the above, but are more obovate.

P. trachylophus, Holmes.—The leaflets are smaller than those of either *P. Jaborandi* or *P. pennatifolius*, and are dark olive green on the upper, yellowish green on the under surface. They are especially distinguished by the under surface, which is clothed with short curved hairs, similar ones being found scattered on the upper surface.

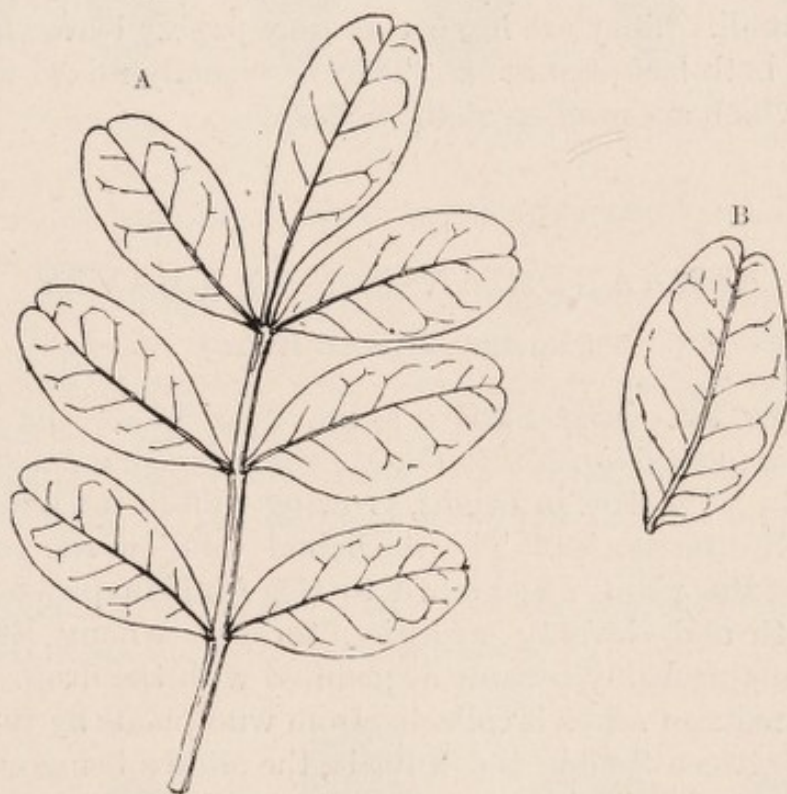


FIG. 22.—A, Leaf, and B leaflet of *Pilocarpus microphyllus*. (Holmes.)

They contain about 0.4 per cent. of total alkaloid (Paul and Cownley, 1896), of which only 0.02 per cent. formed a crystalline nitrate, and was possibly pilocarpine.

P. microphyllus, Stapf.—The leaflets are even smaller than those of the preceding, measuring from 2.5 to 4 cm. in length; they are usually ovate in outline and deeply emarginate at the apex; the rachis is slightly but distinctly winged. The leaves are comparatively rich in alkaloid, yielding up to 0.99 per cent. of pilocarpine nitrate. They are imported in large quantities into Liverpool, whence they are sent chiefly to

Germany, and are the principal source of the alkaloid pilocarpine.

P. spicatus (?); Aracati Jaborandi.—The leaves resemble bay leaves in size and shape; the upper surface is polished, the veins are scarcely visible, the outline is lanceolate, and the petiole short and twisted.

P. racemosus, Vahl; Guadeloupe Jaborandi. The leaves are ovate and very large, attaining 17 cm. or more in length; they contain from 0.6 to 1.0 per cent. of total alkaloid, about one-half of which appears to be pilocarpine.

Piper Jaborandi, Velley.—These leaves have been imported as jaborandi. They are large thin grey papery leaves tapering towards both base and apex. They are usually mixed with the stems, which are swollen at the nodes.

ALEXANDRIAN SENNA LEAVES

(*Senna Alexandrina*)

Source &c.—Alexandrian senna consists of the leaflets of *Cassia acutifolia*, Delile (N.O. *Leguminosæ*), a small shrub from 1 to 1.5 metres in height, growing wild in the middle and upper Nile territories. The medicinal value of the pods and leaves of the plant was known to the Arabian physicians of the tenth and eleventh centuries, through whom European physicians probably became acquainted with the drug.

Alexandrian senna is collected from wild plants by Bedouins, chiefly between Suakin and Kassala, the shrubs being cut down and dried. The leaflets are then separated and brought to the Red Sea ports or conveyed down the Nile to Cairo, where they are carefully sorted, packed in bales or cases, and sent to Alexandria for exportation.

Description.—The plant produces a paripinnate compound leaf about 10 cm. in length. The leaflets, which constitute the Alexandrian senna of the British Pharmacopœia, average about 2.5 cm. in length, not exceeding 4 cm., and, when dried, are of a pale greyish green colour, thin, and brittle in texture. In shape they vary from lanceolate to ovate-lanceolate. The margin is entire and the apex acute and mucronate. At the base the leaves are decidedly unequal, and on the under surface

the veins are distinct. When examined with a lens both surfaces of the leaf are seen to be pubescent, small hairs being distinctly visible, especially near the veins. These hairs, when examined under the microscope, are found to be one-celled and thick-walled, and form a means by which senna leaves can be



FIG. 23.—Alexandrian Senna leaves. Natural size.

distinguished from argel leaves (see below), the hairs of which are three-celled.

The leaves frequently appear in commerce in a more or less broken condition due to their brittle papery texture. They curl slightly as they dry, and, being loosely packed, retain this appearance in the drug; Indian senna leaves, on the other hand, being pressed into bales, are commonly flat and bear other evidence of the pressure to which they have been subjected.

Alexandrian senna has a faint but characteristic odour and a mucilaginous, sickly, unpleasant taste.



FIG. 24.—Obovate Senna leaves (*C. obovata*). Natural size.

The drug sometimes contains the flat curved fruits, fragments of the stalk, and occasionally the obovate, mucronate leaves of *C. obovata*, Colladon, may be found here and there. Beyond these accidental impurities Alexandrian senna seldom contains any admixture.

Microscopical Characters.—The epidermal cells of both surfaces have straight walls and frequently contain mucilage; the stomata are surrounded by two cells with their long axes parallel to the ostiole; the hairs are one-celled, thick-walled, warty, and often curved. Both sides possess long, narrow palisade cells. The midrib contains abundant pericyclic fibres, abutting on which are cells containing prismatic crystals of calcium oxalate, cluster crystals of which occur in the mesophyll.

The student should observe

- (a) The *predominating asymmetrical, lanceolate or ovate-lanceolate shape,*
- (b) The *veins distinct on the under surface,*
- (c) *Both surfaces more or less distinctly pubescent;*

and should compare the leaves with

- (i) *Obovate senna leaves,* which are obovate,
- (ii) *Indian senna leaves,* which are yellowish green in colour, less conspicuously asymmetrical, and less pubescent,
- (iii) *Argel leaves,* which are equal at the base, thick in texture, and in which the veins are not distinct.
- (iv) *Barosma crenulata,* which contain oil-glands.

Constituents.—Although this important drug has been repeatedly subjected to chemical examination its constituents are but imperfectly known. The following have, however, been isolated (Tschirch and Hiepe, 1900): *Senna-emodin*, $C_{14}H_4(CH_3)(OH)_3O_2$, a trioxymethylanthraquinone,¹ apparently identical with aloë-emodin, but different from frangula-emodin and rheum-emodin; *Senna-isoemodin*, which closely resembles senna-emodin, but is soluble in petroleum spirit; *Senna-chrysophanic acid*, $C_{14}H_5(CH_3)(OH)_2O_2$, a dioxymethylanthraquinone, probably distinct from ordinary chrysophanic acid; *Glucosennin*, a glucoside yielding by hydrolysis senna-emodin and a sugar. Probably the drug contains senna-emodin, senna-isoemodin, and senna-chrysophanic acid, together with glucosides yielding these bodies by hydrolysis.

¹ A number of trioxymethylanthraquinones are theoretically possible; they are distinguished by their melting points, &c.

Senna also contains mucilage most abundantly in the young leaves, and a sugar, pinite ; it yields about 10 (occasionally 13) per cent. of ash.

Anthraglucosennin is the name given to a mixture of the constituents of senna obtained by extracting the drug with dilute ammonia, precipitating with hydrochloric acid, drying the precipitate, exhausting it with alcohol, and evaporating the alcoholic solution to dryness. After the extraction of the emodins, etc., by ether and acetone the residue contains senna-rhamnetin and senna-nigrin, both of which are ill-defined bodies.

Although the oxymethylantraquinones are undoubtedly laxative, the quantity present in the drug (Alexandrian senna 1·0 per cent., Tinnevely senna 0·8 per cent., senna pods 1·17 per cent. ; Tschirch and Hiepe) is insufficient to account for its activity. Possibly the glucosides, in which form part at least of the oxymethylantraquinones exist, are more active than their products of hydrolysis.

Recent investigations have revealed the presence of oxymethylantraquinones in a number of laxative drugs ; these therefore form a natural group of drugs allied by the similarity of their constituents. The following are the most important members of the group :

Senna, which contains senna-emodin, senna-isoemodin, and senna-chrysophanic acid.

Cascara Sagrada, the bark of *Rhamnus Purshianus*, De Candolle (N.O. Rhamnaceæ), which contains emodin and frangula-emodin.

Alder buckthorn Bark, from *Rhamnus Frangula*, Linné, which contains frangulin and frangula-emodin (=rheum-emodin).

Rhubarb, the rhizome of *Rheum officinale*, Baillon, &c. (N.O. Polygonaceæ), which contains or yields chrysophanic acid, emodin, rheum-emodin, and rhein.

Aloes, from various species of *Aloe* (N.O. Liliaceæ), which contains and yields aloes-emodin.

Uses.—Senna stimulates the muscular coat of the intestine and produces purgation, which is not followed, as commonly is the case, by constipation ; it is therefore one of the most useful of purgatives, especially in cases of habitual constipation.

Substitutes &c.—Alexandrian senna, as already mentioned, seldom contains any admixture beyond the stalks and fruits of the plant, and occasionally the leaves of *C. obovata*.

Senna pods, the fruits of *Cassia acutifolia*, which are found mixed with the senna, and are also imported as a separate article of commerce, are very flat legumes. They are dark brown or greenish brown in colour, broadly oblong,

slightly curved, and rounded at each extremity. They vary from 4 to 6 cm. in length, and from 2 to 2.5 cm. in breadth, and contain several flat obovate-cuneate seeds. They have been recommended for medicinal use as preferable to the leaves, and have been employed to a considerable extent.

Cassia obovata grows in Upper Egypt, and was formerly highly valued as a drug, being cultivated in Italy during the first half of the sixteenth century. Its leaves are easily recognised by their broadly obovate shape, abruptly tapering apex, and distinct pinnate venation. They appear to contain similar constituents and to be little inferior as a purgative.

Argel leaves, the leaves of *Solenostemma Argel*, Hayne (N.O. *Asclepiadeæ*), a small shrub growing in the same districts as senna, were formerly regularly mixed with Alexandrian

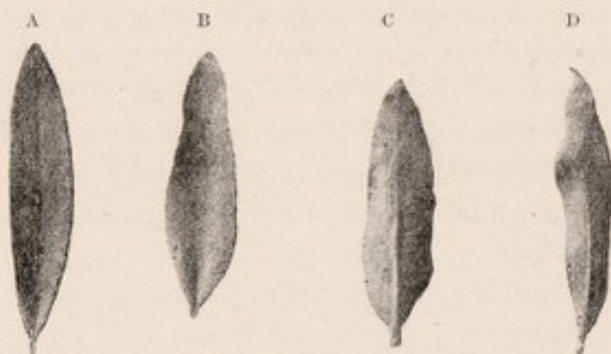


FIG. 25.—Argel leaves. A, showing the shape of the leaf; B, C, D, showing the curled appearance of the dried leaves. Natural size.

senna. They closely resemble senna leaves in their colour and outline, but may be distinguished by their thick, rigid texture and by their peculiarly curled, curved, or twisted appearance; the surface is finely wrinkled, the veins are not evident, and the leaf is equal at the base. They have a distinctly bitter taste. When examined by the microscope they exhibit three-celled hairs, whilst those of senna leaves are one-celled. The trade in senna was formerly a monopoly of the Egyptian Government, and during that time argel leaves were regularly mixed with the drug in the proportion of about 1 part of argel leaves to 4 parts of senna, but this practice was discouraged, and the arrival of senna mixed with argel leaves is now a rarity in the English market.

Arabian, Mecca, or Bombay senna, obtained from wild plants of *C. angustifolia*. These leaves are collected in

southern Arabia and sometimes shipped *via* Bombay, or now more commonly by the Red Sea route, to London. They may be distinguished from Tinnevelly senna by the evident want of care in collecting and drying the leaves, which are usually



FIG. 26.—Arabian Senna leaves. Natural size.

discoloured and mixed with stalks. From Alexandrian senna, under which name they have also appeared, the elongated lanceolate shape of the leaf will distinguish them. Tschirch and Hiepe found that they contained 0·97 per cent. of oxymethylantraquinones.

INDIAN SENNA LEAVES

(Tinnevelly Senna, *Senna Indica*)

Source &c.—Indian or Tinnevelly senna consists of the leaflets of *Cassia angustifolia*, Vahl, which is indigenous to southern Arabia, but is cultivated largely for medicinal use in southern India, especially in the district of Tinnevelly, in the extreme south-east. Here the plant attains an unusual luxuriance, and produces larger leaves than the Arabian wild plant. They are carefully collected, dried, pressed into bales, and exported from Tuticorin.

Description.—Tinnevelly senna is usually free from admixture either of foreign leaves or even of stalks and fruits. The leaves resemble Alexandrian senna rather closely, but are generally of a yellowish green rather than greyish green colour, a difference more noticeable in bulk than in single leaves. They attain a larger size than the Alexandrian, varying usually from 2·5 to 5 cm. in length. They differ also

in being more uniformly lanceolate in shape, less conspicuously asymmetrical, and less pubescent. They are somewhat firmer in texture than the Alexandrian, and are consequently less broken when they arrive, and, being exported in compressed bales, are usually flatter. There is also a slight but perceptible difference in the odour of the two varieties. The student should carefully compare these two varieties of senna and note the *greater symmetry* in the Tinnevelly, the *lanceolate shape*, the *flatness* of the leaves, their *yellowish green colour*, and *less pubescent* surface. It is, however, quite possible to



FIG. 27.—Tinnevelly Senna leaves. Natural size

select from the two varieties exceptional leaves that are indistinguishable from one another. The student must be guided by the characters of the majority.

The fruits of *C. angustifolia* closely resemble those of *C. acutifolia*; they are, however, rather narrower, and the remains of the base of the style are usually more distinct.

Constituents.—The constituents of Tinnevelly senna are identical with those of Alexandrian senna. Either variety may be used in making the official preparations of senna.

Substitutes &c.—Beyond the two varieties of senna described, occasional packages only of other sennas reach the London market.

CHERRY-LAUREL LEAVES

(Folia Laurocerasi)

Source &c.—The cherry laurel, *Prunus Laurocerāsus*, Linné (N.O. *Rosaceæ*), is an evergreen shrub indigenous to Persia and Asia Minor, but cultivated in most temperate regions. It was introduced into this country towards the end of the sixteenth century, but the poisonous property of the water distilled from the leaves was not known till 1731; the poisonous principle contained in it was identified as hydrocyanic acid soon after the discovery of the latter by Scheele in 1782.

Description. — Cherry - laurel leaves, which are official in the fresh state only, are of considerable size, averaging about 15 cm. in length by 5 cm. in breadth. The upper surface is dark green in colour and glossy, the under surface paler. In outline they vary from oblong-lanceolate to nearly obovate, tapering towards both base and apex, the latter being shortly acute and recurved. The leaves are thick and coriaceous in texture, and are supported on short stout petioles. The margin is slightly recurved and is provided



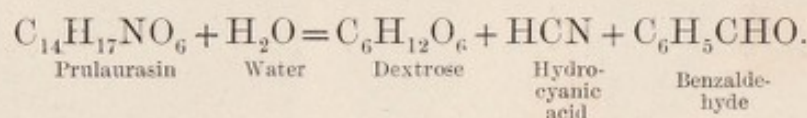
FIG. 28.—Cherry-laurel leaf. Under surface. Slightly reduced.

at intervals with short strong serrations, which are easily felt in the dried leaf when the finger is passed along the margin from apex to base. From the midrib, which is prominent on the under surface, lateral veins are given off at angles of 45° to 60° , and near the base of the leaf, also on the under surface, and on either side of the midrib are from one to four yellowish depressed spots. These spots are the remains of glands in which a sugary substance is

produced whilst the leaf is young. Both surfaces of the leaf are quite glabrous.

When fresh and entire, cherry-laurel leaves are almost inodorous; but when crushed, or even scratched with a needle, the young leaves evolve an odour recalling that of oil of bitter almond and hydrocyanic acid. Old leaves, or dried leaves crushed and moistened with water, yield a much less perceptible odour.

Constituents.—The principal constituent of cherry-laurel leaves is a glucoside, laurocerasin, first isolated by Lehmann (1885), and subsequently by Bourquelot and Hérissé, who further investigated it and called it prulaurasin, by which name it is now generally known. Prulaurasin, $C_{14}H_{17}NO_6$, has been obtained in colourless, odourless, bitter prisms (m.pt. 120° ; O.R. = $-53^\circ.6$). In contact with emulsin (an enzyme ferment also contained in the leaves) and water, prulaurasin is decomposed, yielding benzaldehyde (oil of bitter almonds), hydrocyanic acid, and dextrose.



As long as the leaves remain intact no decomposition takes place, for the emulsin is stored in the endodermis of the veins, whilst the prulaurasin is distributed through the parenchyma of the leaf. The two bodies cannot therefore come into contact with one another until the cells containing them are broken; directly this is effected, as it would be by cutting or bruising the leaf, the reaction takes place.

Fresh leaves from healthy plants yield on an average about 0.1 per cent. of hydrocyanic acid. In the autumn the yield is less than in the spring or early summer, the young leaves, which are more numerous in the latter seasons, being especially rich in prulaurasin; newly unfolded leaves have yielded as much as 2.49 per cent. of hydrocyanic acid (Ven, 1898).

Prulaurasin resembles but is not identical with amygdalin. By acting upon amygdalin with yeast Fischer obtained an amygdonitrile glucoside, $C_6H_5.CH \begin{smallmatrix} \text{CN} \\ \text{O} \end{smallmatrix} C_6H_{11}O_5$. This body is isomeric with prulaurasin, but differs in its optical rotation ($-26^\circ.9$), and yields, when acted

upon by hydrochloric acid, lævo-phenylglycollic acid (mandelic acid), $C_6H_5.CH<\begin{smallmatrix} OH \\ COOH \end{smallmatrix}$. Under similar conditions prulaurasin yields inactive (racemic) phenylglycollic acid. Hence prulaurasin is the glucoside of racemic phenylglycollic acid, and the amygdonitrile glucoside that of lævo-phenylglycollic acid. Sambunigrin, an allied glucoside contained in the leaves of the elder, is the glucoside of dextro-phenylglycollic acid. Both the amygdonitrile glucoside and sambunigrin are readily converted into prulaurasin by dilute alkalies.

Several other glucosides have been discovered (e.g. manihotoxin, lotusin, dhurrin, phaseolunatin, gynocardin, linamarin, corynocarpin) which under the influence of ferments yield hydrocyanic acid; they are collectively termed 'cyanogenetic' glucosides.

Uses.—Cherry-laurel water is employed as a sedative, its action being due to the hydrocyanic acid it contains.

WITCH-HAZEL LEAVES

(Folia Hamamelidis)

Source &c.—The witch-hazel, *Hamamelis virginiana*, Linné (N.O. *Hamamelidææ*), is a common shrub in the United States and Canada. It attains a height of about 3 metres, and resembles the common hazel both in its leaves and in its fruit, which is edible. Both the fresh and dried leaves are official, the former being employed for the preparation of Liquor Hamamelidis. The bark is also used in medicine.

Description.—Commercial witch-hazel leaves are usually in a somewhat indifferent state of preservation, being frequently discoloured, broken, and pressed together into more or less compact masses. Well-preserved full-grown leaves are of a dark green or brownish green colour on the upper surface, paler on the under surface, and attain 15 cm. in length by 10 cm. in breadth. In outline they are broadly oval or rounded-obovate, the lamina tapering somewhat towards the base, where it is decidedly oblique, usually cordate, and provided with a short petiole; at the apex they are obtuse. The margin is coarsely crenate or even sinuate. On the under surface the midrib is prominent, and the lateral veins, which are also very distinct, branch from it at an acute angle, and run straight to and terminate in the crenations of the margin.

In the angles thus formed and on the veins, hairs, which will be seen under the lens to have a characteristic branching form, are usually to be found; they are more frequent on young leaves; very young leaves being brown in colour and densely hairy. The leaves have only a slight odour, but a decidedly astringent and somewhat bitter taste.

The student should observe

- (a) The *sinuate margin*,
- (b) The *lateral veins running straight to the margin*,
- (c) The *branching hairs*.

Constituents. — Witch-hazel leaves have not yet been

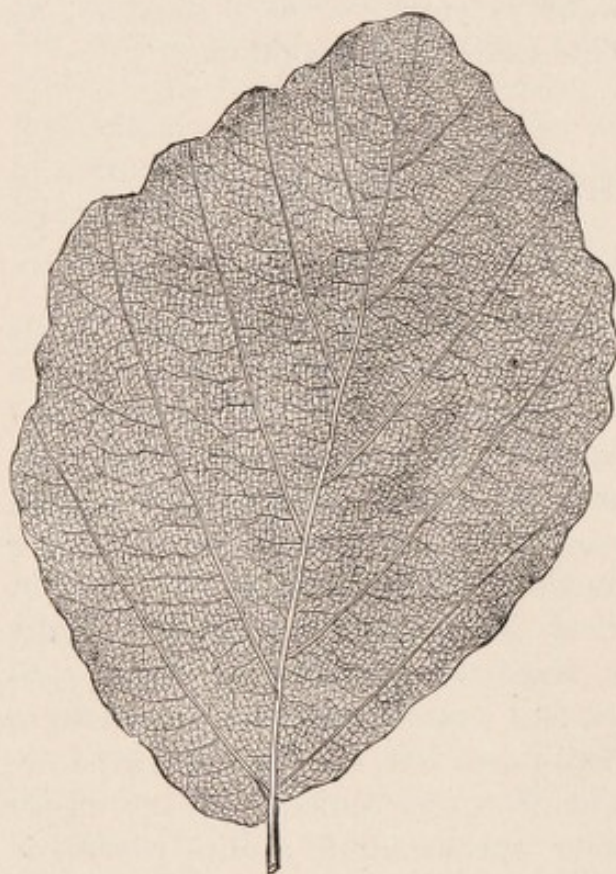


FIG. 29.—Witch-hazel leaf. One-half natural size. (Maisch.)

subjected to careful analysis. They contain gallic acid, tannin, a bitter principle, and a trace of volatile oil. By distilling the fresh or dry leaves with water or dilute alcohol, a distillate is obtained possessing a distinct aroma, different from that of the leaves themselves, due probably to some product of decomposition. The official *Liquor Hamamelidis*, which is made by macerating the fresh leaves with dilute alcohol and distilling, contains, in addition to the aromatic body alluded to, a trace of protocatechuic acid.

Hamamelin is a mixture of substances obtained by extracting the leaves, or sometimes the bark, with strong alcohol and evaporating the tincture thus obtained; it is an extract rather than an active constituent of the drug.

The autumnal leaves are said to contain most tannin and

to be distinguishable by the hairs, which have thicker walls, are yellow in colour, and devoid of contents (Cooley, 1900).

Uses.—Witch-hazel leaves are astringent and hæmostatic; they are useful as a local application in hæmorrhage from the nose, &c.

EUCALYPTUS LEAVES

(Folia Eucalypti)

Source &c.—The official eucalyptus leaves are obtained from *Eucalyptus Globulus*, Labillardier (N.O. *Myrtaceæ*), the ordinary 'blue gum' tree of Victoria and Tasmania. This tree, which is one of the largest known, attains a height of over 100 metres; it is indigenous to Tasmania and eastern Australia, but is now cultivated in Italy, Spain, southern

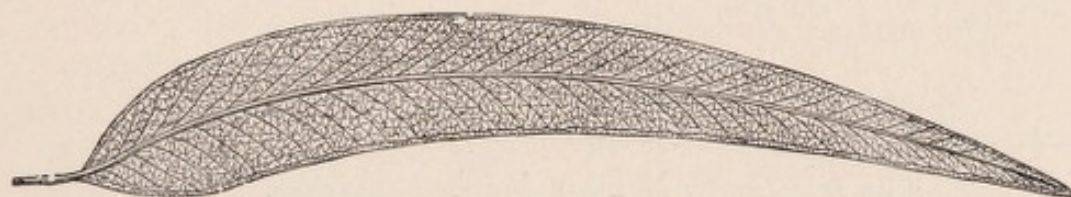


FIG. 30.—Eucalyptus leaf. Reduced in size. (Maisch.)

France, Portugal, Algeria, and other warm countries. It grows rapidly, and is largely planted in unhealthy marshy districts, such as the Campagna near Rome, upon which it exercises a beneficial influence.

The tree is remarkable on account of the dimorphism of its leaves. On young plants these are opposite, ovate, cordate at the base, and sessile, and they grow with one surface directed upwards and one downwards. On older plants, and especially on the upper parts of the trees, longer scimitar-shaped irregularly distributed leaves are produced, the short petioles of which are twisted so that the leaves grow with one margin directed upwards and the other downwards; these alone are employed in making the preparations of eucalyptus leaves. They are collected in southern Europe and dried. Both forms of the leaf are used fresh for the distillation of the volatile oil.

Description.—Eucalyptus leaves are well characterised by their great length (up to 30 cm.) and narrow ensiform outline.

They taper gradually towards the apex, but narrow rather abruptly at the base into a short twisted petiole. The lamina is thick, coriaceous in texture, and, when quite dry, brittle. The margin is entire and somewhat thickened; the midrib is not prominent on either surface, and the lateral veins, most of which leave the midrib at an acute angle, anastomose near the margin to a continuous line.

The leaves are quite glabrous, but distinctly punctate from the presence of numerous oil-glands situated in the mesophyll; these are best observed by examining the surface with a lens whilst the leaf is held against a strong light. The surfaces of the leaves are frequently marked with a number of minute warty brown spots (groups of cork cells).

The odour of fresh eucalyptus leaves is strong, camphoraceous, and characteristic; in the dry leaves it is less perceptible until they are crushed. The taste of the dry leaves is aromatic, pungent, and slightly bitter.

The student should observe

- (a) The *ensiform* outline,
- (b) The *coriaceous texture*,
- (c) The *similarity between the two surfaces*.

Constituents.—Eucalyptus leaves contain, when fresh from 3 to 5 per cent. of volatile oil containing 50 or more per cent. of cineol (eucalyptol). They also contain tannin, a bitter principle which has not yet been investigated, and several resins, one of which is crystalline.

Uses.—Eucalyptus leaves are used as an astringent and as a remedy for diabetes; they have also been employed in the form of a cigarette for asthma. The volatile oil has antiseptic properties.

BEARBERRY LEAVES

(Folia Uvæ Ursi)

Source &c.—The common bearberry, *Arctostaphylos Uva-ursi*, Sprengel (N.O. *Ericaceæ*), is a small procumbent evergreen shrub distributed throughout central and northern Europe and North America. It is indigenous to Great Britain, but is



confined to Scotland, the north of England, and Ireland. The plant sends out branching stems that take root, and so forms small clumps. The drug was probably in use long ago in this country, but was first introduced into the London Pharmacopœia in 1788.

Description.—Bearberry leaves are small shining coriaceous leaves, seldom measuring as much as 25 mm. in length by 12 mm. in breadth. The colour of the upper surface is dark green or yellowish green, that of the under surface paler. In outline they are spatulate or obovate, the lamina being rounded at the apex, but tapering gradually towards the base to a short petiole. They are more or less rigid, and, when quite dry, brittle.

The margin is entire, slightly revolute, and in young leaves ciliate with short hairs, but these are not discernible in the drug, which is quite glabrous. The veins, and even the veinlets, are depressed on the upper surface, which thus assumes a chequered or wrinkled appearance; the greyish



FIG. 31.—Bearberry. Reduced to about one-fourth natural size. (Maisch.)



FIG. 32.—Bearberry leaves. Natural size.

green under surface is reticulately marked with somewhat darker veins, which are often slightly raised, but it does not show raised brown points when examined with a lens. The leaves have no marked odour, but are strongly astringent and somewhat bitter.

The student should observe

- (a) The *spathulate* outline, *entire* margin, and *rounded apex*,
- (b) The *veinlets* *depressed* on the *upper surface*,
- (c) The *absence of brown points* on the *under surface*;

and should compare the leaves with

- (i) *Buchu* leaves, which have a toothed margin,
- (ii) The substitutes mentioned below.

Constituents.—Bearberry leaves contain both tannin and gallic acid; an infusion of the leaves accordingly gives a bluish black precipitate with ferric salts. They also contain arbutin, methyl-arbutin, ursone, quercetin, and possibly myricetin.

Arbutin, $C_{12}H_{16}O_7, \frac{1}{2}H_2O$, crystallises in long white bitter needles melting at $168^\circ C$ and easily soluble in boiling water and in alcohol; when hydrolysed with dilute sulphuric acid (or with emulsin) it yields dextrose and hydroquinone. A similar decomposition takes place when arbutin is administered by the mouth, both arbutin and hydroquinone being excreted by the urine; in fact, the activity of bearberry leaves is said to be partly due to the stimulant and antiseptic properties of the latter substance. Arbutin has also been isolated from several other Ericaceous plants.

Ursone, $C_{30}H_{48}O_3, 2H_2O$, has been obtained in tasteless, colourless, and odourless crystals.

Quercetin, $C_{15}H_{10}O_7, 2H_2O$, is a yellow crystalline body which occurs preformed in the fruits of *Rhamnus infectoria*, Linné, &c., and is also obtained when quercitrin, one of the constituents of quercitron bark (*Quercus discolor*, Aiton), is hydrolysed by boiling with dilute mineral acids.

Ericolin, an ill-defined amorphous substance said to occur in this and other Ericaceous plants, is probably a mixture.

Substitutes.—Bearberry leaves are seldom adulterated; the leaves of the box (*Buxus sempervirens*, Linné) and of the cowberry (*Vaccinium Vitis-idaea*, Linné) are reported to have been used for that purpose, but are easily distinguished, as the former are emarginate at the apex, and the latter have brown dots scattered over the under surface of the leaf.

Uses.—Bearberry leaves are used as a stimulant, diuretic, and antiseptic in diseases of the urino-genital tract; they resemble buchu in their action, but are more astringent.

BELLADONNA LEAVES

(Folia Belladonnæ)

Source &c.—The deadly nightshade, or belladonna, *Atröpa Belladonna*, Linné (N.O. *Solanaceæ*), is a tall branching herb with a perennial root. It attains a height of about 2 metres and is widely distributed over central and southern Europe; in England it is confined chiefly to the southern counties, but



FIG. 33.—Belladonna, showing leaves in unequal pairs. Reduced.

it is cultivated in Bedfordshire, Hertfordshire, and elsewhere, and is grown for medicinal use in Germany also.

The poisonous properties of belladonna were certainly known towards the end of the fifteenth century, probably much earlier. The leaves were introduced into the London Pharmacopœia of 1809, the root coming into use much later.

The fresh leaves and branches of the plant are used for preparing the juice and green extract of belladonna. The dried leaves are frequently imported from Germany, Hungary, and France.

Description.—The stem of the belladonna plant divides usually a little above the ground into three large branches, each of which branches again freely. The lower leaves on the stem are solitary, but the upper are arranged in pairs, consisting of a large and a small leaf, the latter being really a leafy bract. The flowers are solitary and pendulous; they have a dull purplish campanulate corolla and superior, two-celled, many-seeded ovary, which develops into a purplish

black fleshy fruit. The leaves vary from 8 to 20 cm. in length, the lower on the stem being larger than the upper. They are ovate or broadly ovate in outline, acute, entire, tapering towards the base, and glabrous or nearly so, except when quite young, when, in common with the young stems, they exhibit a soft pubescence. Both the midrib and the lateral veins are prominent on the under surface.



FIG. 34.—Belladonna leaf. Under surface, showing the venation. Natural size.

The dried leaves are thin, papery, and brittle; they are usually of a dull green colour, paler below. Their surface exhibits under the lens numerous whitish elevated points; these are produced by cells filled with calcium oxalate contained in the

mesophyll of the leaf, which produce, when the tissue of the leaf dries and shrinks, the appearance described. Neither all specimens of the drug nor both surfaces exhibit this character equally well.

The fresh plant exhales, when crushed, a disagreeable odour, but the dry leaves are almost inodorous. Both fresh and dry leaves have a bitterish taste, and the juice of the former or an infusion of the latter, when dropped into the eye, dilates the pupil.

The leaves should be collected when the plant is in flower, as they are then richest in alkaloid. For the preparation of the extract the larger stalks should be rejected, as it has been shown that the extract prepared from them contains less alkaloid than that prepared from the leaves (Ranwez, 1897). For the same reason the dry drug should be as free as possible from stalk.

Microscopical Characters.—The transverse section of the midrib exhibits strands of bast both above and below the wood (bi-collateral bundles), a feature common in *Solanaceæ* and in a few other orders, but by no means of frequent occurrence, and hence of use in identifying the leaves. There are no bast-fibres or sclerenchymatous cells. Some of the cells of the mesophyll are filled with numerous minute crystals of calcium oxalate, best seen when portions of the leaves are warmed with solution of chloral hydrate (5 parts) in water (2 parts), and examined under the microscope. This is an important character, as it enables these leaves to be distinguished from stramonium, henbane, foxglove, and many others. Each stoma is surrounded by three or four cells, one of which is smaller than the others; the epidermal cells have sinuous walls and striated cuticle.

The student should observe

- (a) The *upper leaves in unequal pairs*,
- (b) The *glabrous surface*,
- (c) The *presence of whitish raised points* (on the dried leaves);

and should compare the dried leaves with

- (i) *Stramonium leaves*, which curl and twist as they dry, have a characteristic odour and lateral veins making a more acute angle with the midrib,
- (ii) *Foxglove leaves*, which are hairy,
- (iii) *Henbane leaves*, which are hairy.

Constituents.—The chief constituents of the drug are the alkaloids hyoscyamine and atropine. Good samples contain about 0·4 per cent. of total alkaloid, but as much as 1 per cent. has (exceptionally) been found. The alkaloids are contained in all parts of the plant; in the calices and young ovaries 0·79 per cent. has been found, in the ripe seeds 0·83 per cent., and in the root 0·5 per cent.

Belladonna leaves also contain a fluorescent substance, β -methylnesculetin (scopoletin, chrysotropic acid), and yield about 14 per cent. of ash.

Hyoscyamine, $C_{17}H_{23}NO_3$, forms colourless crystals melting at $108.5^\circ C$; it is laevorotatory ($[\alpha]_D = -29.97$), and is converted by heating to $110^\circ C$. into its isomer atropine. Atropine differs from hyoscyamine in having a higher melting-point, viz. $115^\circ C$., and in being optically inactive, but both alkaloids yield tropine and tropic acid when hydrolysed by heating with baryta water. Hyoscyamine also crystallises less readily than atropine, is more soluble in water and dilute alcohol, and yields with gold chloride an aurichloride ($C_{17}H_{23}NO_3, HCl, AuCl_3$), crystallising in brilliant yellow scales, melting at $160^\circ C$., whereas the corresponding atropine gold salt crystallises in dull warty prisms melting at $136^\circ C$. Other alkaloids (belladonnine, apoatropine) may possibly also be present, but it is more probable that these are formed from hyoscyamine during the process of extraction. Hyoscyamine is also found in *Hyoscyamus niger*, in *Hyoscyamus muticus*, Linné (about 0.5 per cent.), in *Datura Stramonium*, as well as in other species of *Datura*, and is often accompanied by scopolamine (hyoscine) (compare 'Belladonna Root'). For the distribution of the alkaloid in the various parts of the plant compare thornapple leaves (p. 59).

Assay.—Shake 10 gm. of belladonna leaves in No. 60 powder with 50 c.c. of a mixture of chloroform 1 vol. and ether 4 vols. for ten minutes in a small glass percolator provided with a glass tap. Add 2 c.c. of solution of ammonia, mixed with 3 c.c. of distilled water, and shake frequently and vigorously during one hour. Insert a plug of wool in the exit tube and percolate into a separator, continuing the percolation with 50 c.c. more of the menstruum added at intervals in portions of 5 c.c. Shake out with $\frac{N}{5}$ sulphuric acid, transfer the acid solution to another separator, make alkaline with ammonia, and shake out with chloroform. Evaporate the chloroformic solution to dryness in a beaker over a gentle water-bath, dissolve the residue in ether, and evaporate again to dryness. Dissolve the residue in 3 c.c. $\frac{N}{10}$ sulphuric acid, and titrate back with $\frac{N}{50}$ solution of potassium hydroxide, using hæmatoxylin as indicator. Each c.c. of $\frac{N}{10}$ acid corresponds to 0.0289 gm. of alkaloid.

Adulterations. — (1) The leaves of *Scopöla carniolica*, Jacquin, a Solanaceous plant widely distributed in Hungary

and important as one of the chief commercial sources of hyoscyamine, of which the rhizome contains about 0.55 per cent. *Scopola* leaves closely resemble belladonna leaves, but are more lanceolate, more translucent, brighter in colour, and with more distinct veinlets; the crystal cells are less numerous, hairs are absent, and stomata occur on the under surface only; they contain hyoscyamine.

(2) The leaves of *Phytolacca decandra*, Linné; these may be distinguished by containing acicular crystals of calcium oxalate, and by the epidermal cells which are elongated and straight-walled.

Other leaves have also been found in the commercial drug, but the microscopical characters of the true drug generally suffice for its identification.

Uses.—Belladonna acts as a local anæsthetic and anodyne, and is used externally to relieve pain. Internally, it is given to check the sweating in phthisis, as a sedative to the respiratory nerves, to relieve spasmodic cough, and in numerous other cases.

STRAMONIUM LEAVES

(Folia Stramonii)

Source &c.—The thornapple, *Datura Stramonium*, Linné (N.O. *Solanaceæ*), is a large bushy annual attaining about 1 metre in height, a native probably of the shores of the Caspian Sea, but found commonly on waste ground throughout the temperate and warmer regions, and met with occasionally in England, escaped from cultivation. It is cultivated in this country in Bedfordshire &c., but our supply of the drug is derived largely from Germany, France, and Hungary. The introduction of stramonium into medicine is due chiefly to the exertions of Störck in the latter half of the eighteenth century. For medicinal use, the leaves and young shoots are collected when the plant is in flower and dried.

Description.—The stem of the thornapple is stout and erect, branching repeatedly, and producing in the forks of the branches a leaf and a single flower with a tubular calyx and large white funnel-shaped corolla. This flower is succeeded by an erect spiny capsule about the size of a walnut. In

addition to mature and young leaves the drug therefore frequently contains the remains of the flower with a tubular calyx and yellowish corolla, or of the young shrivelled bristly fruit.

The dried leaves are usually much shrivelled and wrinkled; they are of a dark greyish green colour, especially on the upper surface, ovate in outline, petiolate, and often unequal at the base. They attain 20 cm. or more in length, and are charac-



FIG. 35.—Thornapple leaf. Under surface, showing the venation. Natural size.

terised by the very coarse pointed teeth which impart to the margin a sinuate-dentate outline; the apex of the leaves is shortly acuminate. On the under surface the midrib is distinct though not very prominent; the lateral veins leave it at an angle of about 45° and divide when near the margin, one branch passing into the pointed lobe of the leaf, whilst the other anastomoses with other, tertiary, veins. When quite young the leaves are covered with stout curved hairs, but as

they reach maturity these fall off, and full-grown leaves are glabrous or nearly so. The odour of the drug, though not strong, is disagreeable and characteristic; the taste is unpleasantly bitter.

Microscopical Characters.—The distinctive characters of thornapple leaves are the abundant cluster crystals of calcium oxalate in the mesophyll; the hairs, though not numerous, are also characteristic, being either simple, uniserial, three- to five-celled, and warty, or small, shortly stalked, and glandular. The leaves possess in addition

typical Solanaceous stomata and bicollateral bundles devoid of bast-fibres.

The student should carefully observe

- (a) The *curled and twisted appearance of the dried leaves*,
- (b) The *angle made by the lateral veins with the midrib*,
- (c) The occasional presence of the remains of the *flower and fruit*,
- (d) The *characteristic odour*, and,
- (e) After soaking in water, the *sinuate-dentate outline* (unless the leaves are too much broken) ;

and should compare them with

- (i) *Belladonna leaves* (see before),
- (ii) *Henbane leaves*, which are hairy,
- (iii) *Forglove leaves*, which are hairy.

Constituents. — Stramonium leaves contain the same alkaloids as belladonna leaves, but in somewhat smaller proportion, the average of commercial samples being about 0.22 per cent. ; the percentage may, however, rise to as much as 0.4.

The alkaloids in the leaf are localised chiefly in the bast parenchyma of the veins, the midrib containing more than the petiole, and both being much richer than the leaf. Hence the practice sometimes followed of rubbing the leaves through a coarse sieve (laminating), and rejecting the midribs and larger veins should be discontinued, especially as thereby the difficulty of identifying the leaves is increased. The main stems contain but little alkaloid, and should not therefore be present in the drug.

Assay.—The drug may be assayed by the process given for belladonna leaves (see p. 56).

Adulterations &c.—The leaves of *Xanthium strumarium*, Linné, of *Carthamus helenioides*, Linné, and of other plants have been found mixed with stramonium leaves, especially in imported laminated leaves ; they are, however, easily distinguished by their different structure.

D. Tatula, Linné, the leaves of which are also used for asthma, has a violet corolla and purplish veins to the leaves. The leaves of *D. fastuosa*, Linné, var. *alba*, Nees, which are official in the Indian and Colonial addendum, have a sinuate-

crenate outline; they contain 0·5 per cent. of scopolamine and serve as a source of this alkaloid.

Uses.—Stramonium leaves resemble belladonna in their action; they are, however, almost exclusively used in the treatment of spasmodic affections of the respiratory organs.

HENBANE LEAVES

(Folia Hyoscyami)

Source &c.—The common henbane, *Hyoscyamus niger*, Linné (N.O. *Solanaceæ*), is an erect herb attaining a height of about 1 metre, distributed over the whole of Europe and extending to Persia and India. In England it is found chiefly on waste places near buildings; it is cultivated in this country for medicinal use, but much is imported from Germany, and large quantities are produced also in Russia (Gehe). The medicinal use of the plant dates from very remote ages. It was well known to the Anglo-Saxons in the tenth and eleventh centuries, but subsequently fell into disuse. It was omitted from the London Pharmacopœia in 1746, but restored in 1809 chiefly by the influence of Störck, who also introduced stramonium.

Two varieties of the plant are known, an annual and a biennial, the distinction between them being by no means well marked. Both varieties are used medicinally, but the second year's leaves and flowering tops of the biennial plant are alone official, these having been generally considered to be superior in activity to those of the annual plant, and to the first year's leaves of the biennial plant.

Biennial henbane produces in the first year of its growth simply a rosette of large stalked leaves attaining 30 cm. in length, some of which are frequently collected and form the drug known commercially as 'first biennial henbane'; these are not official. In the second year the plant sends up a large branching stem attaining a height of about 1·5 metres, which flowers, ripens its seeds, and dies. The smaller branches of this plant with the leaves and flowers constitute the drug from which the green extract of henbane and juice of henbane are directed to be prepared, whilst the leaves and flowering tops,

separated from the branches and dried, are employed for making the tincture.

Annual henbane is a much smaller plant than the biennial. The stem does not branch as that of the biennial does, nor are the leaves so large or so deeply incised; the corolla is paler in colour and less deeply veined with purple. This variety flowers in the first year of its growth, ripens its seeds, and dies. Although not official it occurs regularly in commerce.



FIG. 36.—Henbane (*H. niger*). First year's growth of the biennial plant. Reduced.

Three commercial varieties of henbane must therefore be distinguished, viz.:

'*First biennial*,' consisting of the leaves of the first year's growth of the biennial variety.

'*Second biennial*,' or '*biennial*,' consisting of the leaves and flowering tops of the second year's growth of the biennial variety. This is the drug official under the name of '*Henbane Leaves*' (*Folia Hyoscyami*).

'*Annual*,' consisting of the stem with leaves and flowers of the annual variety.

Description.—As previously mentioned, in the second year of its growth the biennial variety of the plant produces a tall, stout, branching stem with leaves and flowers.

The leaves vary considerably in size. The lower are the larger, attaining as much as 25 cm. in length, and are stalked; towards the upper part of the plant they become smaller and sessile. They are pale green in colour, and, especially when fresh, soft and unpleasantly clammy or sticky to the touch. This peculiarity is due to soft hairs which occur on both surfaces of the leaves, but particularly near the veins



FIG. 37.—Henbane (*H. niger*). Flowering top of a large second year's plant of biennial Henbane. Reduced.

on the under surface. These hairs possess glandular heads by which a resinous substance is secreted.

In outline the leaves vary from nearly ovate to elongated triangular; the margin is coarsely dentate or even pinnatifid, and the midrib is broad. The stems are rounded, and bear glandular hairs like those of the leaf.

The flowers, which are usually crowded together, arise from the axils of large, hairy, leafy bracts; they possess a hairy,

urceolate calyx and a yellowish, gamopetalous corolla deeply veined with purple. The fruit is a pyxis; it is two-celled and contains numerous seeds.

The dried drug consists principally of the flowering tops, for these are separated from the fresh plant for drying, whilst the lower leaves and branches are used for the preparation of juice and green extract of henbane. In commerce it is commonly found in irregular rounded or flattened masses about 2.5 to 5 cm. in diameter, in which the coarsely dentate hairy bracts, the yellowish corolla with deep purple veins, and two-celled ovary with numerous ovules can easily be identified.

The fresh plant has a strong heavy odour, which is less perceptible in the dry drug; but the taste of the latter is more distinctly bitter than that of the former.

Microscopical Characters.—

The epidermis closely resembles that of belladonna and of stramonium, but bears numerous very long uniserial, multicellular hairs, some of which are simple, but the majority terminate in oval multicellular glands; the mesophyll contains calcium oxalate chiefly in the form of prismatic, often twin, crystals. The bundles are bicollateral, and there are no pericyclic or bast fibres.

The student should observe

- (a) The *hairy leaves with sinuate-dentate outline and broad midrib*,
- (b) The *purple veins of the corolla*,
- (c) The *characteristic fruit* (or ovary).

Constituents.—The principal alkaloid in henbane leaves is hyoscyamine, but it appears to be accompanied by small



FIG. 38.—Annual Henbane. Small specimen. Reduced.

proportions of atropine and scopolamine (hyoscyne). The drug contains much less total alkaloid than either belladonna or stramonium, viz. from 0.045 to 0.14 or, exceptionally, 0.2 per cent. (of the dry drug). The cultivated plant contains about the same proportion as the wild, but the leaves contain more than the large stems, and the extract of the leaves more than that from the stem. The petiole is, however, rather richer than the lamina (compare p. 59). It should yield about 8 to 12 per cent. of ash, but commercial samples sometimes afford much more.

Assay.—Henbane may be assayed by the process given for belladonna leaves, using 25 gm. of the powdered drug instead of 10.

Uses.—The action and uses of henbane closely resemble those of belladonna and stramonium, but the drug is distinctly weaker. The extract has a decided laxative and carminative effect, whilst the tincture has a more marked action on the urinary organs.

Varieties.—*The first year's leaves* of biennial henbane are easily recognised by their being longer and relatively narrower, stalked, and free from stem and flower. They are equal in activity to the second year's leaves, and there seems to be no good reason why they should not be used. They are sometimes sold for annual henbane.

Annual henbane is distinguished by its slender simple stem, smaller leaves, and paler corolla, with less distinct purple venation. As in this case the entire plant is cut and dried, portions of the stem as well as leaf and flower are found in the drug. Much imported henbane is of this variety, and it often arrives in very poor condition, probably mixed with other species of *Hyoscyamus*. Such henbane contains notably less alkaloid than either the first or second biennial, viz. about 0.03 per cent. English annual henbane consists of such plants as happen under favourable conditions to flower in the first year; such plants are much stronger than the foreign, and being more carefully dried are richer in alkaloid.

FOXGLOVE LEAVES

(Folia Digitalis)

Source &c.—The purple foxglove, *Digitalis purpurea*, Linné (N.O. *Scrophularinæ*), is a handsome biennial herb, widely distributed throughout Europe and common in England, where it occurs wild and is also cultivated as a garden plant, as well as for medicinal use. Much of the commercial drug is collected in the Harz mountains and in the Thuringian forest. It appears to have been long used as a domestic medicine; it was introduced into the London Pharmacopœia as long ago as 1650, although it did not come into frequent use until about a century later.

The foxglove produces, like henbane, in the first year a rosette of leaves, but no aerial stem; in the second year a tall, erect, usually simple stem that may attain a height of 2 metres or more, and bear numerous flowers. The latter are well characterised by their crimson bell-shaped corolla, with darker spots on the inner part of the mouth; the ovary is conical and contains two cells with numerous ovules; the stamens are didynamous.

The plant flowers during the summer months, and the leaves for official use are directed to be gathered from plants commencing to flower, when the presence of the flowers precludes any possibility of the leaves of other plants being collected by mistake. They should be completely dried immediately after collection and preserved quite dry in air-tight containers, when they will retain their activity unimpaired, air-dry leaves rapidly deteriorating.

Description.—Foxglove leaves vary usually from 10 to 30 cm. in length, but may attain as much as 15 cm. in breadth; in shape they vary from broadly ovate to lanceolate, those on the upper part of the stem being the narrower. Towards the base of the leaf the lamina is contracted and passes into a winged petiole of varying length, down which the lower lateral veins are usually decurrent, the petioles of the lower leaves being longer than those of the upper. The upper surface is dull green in colour and bears numerous short hairs, the under surface paler and more or less densely pubescent, the hairs being seen under the lens to be simple and unbranched.

The midrib is prominent on the under surface; the majority of the lateral veins leave the midrib at a rather acute angle (especially in the narrower leaves) and gradually curve round towards the apex, passing into smaller ramifications near the



FIG. 39.—Foxglove leaf. Under surface, showing the lower veins decurrent in the petiole. About two-thirds natural size.

margin. The latter is crenate or irregularly crenate-dentate, the apex blunt or subacute. Each crenation terminates in a small cartilaginous point which is brown or black in old leaves but colourless in young; a veinlet enters each crenation and spreads like a brush, a marginal veinlet approaching from either side, the whole forming a well-marked character of the foxglove leaf. The odour of the fresh leaves is unpleasant, and the taste of both fresh and dried leaves disagreeably bitter.

Although the leaves are directed to be collected from flowering plants, it is not possible to distinguish these accurately from those of the first year; generally speaking, the latter are narrower and have longer petioles, whilst the biennial leaves are usually broader and have shorter petioles, but no sharp line can be

drawn, as the flowering plant often produces a number of lanceolate leaves which cannot be distinguished from first-year's leaves of similar shape, and *vice versa*. The separation is, however, not material, as the first and second year's leaves are of nearly equal activity.

Microscopical Characters.—Under epidermis composed of cells with wavy walls and smooth cuticle; stomata numerous and small; hairs abundant and of two kinds, either simple, uniserial, three to five or more cells, thin-walled, often warty, and frequently collapsed; or small, stalked and glandular. Midrib normal in structure and free from bast or pericyclic fibres. No crystals of calcium oxalate in any part of the leaf.

The student should direct his attention particularly to

- (a) The *crenate margin*,
- (b) The *winged petiole with decurrent veins*,
- (c) The *simple unbranched hairs*,
- (d) The *course taken by the lateral veins*;

and should compare these leaves with

- (i) *Matico leaves*, in which the veinlets are depressed on the upper surface, dividing it into small squares,
- (ii) The possible substitutions mentioned below.

Constituents.—Foxglove leaves contain the glucosides, digitoxin, digitalin, and possibly digitalein, and digitophyllin, to which the physiological activity is to be ascribed. A yellow colouring matter, digitoflavone, and probably a saponin, digitonin, are also present but do not contribute to the therapeutical activity of the drug.

Digitoxin, $C_{34}H_{54}O_{11}$, is a well-defined, colourless, odourless, crystalline, bitter substance, insoluble in water, but nevertheless passing into solution when foxglove leaves are infused in that menstruum. It is the most powerful of all the constituents of the leaves, and completely represents the therapeutical action of the crude drug. It is hydrolysed by dilute mineral acids yielding digitoxigenin, $C_{22}H_{32}O_4$, and a sugar, digitoxose, $C_6H_{12}O_4$. It may be identified by Keller's reaction, which consists in dissolving it in glacial acetic acid, adding a drop of ferric chloride solution, and then gently a stratum of sulphuric acid; the upper part of the latter is coloured red, whilst above this an indigo blue band gradually appears.

Dry foxglove leaves contain from 0.2 to 0.3 per cent. of digitoxin, the first year's leaves containing as much as the second. Wild plants contain more than cultivated, but the quantity rapidly diminishes towards the end of the flowering stage.

Digitalin, $C_{35}H_{56}O_{14}$, has also been obtained in crystals, but is usually in granular aggregations; it yields on hydrolysis digitaligenin

and two sugars, viz. digitalose and dextrose. With Keller's reaction a permanent reddish violet colour is obtained. Like digitoxin its action resembles that of foxglove leaves.

Under the name 'digitalin' substances of very varying composition occur in commerce; thus Nativelle's digitalin consists chiefly of digitoxin; German digitalin, often of digitonin with a little true digitalin. Homolle's digitalin is amorphous and soluble in chloroform.

Digitalein has been obtained from the seeds in the form of a white powder soluble in water; it is also probably present in the leaves.

Digitophyllin crystallising in plates melting at 232° C., has also been isolated from the leaves (Kiliani, 1897); it is probably methyl digitoxin and gives the same colour reaction.

Digitoflavone is a yellow colouring matter allied to quercetin.

Digitonin is a crystalline glucoside of the saponin class; it has been isolated from the seeds, and its presence in the leaves is doubtful. Neither this substance nor digitoflavone contributes to the action on the heart.

Uses.—Foxglove increases the activity of muscular tissue, especially that of the heart and arterioles, and is employed in most forms of cardiac failure. On account of the slowness with which digitoxin is excreted it is cumulative, and its action must therefore be watched.

Assay.—Since the therapeutical activity of foxglove leaves is due to more than one glucoside, it is obviously impossible to assay the leaves by determining one only of these, *e.g.* digitoxin. No method of determining digitalin is known. Hence chemical methods of assay fail, and recourse must be had to the physiological assay (compare p. 195).

Adulterations.—Foxglove leaves are not often adulterated, but the attention of the student may be directed to the following possible admixtures as serving to accentuate the characters of the genuine drug.

Mullein leaves (*Verbascum Thapsus*, Linné) are woolly; the hairs, examined under the lens, are seen to be branched.

Comfrey leaves (*Symphytum officinale*, Linné) are lanceolate or ovate, and present on their surface isolated stiff hairs.

Primrose leaves (*Primula vulgaris*, Hudson) are nearly spatulate; the lateral veins are straight; near the margin they divide.

Ploughman's spikenard (*Inula Conyza*, de Candolle).—The margin is either entire or dentate, with horny points to the teeth.



FIG. 40.—Primrose leaf. Under surface. Slightly reduced.



FIG. 41.—Elecampane leaf. Under surface. Reduced.

Elecampane leaves (*Inula Helenium*, Linné) resemble foxglove leaves, but the lower lateral veins are not decurrent.

LAUREL LEAVES

(Folia Lauri)

Source &c.—The true laurel, bay or bay laurel, *Laurus nobilis*, Linné (N.O. *Laurinææ*), is a small evergreen tree,

common in the western Caucasus and Syria, spread by cultivation over all the temperate and warmer regions of Europe, and a frequent garden plant in this country. The tree was held in high esteem by both the Greeks and the Romans; the leaves were formerly employed as a medicine in Germany, but now they are seldom used except as a domestic flavouring agent.

Description.—Laurel leaves are of a shining green colour on the upper surface, paler below, coriaceous in texture, lanceolate and acuminate in outline, attaining 10 cm. or more in length and shortly stalked, with an entire, wavy margin, the apex being often acute but sometimes blunt. They are quite glabrous, with the exception of a few hairs often present on the under surface in the angles made by the lateral veins with the midrib. The upper surface appears finely shagreened; the lower is reticulated, an appearance due to the prominence of the network of minute veinlets. When crushed they emit an aromatic odour, due to the volatile oil contained in oil-cells situated in the mesophyll of the leaves. These oil-cells are with difficulty visible, even when the leaf is held against a strong light and examined with a lens. The taste is aromatic and bitter.

The student should note

- (a) The *coriaceous texture*,
- (b) The *entire, wavy margin* and *acute apex*,
- (c) The *characteristic odour*;

and should be careful not to confuse these leaves with *cherry-laurel* leaves.

Constituents.—The leaves contain from 1 to 3 per cent. of volatile oil, consisting chiefly of cineol (50 per cent.), eugenol, geraniol, and terpenes. This oil should not be confounded with that of *Pimenta acris*, Wight, also known as oil of bay, and from which bay rum is made. The latter oil is distilled in the West Indies.

Uses.—Laurel leaves are aromatic and stimulant, but are now seldom employed medicinally.

MATICO LEAVES

(Folia Maticæ)

Source &c.—Matico leaves were official in the British Pharmacopœia of 1885, and were directed to be obtained from *Piper angustifolium*, Ruiz and Pavon (N.O. *Piperaceæ*), a climbing plant distributed over the north of South America, extending into Bolivia. The name matico appears to be also applied to a number of other similar plants, and not to be confined to the species of *Piper* under notice. It has been much used in Peru as a styptic, and also for venereal disease; it was introduced into the British Pharmacopœia in 1864, but is now no longer official, although its use in France for the treatment of gonorrhœa is said to be increasing.

The leaves, together with occasional stalks and fruits, are dried and packed into bales for exportation.

Description.—Matico leaves reach this country usually in brittle compressed masses of a dull dark greyish green or yellowish green colour. The leaves, which are very brittle, can easily be separated if the masses are previously soaked in water, they can then be spread out and examined. They are lanceolate in outline, about 10 to 15 cm. long and 2·5 to 4 cm. broad, and taper gradually to an acute apex; they have short stalks, and are cordate and very unequal at the base, the lamina of one side extending over the petiole so as to conceal it. The margin is entire and revolute. On the upper surface the midrib and the network of lateral veins are so deeply depressed as to divide the surface into small raised squares about 1 mm. in diameter. On the under surface the midrib, lateral veins, and veinlets are nearly equally prominent, and both the veins and veinlets, as well as the interneural depressions, are covered with short, grey, shaggy hairs. The latter are less prominent on the upper surface, but the leaves are not all equally hairy.

Both stalks and fruits are frequently found mixed with the leaves; the former are characterised by the swollen nodes which distinguish *Piperaceous* plants; the latter are long, slender, cylindrical spikes.

The leaves have a slight, aromatic odour and an aromatic, camphoraceous, somewhat bitter taste. Although the meso-

phyll contains oil-cells, they cannot easily be seen even with a strong lens if the leaf is very hairy.

Matico leaves frequently appear in commerce of larger size than those described, being ovate-lanceolate or ovate in outline, and attaining 20 cm. in length by 7 cm. in breadth. They are derived from a stouter variety of *Piper angustifolium* (var. *a-cordulatum*) that is found in Brazil. Whether they differ materially in activity from the usual variety is doubtful. It has been shown that the volatile oil distilled from the drug sometimes contains asarone in the place of matico camphor.

The student should observe

- (a) The *veinlets depressed on the upper surface, prominent on the under surface,*
- (b) The *shaggy hairs,*
- (c) The *characteristic taste ;*

and should compare the leaves with

Foxglove leaves, in which the veinlets are not depressed and the taste not aromatic.

Constituents.—Matico leaves contain volatile oil (1 to 3.5 per cent.), tannin, crystalline artanthic acid, and a bitter principle which has not yet been satisfactorily examined. The volatile oil has the sp. gr. 0.93 to 0.99 and deposits on cooling matico camphor and asarone. Latterly, however, from 3 to 6 per cent. of oil has been obtained of sp. gr. 1.06 to 1.13 and containing dill apiol and a little parsley apiol, but no matico camphor or asarone; the leaves from which this oil is obtained are probably derived from a different species of *Piper*.

Uses.—Matico is used as an aromatic astringent in inflammatory conditions of the urinary passages.

SECTION II

FLOWERS

Under this heading are grouped together a number of drugs that consist either of entire flowers or inflorescences, or of parts only of flowers, collected at varying stages of their development and dried.

In some instances the student will find it necessary to soften the drug in water and spread out such parts as the shrivelled petals with a camel's hair brush in order to examine their shape. In other cases a sharp penknife and good lens must be used in order to observe the characteristic details alluded to in the text. For a description of the morphology of the flower and an enumeration of the various forms of inflorescence a text-book of botany must be consulted.

RED POPPY PETALS

(*Petala Rhœados*, *Flores Rhœados*)

Source &c.—The red or field poppy, *Papaver Rhœas*, Linné (N.O. *Papaveraceæ*), is a common herb, which, though doubtfully indigenous to England, grows in abundance in cornfields and waste places throughout Europe and has long been used as a medicine. It is the commonest British poppy, and is distinguished by its rich scarlet petals and glabrous, nearly globular fruit.

The long-headed poppy, *P. dubium*, Linné, is also common and closely resembles the field poppy, but is generally smaller, more slender, and possesses a capsule often twice as long as it is broad.

Description.—The two hairy sepals that are present in the bud fall off as the four delicate crumpled petals expand.

The latter are of a bright scarlet colour, with a short dark violet claw; they are smooth and shining in appearance and broadly elliptical in outline. The margin is entire. They have, when fresh, an unpleasant heavy odour and slightly



FIG. 42.—Red Poppy. (Planchon and Collin.)

bitter taste. By drying, the bright scarlet colour changes to a dingy violet, and the petals, which are used on account of the colouring matter they contain, are therefore official in the fresh state only.

Constituents.—Red poppy petals contain two acids, rhœadic and papaveric (Meier, 1846), of the nature of which

little definite is known. The presence of meconic acid, an important constituent of opium, has not yet been definitely ascertained. In the juice of the capsules and herb Hesse found the alkaloid rhœadine, which is also contained in opium; and it is worth noting that this alkaloid, when decomposed with hydrochloric acid, yields a red colouring matter of intense colorific power. Dieterich (1888) reported the drug to contain 0.1 to 0.7 per cent. of morphine, but according to Hesse and others it is quite free from morphine, Dieterich's alkaloid being rhœadine.

The petals of the *P. dubium* are said to contain a toxic alkaloid resembling thebaine in its action, and they should therefore be rejected.

Use.—Red poppy petals are employed solely as a colouring agent, chiefly in the form of syrup.

CUSSO

(Kousso, Cousso)

Source &c.—The tree yielding this drug, *Brayëra anthelmintica*, Kunth (N.O. *Rosaceæ*), is a native of north-eastern Africa. It is cultivated in Abyssinia, being commonly planted

by the natives near their villages, and is in general use as a remedy for intestinal worms, from which they suffer severely. Bruce became acquainted with it in the course of his travels through Africa (about 1770). It was brought to London about 1851, and introduced into the British Pharmacopœia in 1864, but is not much used.

The panicles of pistillate flowers are collected after fertilisation and dried. They are usually packed into cylindrical rolls about 30 to 60 cm. in length and 5 to 8 cm. in diameter, bound round with the flexible stem of a monocotyledonous plant. The staminate inflorescences, which are sometimes borne on the same, sometimes on different trees, are also collected and the flowers stripped from them, but they are not official.

Description.—The panicles, of which a roll or, as it is technically termed, 'hank' of cusso consists, are of a large size, attaining as much as 60 cm. in length, and of a decided, though dull, reddish or mauve colour, whence this variety of the drug derives the name of 'red' cusso. The main axis, which is stout and covered with shaggy brown hairs, branches repeatedly, forming a sympodial branch system. The branches spring from the axils of large bracts, and are more or less thickly covered with shaggy brownish or greyish hairs and with minute glands, the latter appearing under the lens as a brownish powder adhering to the surface. The flowers, which are very numerous, are shortly stalked. Each bears on its pedicel two rounded bracts, and consists originally of two whorls of greenish sepals, a caducous white corolla, abortive stamens, and two monocarpellary ovaries enclosed in the tube of the calyx. After fertilisation the inner sepals bend over the young fruit and shrivel; the outer grow larger and become deeply veined with purple. Only one of the two ovaries arrives at maturity. In the drug the most conspicuous part of the flower is the outer whorl of reddish veined sepals; in its centre may be found the inner sepals bending over the immature fruit; of corolla and abortive stamens no trace is to be found.

Cusso has no marked odour, but possesses a bitter and acrid taste.

The student should soak a little cusso in water and, when thoroughly softened, examine it with the help of lens and dis-

secting needles. The two whorls of sepals and the young fruit can then be distinguished without difficulty.

The drug is easily identified, but the student should particularly observe

- (a) The *inner whorl of sepals bending over the young fruit*,
- (b) The *enlarged, veined outer whorl of sepals*,
- (c) The *reddish colour of the drug*,

as these characters serve to distinguish the pistillate flowers, which alone are official, from the staminate.

Constituents.—The most important constituent of cusso is kosotoxin (Leichsenring, 1894), a highly active, amorphous, yellowish substance, of which 0.004 gm. is sufficient to kill a frog. Protokosin and kosidin are inactive colourless crystalline substances; α - and β -kosin are inactive yellowish crystalline substances and appear to be decomposition products, it being uncertain whether they occur preformed in the drug. Cusso also contains tannin and resin, and yields about 5 per cent. of ash.

Kosotoxin is insoluble in water but easily soluble in alcohol, ether, acetone, chloroform, &c., as well as in solutions of alkaline carbonates. Caustic alkalis convert it into kosin. By the action of zinc dust and caustic soda kosin and trimethylphloroglucin are obtained; this reaction indicates a close relationship with the vermifuge constituents of male fern and kamala, which under similar conditions yield trimethylphloroglucin and dimethylphloroglucin respectively.

Protokosin occurs in colourless needles melting at 176°C ., α -kosin, $\text{C}_{21}\text{H}_{24}(\text{OCH}_3)_2\text{O}_5$, in yellowish needles melting at 161°C ., and β -kosin, $\text{C}_{23}\text{H}_{28}(\text{OCH}_3)_2\text{O}_7$, in dark yellow prisms melting at 121°C .

Substitutions &c.—Under the name of ‘loose cusso’ the flowers stripped from the panicles and dried are sometimes imported. They arrive usually in more or less fragmentary condition, and frequently contain a considerable admixture of staminate flowers. These may be easily distinguished by their greenish colour, small outer sepals densely covered with short hairs, and fertile stamens; they are often unexpanded. They are said to possess emetic properties, and to be a much less active anthelmintic than the pistillate flowers; the Pharma-



FIG. 43.—*Brayera anthelmintica*. A, flowering branch, three-fourths natural size (after Berg and Schmidt). B and C, staminate flower closed and open, magnified. D, pistillate flower, magnified. E, the same, cut longitudinally, magnified: b, outer, k, inner whorl of sepals; c, corolla. (Luerissen.)

copœia, by describing the drug in panicles, properly excludes the use of loose cusso.

Use.—Cusso is used as an anthelmintic, tapeworms being readily killed by it. In large doses it produces nausea, vomiting, and colic. It is commonly administered in the form of an infusion, the dregs being swallowed, but probably an ethereal or ether-alcohol extract would be preferable.

RED-ROSE PETALS

(*Petala Rosæ Gallicæ*)

Source &c.—The red or Provins rose, *Rosa gallica*, Linné (N.O. *Rosaceæ*), is probably indigenous to southern Europe, but has been cultivated as a garden plant in numerous varieties everywhere. For medicinal use the red rose is grown in England (Oxfordshire, Derbyshire, &c.), in the south of France, near Hamburg, &c.

The drug is collected by plucking the whole of the unexpanded petals from the calyx and cutting off the lighter-coloured lower portion from the deep purplish red upper part. The little masses of petals are then either used fresh for the preparation of the confection, or dried, in which state they are officially employed for making the infusion; in the latter case they are often gently sifted to remove the stamens. The petals of the red rose are obovate in outline, velvety, and of a deep purplish red colour, with a paler claw.

Description.—When collected as described they remain united in small conical masses of a deep purplish red colour, paler towards the base; these, however, are often broken up into the separate petals for convenience in use. They possess a delicate rose-like aroma and slightly astringent taste.

Constituents.—Our knowledge of the constituents of red-rose petals is in an unsatisfactory state. They owe their aroma to a trace of volatile oil, and they contain an amorphous deep red colouring matter of an acid nature, soluble in water and in alcohol, the colour being deepened by the addition of sulphuric acid, and changed to green by alkalies. They also contain a yellow crystalline substance, $C_{15}H_{12}O_6$, soluble in

ether, but not identical with quercitrin (Naylor and Chappel, 1904); gallic, and possibly quercitannic acids are also present.

Substitute. — Red-rose petals should have attached a portion of the paler base of the petal. Artificially coloured petals, which have been met with in commerce, may be recognised by their uniform dark reddish colour.

Uses. — The petals are slightly astringent; they are chiefly used medicinally, in the form of acid infusion, as an agreeable astringent vehicle or as a colouring agent.

CLOVES

(Caryophylla)

Source &c. — The clove tree, *Eugenia caryophyllata*, Thunberg (N.O. *Myrtaceæ*), is a handsome evergreen tree and a native of the Molucca Islands, where, as well as on the neighbouring islands, it was formerly extensively cultivated.

Although the spice was known in Europe in the fourth century, the Clove Islands were not discovered till 1504. They passed into the hands of the Portuguese and then into those of the Dutch, who unsuccessfully attempted to monopolise the trade in cloves and confine the tree to the Moluccas. The French succeeded in introducing the plant into Mauritius and Réunion, whence it was brought to Cayenne and to Zanzibar. On the latter island and its neighbour, Pemba, the clove tree is now extensively cultivated, and these two islands furnish the bulk of the world's supply, the remainder being obtained from Penang, Amboyna, Réunion, Madagascar, &c.

The inflorescence of the plant is a compound raceme, on the ultimate ramifications of which the flowers are borne. When quite young the buds are white; as they develop they assume a green and finally a crimson colour. They are then collected, before the white corolla expands, and dried in the sun, during which the crimson colour changes to a dark reddish brown. Sometimes the whole inflorescence is collected, or sometimes the buds are knocked off with bamboos, but usually each bud, as it reaches the proper stage, is picked off singly from the tree by hand. The buds are finally separated from peduncles, which are exported separately under the name of

'clove stalks.' The ripe fruits are also occasionally collected; they are known in commerce as 'mother cloves' (anthophylli).

Description.—The cloves of commerce are therefore the dried flower-buds of the tree. Each of them consists of a nearly cylindrical dark reddish brown portion slightly tapering at the base, which is sometimes regarded as a gynophore, sometimes as a fleshy calyx-tube, but is perhaps most correctly interpreted as the solid lower portion of the ovary (Tschirch), crowned by four thick divergent calyx-teeth of a similar colour, from the centre of which arise four paler, brown unexpanded

imbricated petals. After soaking in water for twenty-four hours these petals can be removed, and they will be found to enclose a large number of stamens bending over a stiff erect style arising from a depression in the centre of a small disc. Just below the disc is the two-celled ovary with its numerous ovules; it can be found by cutting the clove either longitudinally or transversely.

The lower part of the ovary is solid and fleshy, spongy near the centre.

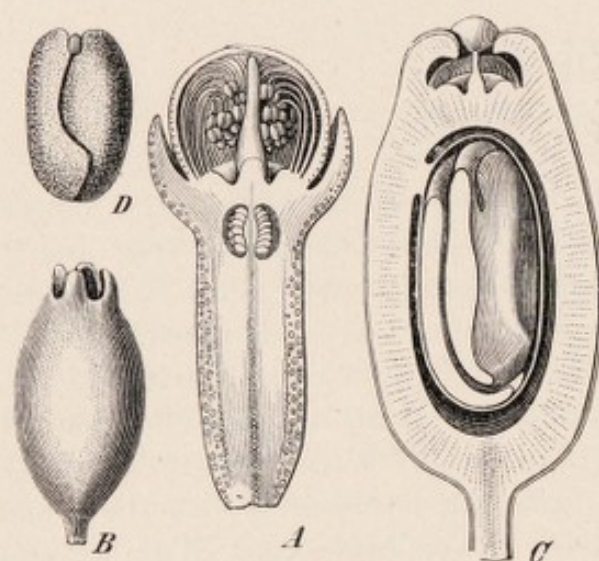


FIG. 44.—Clove (*Eugenia caryophyllata*).
A, clove cut vertically, showing calyx, corolla, stamens, pistil, and ovules; near the margin oil-glands; magnified.
B, fruit (mother clove), natural size.
C, the same, cut vertically and magnified.
D, embryo, natural size. (Luerssen.)

It contains, especially near the periphery, a large number of oil-glands, visible, when the transverse section is examined under the lens, as dark shining points or small cavities. Similar glands can be seen both in the calyx-teeth and petals; in the latter they appear as translucent dots by transmitted light.

Cloves are strongly aromatic and have a pungent aromatic taste. Good cloves should be plump and heavy, have a bright reddish brown colour, sink in water, and exude oil when indented with the finger-nail.

Constituents.—Cloves contain a large quantity of volatile oil, a considerable proportion (13 per cent.—Peabody, 1895) of

tannin, which has been identified as gallotannic acid, and a colourless, odourless, crystalline substance, caryophyllin. They yield from 5 to 7 per cent. of ash.

The most important of these constituents is the volatile oil, and the value of the drug is determined chiefly by the amount of oil that it contains, good cloves yielding from 15 to 20 per cent.

The chief constituent of the oil is 70 to 85 per cent. of eugenol, $C_{10}H_{12}O_2$, a colourless liquid with an odour of cloves, boiling at $253^{\circ}C.$; a terpene, caryophyllene, and acetoeugenol are also present. The amount of eugenol present can be approximately determined by shaking a measured quantity of the oil with 5 per cent. solution of potassium hydroxide with which the eugenol forms a water-soluble compound; the caryophyllene which floats on the surface can be measured by suitable means and deducted from the volume of oil used, the difference being eugenol. Clove oil should have a sp. gr. not under 1.05 and be slightly laevorotatory.

Uses.—Cloves are used as an agreeable aromatic stimulant, antispasmodic, and carminative, properties that are due to the volatile oil they contain.

Varieties &c.—Although Zanzibar supplies the bulk of the cloves imported, those from Penang, Amboyna, Réunion, and Madagascar are considered the best and realise the highest prices. Smaller quantities are imported from Java, the Seychelles, Ceylon, &c.

Penang cloves are large, plump, and of a bright reddish brown colour; *Amboyna cloves* are similar but rather smaller; *Zanzibar cloves* are darker in colour, leaner, and smaller still.

'*Blown*' cloves are the expanded flowers from which both corolla and stamens have usually been broken off (forming clove dust).

Clove stalks.—These do not often exceed 3.5 cm. in length or 3 mm. in thickness; they branch usually twice or thrice trichotomously, the ultimate branchlets which support the flowers being about 3 mm. long. They are dry, woody, and brownish in colour; they break with a short fracture, and exhibit in transverse section but few oil-glands. They have however, when crushed, an aromatic odour and a pungent clove-like taste. They yield much less volatile oil than cloves (about 5 to 7 per cent.), and that which they do yield is less

aromatic. They are said to be used for adulterating powdered cloves, a sophistication easily determined by microscopical examination (they contain isodiametric sclerenchymatous cells¹ which do not occur in cloves) and by the amount of ash yielded by the drug, good cloves affording not more than 7 per cent.

Mother cloves ('Anthophylli').—Of the numerous ovules contained in the ovary of the clove, only one arrives at maturity. After fertilisation it rapidly increases in size, pushes the other ovules and surrounding tissue aside, and forces its way into the lower part of the ovary (compare fig. 44, C). The ripe fruits are ovoid brown berries and about 12 mm. long. They contain much less oil than cloves, and are said to be used for adulterating powdered cloves; their presence can easily be detected, as they contain starch, from which cloves are free.

Exhausted cloves, i.e. cloves which have been deprived of their volatile oil by distillation, are darker, yield no oil when indented with the nail, and float in water.

ELDER FLOWERS

(Flores Sambuci)

Source &c.—The common elder, *Sambucus nigra*, Linné (N.O. *Caprifoliaceæ*), is indigenous and common in England, and is distributed throughout the whole of central and southern Europe. It flowers in the early summer, producing large polychasial cymes, about 15 cm. in diameter, of small white flowers. The entire inflorescences are collected and allowed to remain in heaps for a few hours, during which they become slightly heated and the flowers drop off from the stalks. The latter are removed by sifting, and the flowers are either dried or preserved by mixing them with common salt. By this 'pickling,' as it is termed, the rather disagreeable odour of the fresh flowers is gradually changed to a pleasant fragrance. Either the fresh or pickled flowers may be used officially for the preparation of elder-flower water, but that made from the fresh flowers has a distinct and unpleasant odour, which it is

¹ Compare Greenish and Collin, *Anatomical Atlas*, p. 96.

said to lose when redistilled after having been kept for some weeks.

Description.—Each flower of the cyme consists of a three-celled, three-seeded, inferior ovary bearing five small green calyx-teeth and a white, rotate, monopetalous corolla; the latter possesses five ovate or rounded lobes, and a very short tube in which five stamens with short filaments and yellow anthers are inserted. The dried flowers, which are so shrivelled that their details are quite obscured, have a dingy brownish yellow colour and faint odour.

The student should examine the drug by boiling a little for a few moments in water and pouring on a plate to cool; in addition to the flowers, numerous portions of the stalks (pedicels), as well as occasional buds and immature fruits, may be readily seen under a lens.

He should observe

- (a) The *five-lobed monopetalous corolla*,
- (b) The *yellow anthers* of the stamens.

Constituents.—Elder flowers contain about 0·32 per cent. of volatile oil, possessing the odour of the flowers in a high degree. It is obtained by distilling the fresh flowers with water, saturating the distillate with salt and shaking it with ether. On evaporating the ethereal solution the oil is obtained as a yellowish buttery mass.

Substitutes &c.—The flowers of various small composite plants (*Achillea Millefolium*, Linné &c.) are said to have been used for adulterating elder flowers. The latter can be easily distinguished by the characters detailed above.

The flowers of the dwarf elder (*Sambucus Ebulus*, Linné), which, however, is a comparatively rare plant, are distinguished by their dark red anthers.

Use.—Elder flowers are chiefly used for the preparation of the distilled water.

Notes.—The fresh ripe fruits contain tyrosin; the leaves and bark an alkaloid, sambucine, and a purgative principle. The leaves also contain the cyanogenetic glucoside sambunigrin, the glucoside of lævo-phenylglycollic acid (compare p. 46).

CHAMOMILE FLOWERS

(Flores Anthemidis)

Source &c.—The common or Roman chamomile, *Anthemis nobilis*, Linné (N.O. *Compositæ*), is a small creeping perennial plant with shortly ascending, leafy, flowering branches bearing terminal white-rayed flowerheads. It is common on waste grounds in this country, and is cultivated for medicinal use both in England (Hampshire &c.) and in Belgium, France, and Saxony. Formerly large quantities were produced near Mitcham, but at present there is but little grown in Surrey, and that little is chiefly used for distillation. The flowers have long enjoyed a wide reputation as a domestic medicine.

The inflorescence of the wild plant is a capitulum surrounded by two or three rows of overlapping bracts; the disc-florets are yellow, tubular, closely packed on an elongated conical receptacle



FIG. 45.—Single chamomile. A, entire; B, cut vertically, showing the solid, conical receptacle. Natural size. (Bentley and Trimen.)

and surrounded by a single row of ray-florets with white ligulate corollas. Such chamomile flowers, which are properly designated 'single,' are collected to some extent in Scotland, but they are not official.

Under cultivation the flower usually becomes more or less double. The yellow tubular corollas of the disc-florets become more or less completely white and ligulate, and the flowerhead is converted into a hemispherical mass of white ligulate florets. These are 'double' chamomiles, and form the bulk of the imported cultivated flowers; intermediate forms, or semi-double flowers, in which the conversion of tubular into ligulate corollas has been only partially effected, may, however, frequently be found.

The entire flowerhead is collected for medicinal use, and dried in a warm room.

Description.—The official chamomiles are limited to the 'double' or semi-double flowerheads obtained from cultivated plants, those imported from Belgium, France, and Saxony being preferred by the drug trade on account of their handsome appearance, whilst English flowers yield more volatile oil when distilled.

The flowerheads are hemispherical in shape, 10 to 20 mm. in diameter, and white or nearly white in colour, becoming yellow or buff-coloured when kept. The involucre surrounding each flowerhead consists of two or three rows of overlapping bracts with membranous margins, and is almost entirely concealed in the drug by the reflexed outer ligulate florets. The latter are pistillate, the yellow tubular central



FIG. 46. — Double chamomile. Natural size. (Bentley and Trimen.)

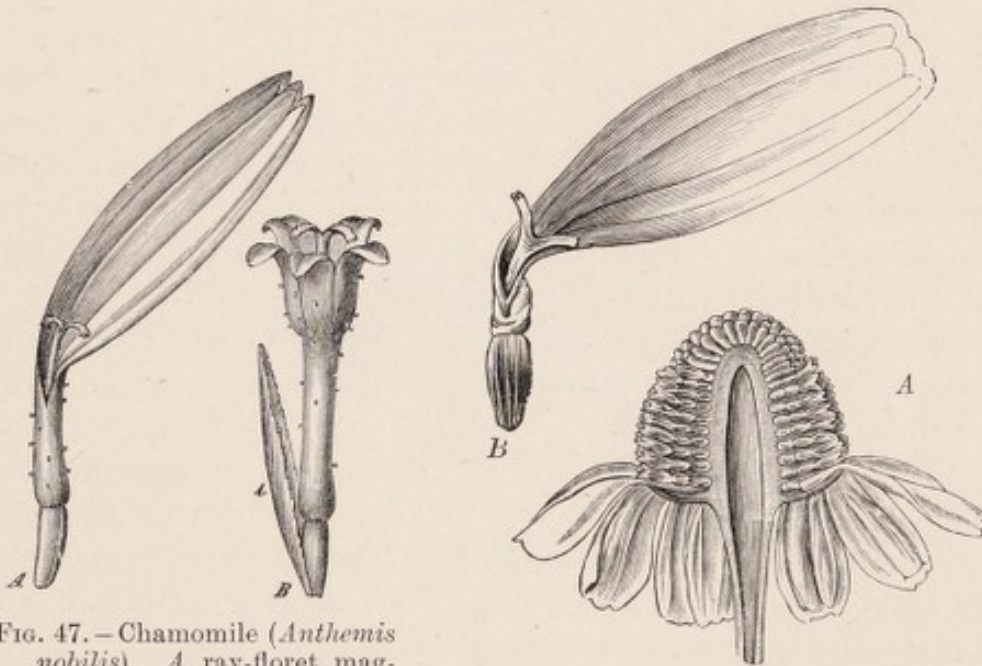


FIG. 47. — Chamomile (*Anthemis nobilis*). A, ray-floret, magnified 4 diam. B, disc-floret with bract (b), showing external glands; more highly magnified. (Luerissen.)

FIG. 48. — German chamomile (*Matricaria Chamomilla*). A, flowerhead cut vertically. B, ray-floret, magnified. (Moeller.)

florets (if present) being hermaphrodite. The corolla of the ligulate florets is white, rather narrow, and terminated by three teeth; towards the base it is contracted to a short tube, immediately below which is the small, nearly smooth ovary. The calyx is completely adherent to the ovary, and,

as there is no pappus developed, is not distinguishable. If the florets are all carefully plucked from the flowerhead, a number of blunt, narrow, concave, scaly bracts (*paleæ*) will be found standing on a conical receptacle; on cutting a flowerhead longitudinally through the centre each floret will be seen to spring from the axil of a bract, and the conical receptacle will be found to be solid. When closely examined with a powerful lens, the lower part of the corolla may be seen to be sprinkled with minute, yellowish, shining oil-glands.

Chamomiles have an aromatic odour and an aromatic intensely bitter taste.

The student should carefully strip the florets from a flowerhead, and observe

(a) The *presence and shape of the paleæ*;

and should also cut a flowerhead longitudinally through the centre, and note

(b) The *solid elongated conical receptacle*.

He should further compare these with those of the flowers of the wild chamomile, German chamomile (*Matricaria Chamomilla*, Linné), and of the feverfew (*Chrysanthemum Parthenium*, Bernharti), which are alluded to below. He should also soak a few ligulate florets in water, spread them out on a dark surface and examine the three-toothed apex.

Constituents.—The principal constituents of chamomile flowers are the volatile oil (0·8 to 1·0 per cent.) and the bitter principle, anthemic acid.

The volatile oil is blue when freshly distilled, but becomes greenish or brownish yellow on keeping; it consists chiefly of the esters of the isomeric acids angelic and tiglic, with butyl and amyl alcohols; it also contains an alcohol, anthemol, and a crystalline hydrocarbon, anthemene.

Anthemic acid is an intensely bitter, crystalline glucoside easily hydrolysed with total loss of bitterness, prolonged boiling in water being sufficient to produce the reaction.

The flowers also contain a crystalline phytosterin, anthe-sterin, melting at 221° C., wax, fatty oil, glucose, &c. They yield about 5 per cent. of ash.

Uses.—Chamomile flowers possess aromatic, bitter stomachic properties; the oil is frequently administered in pills as a carminative.

Substitutes &c.—The characters given above will easily distinguish the true or Roman chamomile from the following, which somewhat resemble it :

Matricaria Chamomilla, Linné, German Chamomile.—The flowerheads are single, and have a hollow conical receptacle devoid of paleæ.

Chrysanthemum Parthenium, Bernhardt, Feverfew.—The cultivated plant has double flowerheads, resembling those of the chamomile. The receptacle is flat ; paleæ may be present or absent, according to the variety ; if present they are acute.

ARNICA FLOWERS

(Flores Arnicæ)

Source &c.—Arnica flowers are the flowerheads of *Arnica montana*, Linné (N.O. *Compositæ*), a small plant with creeping



FIG. 49.—Arnica flower. Natural size. (*Pharmaceutical Journal*.)

perennial rhizome, indigenous to central Europe. In the warmer districts it is common in the meadows on the lower

mountain spurs; in the more northern districts it grows in the valleys. It produces on the summits of the flowering stems large, solitary, orange-yellow flowerheads, not unlike yellow marguerites, measuring about 5 cm. in diameter.

The flowerheads are usually collected entire and dried; the receptacle being especially liable to be attacked by insects, this, together with the involucre, is sometimes separated, and the drug then consists of the ligulate and tubular florets.

Description.—The drug as met with in English commerce commonly consists of the entire flowerheads, the most con-

spicuous parts of which are the green involucre and whitish bristly pappus; the dark yellow ligulate corolla, so prominent in the fresh flower, shrivels so much as to become quite inconspicuous.



FIG. 50.—Arnica flowers.
Receptacle magnified
4 diam. (Vogl.)

The involucre consists of two rows of dark green, acutely pointed, linear-lanceolate, hairy bracts. The florets of the ray are pistillate and arranged in a single row; they possess long, narrow, dark yellow ligulate corollas. When the corollas,

expanded by soaking in water, are examined with a lens, it will be seen that each contains from seven to nine veins and is terminated by three teeth; these characters should be carefully noted.

The disc-florets are numerous, and have a long, dark yellow, tubular corolla, which bears on its outer surface minute glands, visible under a strong lens; similar glands are found also on the ligulate ray-florets. The fruit, which is more or less shrivelled, is elongated, straight, covered with appressed hairs, and surmounted by a single ring of stiff whitish barbed bristles (pappus); the hairs consist of two long, narrow, contiguous cells which are divergent at the apex and pointed, but this character can scarcely be seen under a lens.

After the florets have been removed, the receptacle, which is about 8 mm. in diameter and arched, exhibits a corresponding number of depressions, each of which bears in its centre a stiff dark bristle, and is surrounded by short bristly hairs, the latter being, however, sometimes absent.

Arnica flowers have a slight pleasant odour, and bitter, rather acrid taste.

The student should particularly note

- (a) The narrow, ligulate corollas, with from seven to nine veins and three teeth,
- (b) The straight, bristly fruit and abundant, whitish, bristly pappus,
- (c) The linear-lanceolate, hairy, involucral bracts,
- (d) The characteristic twin hairs on the fruit.

Constituents.—Arnica flowers contain traces of volatile oil and a bitter principle, arnicin, which has been obtained in minute yellow deliquescent crystals. The flowers are said to contain more arnicin than the root. The drug also contains a phytosterin, arnisterin, melting at 250° C.

Uses.—Preparations of arnica flowers applied to the skin appear to increase the activity of the circulation, and the tincture, diluted with water, is used for application to the skin; internally they are stimulant and irritant, but are now seldom administered.

Substitutes &c.—Numerous other composite flowers are reported to have been mixed with or sold for arnica, as, for instance, those of *Calendula officinalis*, Linné, *Inula britannica*, Linné, *Tragopogon pratensis*, Linné, *Scorzonera humilis*, Linné, &c. The straight (not curved) fruit, bearing characteristic hairs, the single row of bristles surmounting it, and the number of veins and teeth in the ligulate corolla as above described, are sufficient to distinguish arnica from all of them. To these characters the student should therefore pay particular attention. Arnica flowers coming from the Italian Alps are said to consist frequently of the flowerheads of *Inula britannica*.

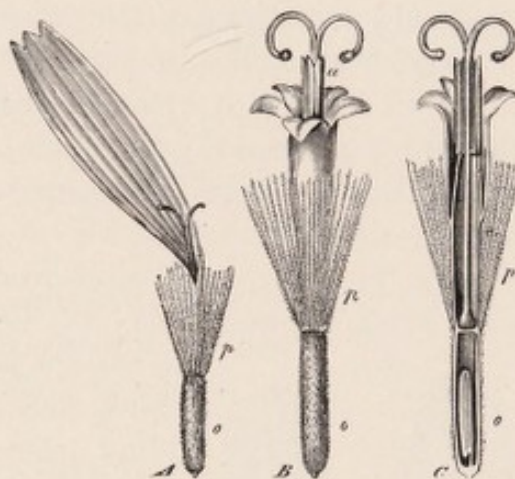


FIG. 51.—Arnica flowers. A, ray-floret. B, disc-floret. C, the same, cut vertically: o, ovary; p, pappus; a, anthers. All magnified. (Luerssen.)

WORMSEED

(Santonica, Semen Cinæ, Semen Contra)

Source &c.—The drug that is known by the name of wormseed consists of the small unexpanded flowerheads of *Artemisia maritima*, var. *a. Stechmanniana*, Besser (N.O. *Compositæ*). The species has, in numerous varieties, an extremely wide distribution, from the Bay of Biscay to Chinese Mongolia. The variety from which part at least of the drug is obtained, and which, according to some botanists, should be considered a distinct species (*A. Cina*, Berg) grows in enormous quantities in the deserts of the Kirghiz in Turkestan, especially near the town of Chimkent, which lies to the north of Taschkent and some seventy miles east of the Sir Daria river; in Chimkent a factory has been erected, in which large quantities of santonin are produced from the wormseed collected in the vicinity. Comparatively little of the crude drug is now exported.

The plant is small and woody, throwing up a number of erect branches about 40 cm. long, on which the little flowerheads are borne. These are stripped from the stems before they expand, and dried. They are collected in July and August by Kirghiz and other tribes and brought to Chimkent.

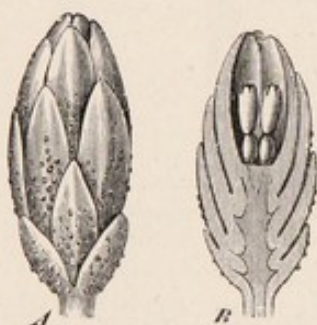


FIG. 52.—Flowerhead of *Artemisia*. A, entire, showing imbricated bracts with external glands: B, cut longitudinally, showing florets. Magnified. (Luerssen.)

Wormseed has long been used as an anthelmintic; it was employed in Italy under the name of *semenzina* (diminutive of *semenza* = seed), under the belief that it consisted of small seeds. From this word *semenzina* is derived the name 'semen cinæ,' by which the drug is often known; *semen contra* (another of its names) is an abbreviation of 'semen contra

vermes.' The drug appears at first sight to consist of a number of small brownish ridged seeds, and it is not till they are closely examined and dissected that their true nature becomes apparent.

Description.—When collected the flowerheads are of a greenish yellow colour, but they turn brown by drying and keeping. They are very small, being only about 1.5 mm. long,

elongated ovoid in shape, and somewhat angular; their surface is shining and glabrous, or at most only slightly hairy.

The involucre consists of imbricated bracts of ovate or lanceolate shape, furnished with a distinct keel, on each side of which are shining oil-glands; the latter, however, are not easily seen even under a powerful lens. After the drug has been well soaked in water the bracts can be removed with dissecting needles, and in the centre from three to six very minute unexpanded tubular florets will be found; they are completely enclosed by the upper bracts of the involucre, and bear minute oil-glands on the lower portion of the corolla.

The drug exhales, when crushed, an agreeable aromatic odour, and possesses a bitter, aromatic, camphoraceous taste. It frequently contains a considerable admixture of fragments of the leaves and very slender flower stalks.

The student should soak the wormseed in water for twenty-four hours, and then dissect a flowerhead with the aid of the dissecting needles and a lens. He should note

- (a) The *imbricated keeled glabrous bracts*,
- (b) The *minute florets enclosed within them*,
- (c) The *characteristic odour and taste*.

Constituents.—Wormseed contains a volatile oil and a crystalline principle, santonin, to which the anthelmintic property of the drug is due. The santonin attains its maximum (2.3 to 3.6 per cent.—Ehlinger, 1885) in July and August. After flowering it rapidly disappears.

Santonin, $C_{15}H_{18}O_3$, forms colourless bitter crystals that are very slightly soluble in water but unite with alkalies, forming soluble salts of monobasic santonic acid, $C_{15}H_{20}O_4$. Exposed to light, santonin assumes a yellow colour.

Wormseed contains also a crystalline substance, artemisin.

Santonin is extracted from the flowerheads by treating them with milk of lime, the santonin being converted into soluble calcium santonate. From the filtrate excess of calcium is removed by a current of carbon dioxide, and the calcium salt is converted into the sodium salt by means of sodium carbonate. The liquid is filtered warm and the santonin separated by the addition of sulphuric acid. It is purified by decolourisation with charcoal and recrystallisation from hot alcohol.

Use.—Wormseed is now seldom administered, but its active constituent, santonin, is often employed as an anthelmintic for round worms which it rapidly expels; it has less effect upon thread-worms. It produces remarkable disturbances of vision, objects appearing first blue and then yellow.

CALENDULA

(Flores Calendulæ, Marigold Florets)

Source &c.—The marigold, *Calendula officinalis*, Linné (N.O. *Compositæ*), is a native of southern Europe and the Levant, but is commonly cultivated in numerous varieties as a garden plant. It produces an orange yellow flower about 5 cm. in diameter, with numerous barren disc-florets and one or more rows of fertile ligulate ray-florets. The latter are collected when the flower is fully expanded and dried.

Description.—The drug consists almost entirely of the yellow ligulate corollas of the ray-florets, about 2.5 cm. in length, enclosing in a short tube the remains of the style and two stigmas. The limb of the corolla, the tube of which is hairy externally, is terminated by three teeth, and exhibits, when examined with a lens, four principal veins. (Compare fig. 54 B.)

The drug has a somewhat aromatic odour and a distinctly bitter taste.

The student should soften some calendula in water, spread the florets out, and examine them with a lens, noting

- (a) The *three teeth of the corolla*,
- (b) The *four principal veins*;

and should compare them with the ligulate florets of arnica (which have from seven to nine veins) and of dandelion (which have five teeth). (Compare figs. 51, A, and 54, B.)

Constituents.—Calendula contains traces of volatile oil, a bitter principle, and calendulin, the latter being a tasteless substance swelling in water (Geiger, 1818).

Uses.—Calendula is used chiefly in the form of the tincture diluted with water as an application to bruises to promote the absorption of effused blood.

INSECT FLOWERS (Dalmatian)

(Flores Pyrethri, Pyrethrum Flowers)

Source &c.—Dalmatian insect flowers are the unexpanded flowerheads of *Chrysanthemum cinerariæfolium*, Visiani (N.O. *Compositæ*), a native of Dalmatia, Herzegovina, and Montenegro, and cultivated both in Dalmatia and California. The attempt has also been made to cultivate the plant in Australia, southern Africa, and elsewhere, but the supply of insect flowers is at present derived chiefly from Dalmatia and Montenegro.

The flowers of several composite plants have long been known to possess the remarkable property of stupefying flies and other small insects. None, however, appear to act so energetically as those of the plant under consideration, and they are most active if collected when they are fully developed, but before they expand. They are then known commercially as 'closed' flowers; 'half-closed' and 'open' flowers being collected, as the terms indicate, at more advanced stages of development. They retain their insecticidal properties indefinitely, even in the state of dry powder.

The flowers alone appear to be active; the leaves have been shown to be destitute of insecticidal properties.

Description.—The closed flowerheads of commerce are of a dull brownish yellow or greyish brown colour and nearly globular shape, measuring about 10 mm. in diameter. The bracts of the involucre, which are arranged in two or three rows, are yellowish or greyish in colour, lanceolate, hairy, and membranous at the margin. In the closed flowers they are erect, but as the flowers expand they bend outwards, the capitulum assuming a flattened hemispherical shape. There is only one row of ray-florets, with brownish or whitish ligulate corollas. The disc-florets, which are numerous, have a comparatively short yellow corolla. The fruit is longer than the corolla, club-shaped, and provided with five ribs that project so strongly as to make it appear almost winged. Both the corolla and the fruit are sprinkled with yellow shining oil-glands. After the corolla has been removed, the calyx may be seen in the form of a raised membranous ring crowning the fruit. The receptacle is naked and nearly flat.

'Closed' flowers are sub-globular or sub-conical in shape, and usually bear the yellowish, shrivelled, ligulate corollas; 'half-closed' flowers are nearly hemispherical in shape, and the corollas of the ray-florets are more spreading; 'open' flowers are still flatter, and most of the ligulate corollas have been broken off; they are often devoid as well of the tubular corollas of the disc-florets, and then present a reticulated appearance due to the membranous calices of the closely packed fruits.

Insect flowers possess a bitter, acrid taste; the odour is aromatic, but not strong.

The student should observe

- (a) The *sub-globular or sub-conical shape of the 'closed' flowers,*
- (b) The *yellowish colour of the bracts,*
- (c) The *short corolla and membranous calyx of the tubular florets,*
- (d) The *five prominent ribs of the fruit.*

Constituents. — Dalmatian insect flowers contain up to 1.25 per cent. of volatile oil, which, however, does not contribute to the insecticidal properties of the flowers. The toxic principle is a yellow butyraceous substance, to which the name of pyrethrotoxic acid has been given. It is not volatile, and the flowers do not lose their activity when exposed to the air.

Substances of alkaloidal and glucosidal nature have also been isolated, but our knowledge of them is very imperfect.

Good insect powder should stupefy common house-flies kept near it within a minute; less active powders may take as much as twenty minutes to effect this. It should yield about 8 or 9 per cent. of ash and about 10 per cent. of moisture. The quality of the powder is also indicated by the ethereal extract, good closed flowers affording from 7.5 to 10.5 per cent. of yellow extract; half-closed flowers yield from 6 to 7 per cent., and closed flowers from 5 to 6 per cent., while the presence of much stem or leaf is indicated by the greenish colour of the extract.

Substitutes &c.—*Chrysanthemum coccineum*, Willdenow, (*C. roseum*, Weber et Mohr), a native of the Caucasus and northern Persia, yields the Persian (or Caucasian) insect flowers, which were formerly more commonly used than the

Dalmatian. The importation has now, however, practically ceased.

The flowerheads are distinguished from the Dalmatian by the dark, nearly black, colour of the involucral bracts, by the rose colour of the ray-florets, and by the ten-ribbed fruit. They are said to be less active than the Dalmatian.

Dalmatian insect powder is largely adulterated, not only with the powder of other composite flowers, but also with turmeric, lead chromate, &c. One of the best tests is the practical one of keeping a few house-flies under a tumbler with a little of the powder; they should be stupefied within a minute.

Use.—Powdered insect flowers and also a tincture prepared from them are used to stupefy small insects.

LAVENDER FLOWERS

(Flores Lavandulæ)

Source &c.—The common lavender, *Lavandula vera*, de Candolle (N.O. *Labiata*), is a small under-shrub indigenous to southern France, Italy, and Spain, but cultivated in this country as a garden plant, as well as on a large scale for its aromatic flowers. It is also extensively cultivated in southern France.

The best lavender is said to be that grown in Surrey. Formerly large quantities were produced near Mitcham, but Walsington is said to be now the centre of the Surrey lavender district. Lavender is also grown in Kent, Hertfordshire, Bedfordshire, &c.

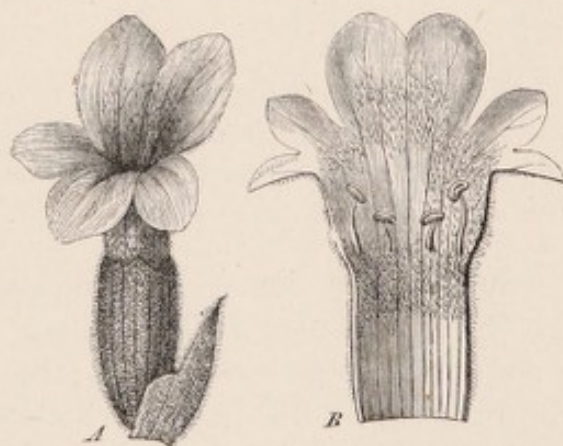


FIG. 53.—*Lavandula vera*. A, entire flower, showing bract and hairy calyx, magnified. B, the corolla opened vertically, magnified. (Luerssen.)

The bulk of the flowers produced are used for the distillation of the volatile oil. The spikes are cut with a small hook about 15 to 30 cm. below the flowers. They are then thrown into

large stills situated near the fields, water is added, and distillation conducted over a naked fire or by steam, the distillate being received in a separating can, in which the oil that is carried over is retained.

Description.—The inflorescence of the lavender is a terminal spike, on which the flowers are arranged in small verticillasters, each of which arises from the axil of a rhomboidal bract. The calyx is tubular and ribbed, bluish-violet in colour, five-toothed, and hairy, shining oil-glands being visible with a lens amongst the hairs. The majority of the oil yielded by the flowers is contained in these glands on the calyx.

The corolla is bilabiate and of a beautiful bluish violet colour.

Lavender flowers have an agreeable fragrant odour, which is especially perceptible when they are warmed or rubbed; their taste is bitter and aromatic.

The student should observe

- (a) The *hairy, ribbed, tubular calyx*,
- (b) The *rhomboidal bracts supporting the flowers*.

Constituents.—The principal constituent of lavender flowers is the volatile oil, of which the dried flowers contain from 1.5 to 3 per cent., fresh flowers yielding about 0.5 per cent.

The chief constituents of the volatile oil are linalool and linalyl acetate; cineol (in English oil), pinene, limonene, and other bodies are also present. The oil should have a sp. gr. of 0.885 to 0.900 and an optical rotation -5° to -10° .

Substitutes &c. — *Lavandula spica*, de Candolle, from which oil of spike is distilled, is distinguished from the common or true lavender by the inflorescence which is more compressed, by the bracts which are linear instead of rhomboidal, and by the leaves of the plant, which are spathulate. The oil distilled from the flowers is less fragrant than that of the true lavender, and slightly dextro-rotatory.

SAFFRON

(Crocus)

Source &c.—The saffron crocus, *Crocus sativus*, Linné (N.O. *Iridææ*), has been cultivated for so many centuries that its native country is no longer known. It was well known to the Greeks and Romans, who used it as a medicine, as a dye, and as a flavouring agent. It was cultivated in Spain in the tenth century, and was subsequently introduced into France and England; it is, however, no longer grown in this country.

At the present time Spain produces the bulk of European saffron. On the plains towards the east and south-east the saffron crocus is grown extensively, the saffron being exported from Valencia and Alicante. A little is also produced in France, near Pithiviers, about fifty miles south of Paris.

The plant produces in the autumn usually one or two flowers of a pale purplish violet colour, not unlike the ordinary garden crocus. The long pale yellow style terminates in three deep red elongated stigmas (fig. 54, *A*), which protrude from the flower and are pendulous. The whole flower is collected, and from it the three stigmas, with the upper part of the style, are separated and dried. This forms the hay saffron of commerce, which must necessarily be a valuable drug, since it takes about 750 fully developed stigmas to make one gramme of saffron.

Description.—Hay saffron thus produced forms a loosely matted mass of dark reddish brown flattened stigmas with a strong characteristic odour and bitterish taste. When fresh it is unctuous to the touch and glossy, but after keeping, when quite dry, it becomes dull and brittle.



FIG. 54.—*A*, three stigmas of Saffron with a portion of the style, magnified 2 diam. *B*, Calendula floret, magnified $1\frac{1}{2}$ diam. *C*, Safflower floret, magnified $1\frac{1}{2}$ diam. (Vogl.)

Thrown on the surface of water the dry stigmas rapidly expand, and their form can be easily studied. At the same time the water surrounding them assumes a deep yellow colour. Each stigma is about 25 mm. in length, and has the shape of a long tube, narrow at the base, where it joins the style, but broadening towards the upper extremity, where it is slit on the inner side. The mouth of the tube is irregularly notched. The stigmas are either single or attached in threes to a short portion of the pale yellow style.

The characteristic shape of the saffron stigmas is of the greatest service in the detection of adulteration; the student should therefore soak a little saffron in water and examine it carefully with a lens.

Constituents.—Saffron contains a trace of volatile oil, a bitter principle, picrocrocin, and red colouring matter, polychroite (also called crocin). Polychroite resembles carotin, the colouring matter of carrots, in assuming a deep blue colour in contact with concentrated sulphuric acid.

The volatile oil consists principally of a terpene, probably associated with a small quantity of an oxygenated aromatic constituent.

Picrocrocin is a colourless crystalline glucoside yielding by hydrolysis crocose (a reducing sugar) and a terpene with an odour recalling saffron.

Polychroite stands in some unknown relation to carotin. It has been obtained as a ruby-red, amorphous, glucosidal substance yielding by hydrolysis a new red colouring matter, crocetin (also called crocin), volatile oil, and sugar. Crocetin is acid and forms crystalline salts with ammonia, brucine &c.; it is said to be the palmitate and stearate of phytosteryl (Hilger; 1899).

Substitutes &c.—The high price of the drug has naturally been, even during the time of Dioscorides and Pliny, a great inducement to adulteration. This has been affected in one (or more) of the following three ways:

- (i) By substituting some substance for the saffron stigmas,
- (ii) By recolouring exhausted saffron,
- (iii) By artificially increasing the weight of genuine saffron.

(i) Under this heading the following may be mentioned as of frequent occurrence, but numerous others have from time to time been observed: the long pale coloured *styles* of the saffron crocus, or the *stamens*, or portions of the *perianth* of the same; *calendula florets* coloured with methyl-orange and sold under the names of *feminell* or Chinese safflower; the florets of the *Safflower* (*Carthamus tinctorius*, Linné), an Indian composite plant largely used as a dye and often found in the cake saffron of commerce; the slender *stems and roots of monocotyledonous plants*.

(ii) Artificial coloration has been effected with aniline dyes, logwood, Brazil wood, the salts of dinitrocresylic acid (Victoria yellow, Victoria orange), &c. Genuine saffron, when thrown on to the surface of water, should surround itself with a circle of yellow (not red or pink) liquid; it should yield but little colour to ether or petroleum spirit, in which many artificial colours are readily soluble, and should be changed to deep blue by concentrated sulphuric acid. Useful information may also be obtained by comparing the colour of an infusion of 0.1 gm. of the suspected sample in 100 c.c. of water with the colour of a similar infusion of genuine saffron, both depth and tint being scrutinised. A solution of chromic acid may also be used as a standard for comparison; 0.1 gm. of saffron should impart as deep a colour to 50 c.c. of water as 0.275 gm. of chromic anhydride. Animal charcoal almost instantaneously decolorises an infusion of saffron, whereas aniline colours are much less readily removed.

(iii) Saffron may be artificially weighted in a variety of ways. Vegetable or mineral oil, which, in addition to increasing the weight, improves the appearance, may be detected by pressing the saffron between thin sheets of paper; a greasy stain indicates the presence of oil. Saffron should not contain more than 12.5 per cent. of moisture (absence of an undue proportion of water), or yield more than 7 per cent. of ash (presence of fraudulently added inorganic matter). The presence of glycerin, and of other substances soluble in water, but leaving no ash when incinerated, may be detected by ascertaining the amount of aqueous extract yielded by the saffron; it should not exceed 51 per cent.

Cape saffron, which however is seldom imported into the London market, consists of the flowers of a Scrophulariaceous

shrub, *Lypēria atropurpurea*, Bentham, a native of South Africa; it contains a yellow colouring matter, but could scarcely be mistaken for saffron.

Cake saffron ('croci placentæ,' 'crocus in placenta') commonly consists of safflower florets made into cakes with an adhesive sugary substance. The structure of the florets is easily seen when a little of the drug is soaked in water.

Uses.—Although chiefly employed as a colouring agent, saffron has been regarded as stimulant, antispasmodic, and emmenagogue.

LILY OF THE VALLEY FLOWERS

(Flores Convallariæ)

Source &c.—The common lily of the valley, *Convallaria majālis*, Linné (N.O. *Liliaceæ*), is a small herbaceous plant, with perennial creeping rhizome. It is widely distributed over Europe and indigenous in England, where it occurs in woods or thickets, being much more abundant in some counties than in others.

The plant produces two broadly elliptical leaves and a flowering scape, bearing in the axils of small bracts pedicellate campanulate flowers, forming a graceful, unilateral raceme of fragrant, white drooping flowers. The root, leaves, and flowers have all been used in medicine for the same purposes as fox-glove leaves, but the part now usually employed is the flowers. The entire inflorescence is collected and dried, during which process the white flowers assume a brownish yellow tinge and the fragrant odour almost entirely disappears.

Description.—The drug consists of the slender scape, bearing from three to eight brownish yellow campanulate flowers. The perianth has six recurved teeth, and bears on its inner surface six large anthers; the ovary is superior and three-celled. It possesses but a slight agreeable odour and a bitter taste.

Constituents.—Two crystalline glucosides have been isolated from the lily of the valley, convallamarin and convallarin.

Convallamarin, $C_{23}H_{44}O_{12}$, has been obtained as a crystalline powder readily soluble in water and in alcohol, but only slightly

in ether; it yields a violet coloration with sulphuric acid and is hydrolysed into dextrose and convallamaretin; its action is that of a cardiac tonic and diuretic.

Convallarin, $C_{34}H_{62}O_{11}$, crystallises in prisms, soluble in alcohol and slightly soluble in water, the aqueous solution frothing when shaken; it has a purgative action.

Use.—Lily of the valley flowers are occasionally used as a cardiac tonic in the place of foxglove.

SECTION III

FRUITS

Fruits are generally classified into true, spurious, and collective fruits. A true fruit may be defined as the mature ovary of a single flower. A spurious fruit is one in the formation of which other structures have taken part, while a collective fruit consists of the mature carpels of several flowers united with the bracts and floral envelopes.

True fruits may be further sub-divided according as they are indehiscent or dehiscent, monocarpellary or polycarpellary.

The following classification of the most important fruits may be useful to the student for reference :

A. TRUE FRUITS

1. INDEHISCENT MONOCARPELLARY FRUITS

- (a) *The Achene*, a superior one-celled, one-seeded fruit with a dry, indehiscent, closely applied but separable pericarp (true fruits of the fig).
- (b) *The Caryopsis*, a superior one-celled, one-seeded, indehiscent fruit with a dry, indehiscent, inseparable pericarp (Gramineaceous fruits).
- (c) *The Drupe*, a superior one-celled, one- or two-seeded, indehiscent fruit with a fleshy or pulpy mesocarp and hard endocarp (prune, pimento, cocculus indicus).

2. INDEHISCENT POLYCARPELLARY FRUITS

- (a) *The Nut*, a dry, hard, indehiscent, one-celled, one- or two-seeded fruit more or less enclosed in a cupule.
- (b) *The Cremocarp*, an inferior dry, indehiscent, two-celled, two-seeded fruit, splitting as it ripens into its two component halves, called mericarps, which remain attached to the carpophore (Umbelliferous fruits).

- (c) *The Berry*, an inferior, indehiscent, one or more celled, many-seeded, pulpy fruit (orange, lemon, bitter apple, pomegranate, &c.).

3. DEHISCENT MONOCARPELLARY FRUITS

- (a) *The Follicle*, a superior one-celled, one- or many-seeded fruit dehiscing by one suture only (star anise).
(b) *The Legume*, a superior one-celled, one- or many-seeded fruit dehiscing by both sutures (tamarind).

4. DEHISCENT POLYCARPELLARY FRUITS

The Capsule, a superior one or more celled, many-seeded, dry, dehiscent fruit (poppy head). Fruits which differ from the capsule in being inferior are often termed capsular (cardamom); the siliqua, a superior, spuriously two-celled, many-seeded, long, narrow fruit dehiscing by two valves from below upwards (mustard) and the silicula, which differs from the siliqua only in being short and broad, are varieties of the capsule.

B. SPURIOUS FRUITS

The Pome, an inferior, indehiscent, two or more celled, few-seeded, fleshy fruit, the flesh being generally considered to be the enlarged calyx-tube (quince).

C. COLLECTIVE FRUITS

- (a) *The Cone*, an elongated fruit composed of a number of indurated scales, each of which bears one or more seeds in its inner surface.
(b) *The Galbulus* differs from the cone in being more or less rounded; the scales are sometimes fleshy (juniper berry).
(c) *The Strobile* resembles the cone, but the scales are membranous, and the seeds are contained in carpels (hop).
(d) *The Syconus* is formed of an enlarged hollow and more or less succulent receptacle which bears a number of separate flowers on its inner surface (fig).

STAR ANISE FRUIT

(Fructus Anisi Stellati)

Source &c.—Star anise fruit is the ripe fruit of *Illicium verum*, Hooker filius (N.O. *Magnoliaceæ*), a small tree indigenous to the southern and south-western provinces of China. The drug has long been known in China, but effected its introduction into Europe very slowly. The bulk of star anise

is used in the former country for the distillation of the volatile oil, only a small proportion of the dried fruits finding their way into the European market, from Hong Kong and from the southern Chinese port, Pakhoi.

Description.—Star anise fruit is apocarpous, and consists normally of eight one-seeded ovaries. In the flower these are erect, but as the fruit ripens they bend outwards, and finally radiate from a central axis; simultaneously the pericarp becomes dark brown

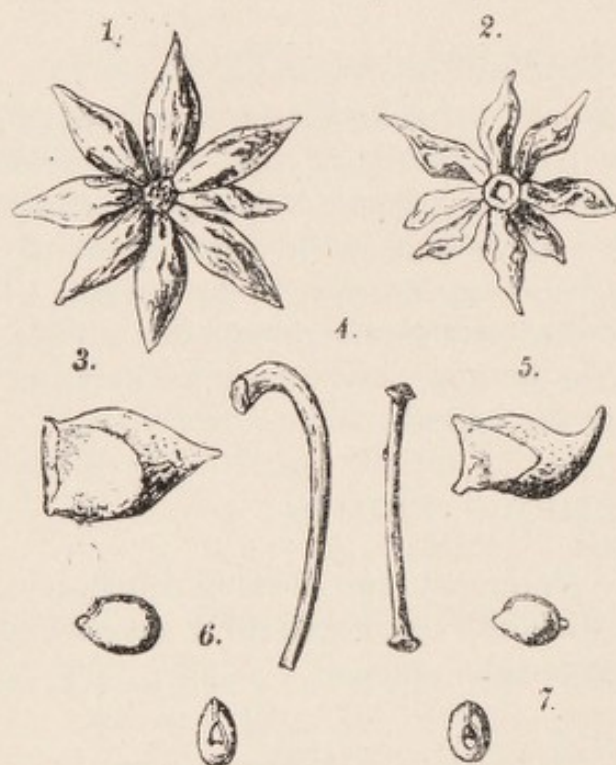


FIG. 55.—Fruits of *Illicium verum* and *I. religiosum*. 1, entire fruit of *I. verum*; 3, a single carpel; 4, stalk (left); 6, seed; 2, entire fruit of *I. religiosum*; 4, stalk (right); 5, single carpel; 7, seed. (Vogl.)

and woody, and dehisces by the now fully exposed ventral suture, disclosing a single, shining, brown seed. This is the appearance usually presented by the drug.

The carpels measure about 1.5 cm. or rather more in length; they are boat-shaped, and usually bluntly beaked at the apex, but nearly flat at the base, where they are attached to a short central column proceeding from a curved peduncle. They are of a reddish brown colour and woody; externally irregularly wrinkled, internally paler, smoother, and glossy. The seed is reddish brown in colour, smooth, shining, hard,

ovoid in shape, and slightly compressed. The hilum is conspicuous as an oval depression at one extremity. The seed-coats, though hard, are brittle, and enclose a large, soft, oily kernel.

Both the pericarp and the kernel have an agreeable aromatic odour and a sweet spicy taste.

The student should particularly observe

- (a) The *size, regular appearance, and blunt beaks of the carpels,*
- (b) The *peduncle, which is curved near the fruit,*
- (c) The *spicy odour and taste;*

and should compare these fruits with the Japanese star anise (see below).

Constituents.—Star anise fruit contains a volatile oil to the extent of about 5 per cent., and this is the principal constituent. It is secreted in large oil-cells in both the pericarp of the fruit and the kernel of the seed, the latter yielding about half as much oil as the former.

The oil is distilled in large quantities in crude native stills by the peasants of Langson, in southern China, and brought to the ports of Hai-fong and Hong Kong for exportation. It is scarcely distinguishable from that of *Pimpinella Anisum*, Linné, and may be substituted for it; its chief constituent is anethol, $C_{10}H_{12}O$ (80 to 90 per cent.).

Substitutes &c.—True star anise fruits have been largely replaced in India by the fruits of the Japanese star anise (*Illicium religiosum*, Siebold); and a similar substitution has frequently taken place elsewhere. Large quantities of the Japanese fruit are exported from Japan, and some find their way to the London market. As they are poisonous and have produced unpleasant effects when eaten, they must be carefully distinguished from the genuine.

Japanese star anise fruit (fig. 55), or sikimi or shikimi fruits as they are termed, resemble the genuine in general appearance, but may be distinguished by the following characters: The fruits are less regularly developed, the carpels usually more wrinkled and provided with a more acute beak, which is commonly directed upwards; the ventral suture is usually more open, and the peduncle, to which the carpels seldom remain attached, is straight. Moreover, the taste and odour

are quite distinct, for the Japanese fruits have a balsamic but not anise-like odour and a disagreeable bitterish taste; the taste and odour are, indeed, the best characters by which to distinguish the genuine from the false, as they can be applied to fragments only of the fruit.

From the seeds of Japanese star anise fruit Eykmann (1881) obtained 52 per cent. of fixed oil and a poisonous crystalline principle, sikimin, soluble in hot water, alcohol, and chloroform; the leaves and fruits yielded volatile oil, sikimic (schikimic) acid, and sikimipicrin.

Uses.—The oil is employed as a carminative and as a flavouring agent, especially in cough mixtures, as it is supposed to possess a special action on the bronchial mucous surfaces.

COCCULUS INDICUS

(Levant Berries, Fructus Cocculi)

Source &c.—The fruits commonly known as *Cocculus indicus* are produced by *Anamirta paniculata*, Colebrooke (N.O. *Menispermaceæ*), a tall woody climbing shrub indigenous to Eastern India and the Malayan Archipelago. They derive the name of Levant berries, by which they are sometimes known, from the fact of their having been formerly brought from India by way of Alexandria and the ports of the Levant.

The plant produces a pendulous panicle of flowers; the ovaries of the pistillate flowers are apocarpous, each carpel being gibbous and developing into a drupaceous fruit containing a single seed. The fruits are collected when ripe, and dried; they are exported chiefly from Bombay and Madras.

Description.—*Cocculus indicus* of commerce consists of small dark brown or nearly black fruits, not quite half an inch in length. When examined carefully they will be seen to be more or less distinctly reniform in shape, one side being flattened or even slightly concave, whilst the other is boldly arched. On the former the small scar left by the stalk can usually be distinguished, and near it is a minute prominence, the apex of the fruit. The gibbous dorsal surface of the carpel from which the fruit is formed develops much more rapidly

than the ventral, and the apex of the fruit thus remains near to the base, the dorsal surface becoming conspicuously arched; the latter is traversed from base to apex by an indistinct ridge. The pericarp is rough and finely wrinkled, and although thin is hard and woody. It encloses a single oily seed, which is so deeply hollowed out as to be cup-shaped. This cup-shaped hollow is completely filled by two parallel lenticular ingrowths of the endocarp and mesocarp, which can easily be seen by cutting a fruit longitudinally through the median line of the carpel and removing the two halves of the seed, or less clearly

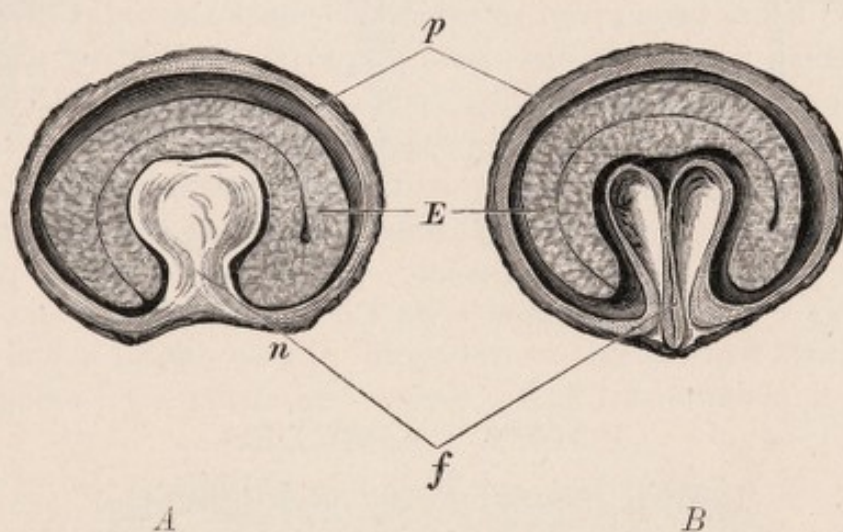


FIG. 56.—*Cocculus indicus*. A, vertical; B, transverse section; p, pericarp; n, base of fruit; E, seed; f, fold of pericarp. Magnified. (Moeller.)

by cutting the fruit transversely. The seed exhibits a crescent-shaped section when cut either longitudinally or transversely. *Cocculus indicus* has no odour; the pericarp is tasteless, but the seed is very bitter.

The student should observe

(a) The *sub-reniform shape of the fruit*,

and should cut it longitudinally and transversely, noting

(b) The *shape of the seed*,

(c) The characteristic *ingrowths from the pericarp*.

He should further notice that the seed is bitter, but the pericarp is almost tasteless.

Constituents.—The seed contains from 1 to 1.5 per cent. of an intensely bitter, crystalline principle, picrotoxin, accompanied by a crystalline but tasteless body, cocculin, and a large

proportion of fat. Picrotoxin, $C_{45}H_{50}O_{19}$ (m.p. $199^{\circ}C.$), contains no nitrogen and is therefore not alkaloidal, nor does it possess glucosidal properties. It is readily separable into toxic picrotoxinin, $C_{15}H_{16}O_6$, and non-toxic picrotin, $C_{15}H_{18}O_7$, but its further constitution is as yet unknown.

From the pericarp, which is tasteless, two alkaloids, menispermine and paramenispermine (Pelletier and Couerbe, 1833), have been isolated, but they require re-investigation.

Uses.—*Cocculus indicus* is now used almost exclusively for the preparation of picrotoxin, which is a powerful convulsive poison; it has been given internally to check the night-sweating of phthisis; and has also been employed to destroy pediculi. The power possessed by the fruits, when thrown into water, of stupefying fish has long been known, and is due to the picrotoxin contained in the seed. So susceptible are fish to the influence of picrotoxin, that they have been used as a means of detecting its presence. A number of other plants, however, share this property with *Cocculus indicus*.

POPPY CAPSULES

(Poppy Heads, *Fructus Papaveris*)

Source &c.—The opium poppy, *Papaver somniferum*, Linné (N.O. *Papaveraceæ*), is probably a native of Asia Minor, but is now cultivated in many warm or temperate countries both as a garden plant and for the sake of its fruits and seeds. The plant is an erect herbaceous annual; it varies very much in the colour of the petals, as well as in the shape of the fruit and colour of the seeds.

In England a variety with pale flowers and whitish seeds is cultivated for medicinal use. The fruits are of a pale glaucous green when young, and exude when wounded a bitter white milky juice (latex); as they mature and ripen they change to yellowish brown, and are then cut from the stems. In Germany the unripe fruits are considered to be more active than the ripe.

Description.—Poppy heads vary very much both in shape and size. Some varieties are ovoid, others are nearly globular, others again depressed both at the summit and base, the latter variety attaining 8 cm. or more in diameter. The fruit is of

a pale yellowish brown colour, often marked with darker spots, glabrous, and crowned with the persistent remains of the stellate sessile stigmas, usually twelve or fifteen in number;



FIG. 57.—Poppy capsules. Reduced. (Maisch.)

below, it is contracted into a neck which is swollen just above the point of attachment to the peduncle and marked there with the scars of the petals and sepals. Cut transversely the fruit

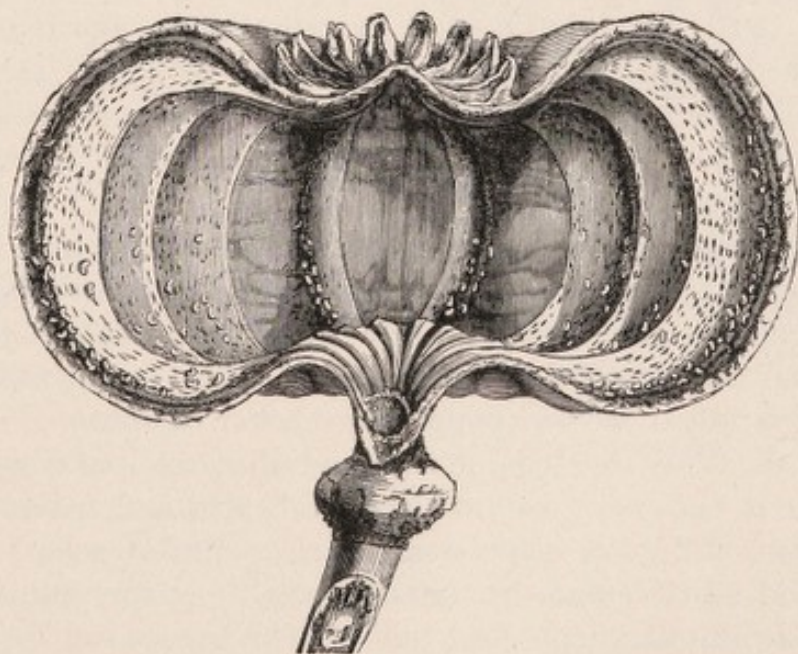


FIG. 58.—Poppy capsule, cut vertically. (Planchon and Collin.)

is seen to be unilocular, but formed by the union of as many carpels as there are stigmas. From the inner surface of the pericarp, which is thin and brittle, the yellowish, membranous

placentas, corresponding in number to the carpels, project into the cavity of the fruit.

The seeds, which for the most part lie loose in the fruit, are minute and very numerous. Under a lens they may be seen



FIG. 59.—Poppy seed. Magnified. (Bentley and Trimen.)

to be reniform in shape and covered with distinct delicate reticulations. They vary in colour from whitish to slate (the latter being known as maw seed), and contain an oily endosperm.

Poppy capsules have no odour; the seeds have an oily taste, but the pericarp is distinctly bitter.

The student should observe

- (a) The *sessile stellate stigmas*,
- (b) The *membranous placentas*,
- (c) The *reniform shape of the seed* and the *reticulations on its surface*.

Constituents.—Poppy capsules contain the principal constituents of opium, the most important of which is the crystalline alkaloid morphine. Ripe capsules have been found to contain 0.018 (Malin, 1906), 0.16 (Dieterich), and 0.28 (Paul and Cownley) per cent. of morphine; unripe 0.06 (Malin) and 0.086 (Dieterich) per cent.; there is, therefore, some uncertainty as to the actual and the relative medicinal value of ripe and unripe fruits.

Poppy capsules also contain meconic acid, an organic acid found only in the latex of the opium poppy. Although this acid is not an active constituent from a therapeutic point of view, the detection of its presence is often important as indicating a preparation of poppy capsules or of opium.

The seeds are free from morphine; the principal constituent in them is the pale yellow fixed oil, which consists of the glycerides of linolic, oleic, stearic, and palmitic acids; it is a drying oil and is used by artists as well as for culinary and various technical purposes.

Uses.—The action of poppy capsules is the same as that of opium, but much weaker. The warm decoction is a favourite anodyne fomentation. The extract and syrup are uncertain remedies, and preparations of opium are in every respect preferable.

BAEL FRUIT

(Indian Bael, *Fructus Belæ*)

Source &c.—Indian bael is the fruit of *Ægle Marmēlos*, Correa (N.O. *Rutaceæ*), a tree attaining a height of 12 metres and growing both wild and cultivated throughout the entire Indian peninsula. Being a sacred tree the Hindoos plant it near their temples. It became known to the Portuguese as a remedy for dysentery when they occupied the eastern shores of India, the pulp of the half ripe fruit being eaten while fresh. It was introduced into European medicine about the middle of the last century, but the dried fruit appears to be much less efficacious than the fresh.

Description.—The fruit is ovoid or rounded, and about the size of an orange, although sometimes rather larger. Externally it is yellowish brown, smooth, or slightly granular and hard, and bears a circular scar at the point of attachment of the peduncle. The entire fruit is too hard to cut with a knife, but may be sawn across, and will then be found to consist of a reddish woody rind about 1.5 mm. thick, enclosing from ten to fifteen carpels, each containing several hairy seeds embedded in a transparent yellowish or red mucilage. The dried pulp, which is mucilaginous and aromatic when fresh, is hard, and varies in colour from pale to dark red; it frequently breaks away from the rind during the drying, leaving only a thin layer attached to it. Even the dried fruit has an agreeable odour and mucilaginous, sometimes also aromatic, taste.

The fruit is frequently imported in dried quarters or in transverse slices. The latter have an appearance similar to that of the transverse section of the entire fruit, but the pulp usually adheres firmly to the rind and has a darker colour

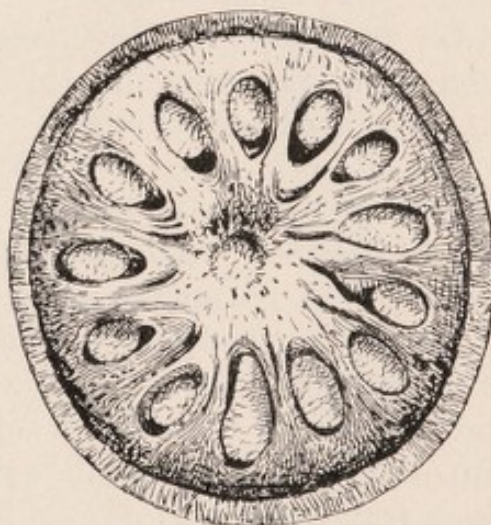


FIG. 60.—Bael fruit. Transverse section of a small specimen. Natural size. (Holmes.)

externally, being paler within. Preference should be given to unripe fruits, or the slices cut from them, and these may be recognised by the small undeveloped seeds they contain; they are also less aromatic than the ripe fruits. In this respect the entire fruits are often inferior to the slices.

The student should observe

- (a) The comparatively *smooth hard rind* to which (in the sliced fruit) the *reddish pulp* firmly adheres,
- (b) The *numerous carpels*,
- (c) The *hairy seeds embedded in mucilage*.

Constituents.—As far as has been ascertained the principal constituent of bael fruit is the mucilage that it contains. Tannin is not present in the unripe fruit, but the infusion of the ripe fruit yields the reaction for that body when tested with a ferric salt.

Substitutes.—Several substitutes for bael have been met with, viz. *Mangosteen fruits* (*Garcinia Mangostana*, Linné, N.O., *Guttiferæ*); these may be distinguished by the darker rind to which the pulp does not firmly adhere, and by the wedge-shaped radiate stigmas.

Wood apple (*Feronia elephantum*, Correa, N.O. *Rutaceæ*).—The fruit is five-lobed but one-celled, and has a rough exterior.

Pomegranate rind may be distinguished by its astringent taste and the triangular impressions of the seeds.

Uses.—In the fresh state Indian bael is a pleasant refreshing fruit with astringent refrigerant properties which render it valuable in the treatment of diarrhoea and dysentery. As imported it is probably useless, but a liquid extract from the *fresh* fruit appears to possess its specific effects.

BITTER ORANGE

(Seville Orange, *Fructus Aurantii*)

Source &c.—The bitter or Seville orange, the fruit of *Citrus Aurantium*, var. *Bigaradia*, Hooker filius (*C. Aurantium*, Linné; *C. vulgaris*, Risso, N.O. *Rutaceæ*), is a small tree, probably a native of north-eastern India, but cultivated in most warm countries. In Europe it is grown in the countries bordering on the Mediterranean, whither it was probably

brought by the Arabs, as it was unknown to the Greeks and Romans. The fruit is collected before it is quite ripe, packed in boxes and exported, the ripening being completed during the voyage. Bitter oranges are shipped chiefly from southern Spain (Seville and Malaga) and from Sicily (Messina and Palermo), Seville oranges being considered to be the best for medicinal use.

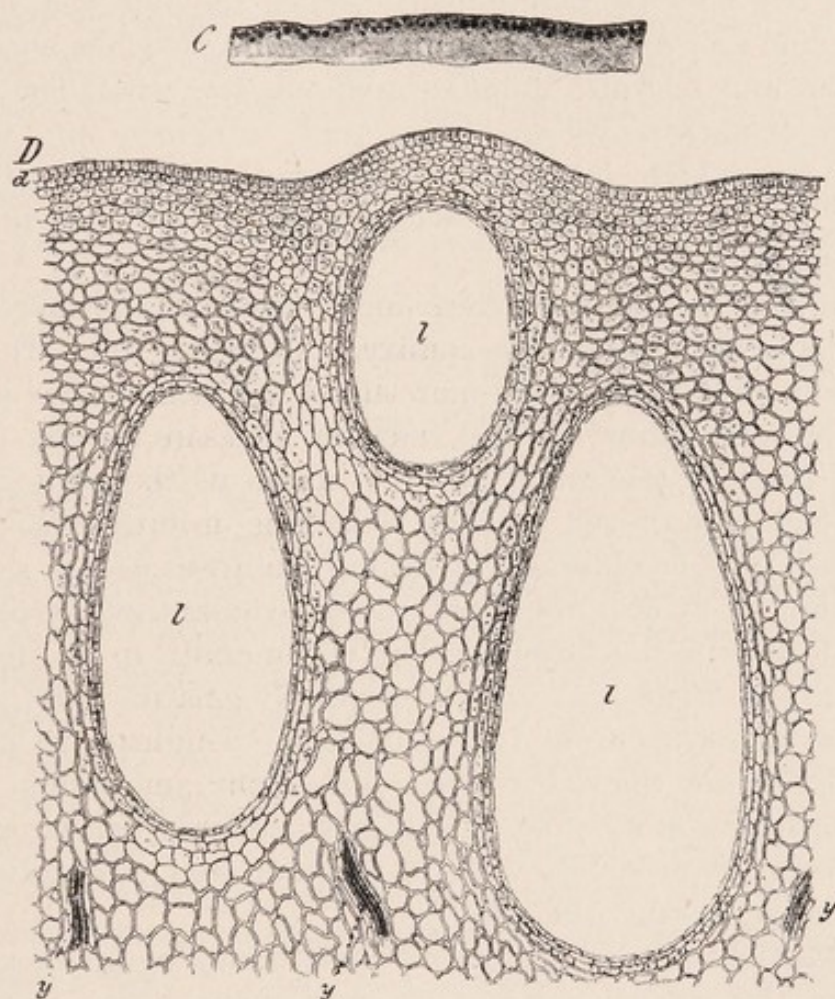


FIG. 61.—Orange peel. C, transverse section, natural size; D, transverse section, enlarged 100 diam.; l, oil-glands. (Berg.)

In addition to the fresh fruit the dried peel is also largely imported from Malta, Spain, and Morocco.

Description.—The ovary of the orange tree is superior and polycarpellary; it is composed of eight (or sometimes more) carpels, each containing two rows of seeds with axile placentation. During the growth of the ovary the loculi increase in size, and the outer wall (pericarp) in thickness. Into the loculi there

grow from the inner epidermis of the pericarp numerous hair-like processes which fill with juice and completely occupy the loculi; they form the pulp contained in the 'quarters' of the orange, the thin membrane enclosing each quarter being the endocarp. The fruit is a variety of berry sometimes termed 'hesperidium.'

The bitter orange resembles in size and shape the sweet orange, but may be distinguished by its rougher and usually darker rind and sour, bitter pulp. The rind, which is agreeably aromatic and has also a bitter taste, shows, when cut transversely, a narrow yellow outer part corresponding to the epicarp, in which large oil-glands are discernible with the naked eye, and an inner white portion corresponding to the mesocarp.

The peel is used both fresh and dried. The former is cut from the fresh fruit in this country, care being taken that the oil-glands are not ruptured more than is necessary, for it is to the volatile oil they contain that the pleasant aroma of the peel is due; at the same time too much of the white 'zest' should not be removed, as that is lacking in bitterness. The dried peel may be obtained by drying the fresh peel in a warm room, but it is also imported in large quantities, especially from Malta; in the latter case it is generally in the form of very narrow strips cut by machinery ('gelatin cut'), or in wider spiral strips or in four 'quarters.' English cut peel is generally rather thick, but has a fine colour and aroma. The transverse section assumes a dark green colour when moistened with strong hydrochloric acid, a reaction that is occasionally useful in identifying the peel.

Constituents.—The principal constituents of bitter orange peel are the volatile oil and an amorphous bitter principle, aurantiamarin (1.5 to 2.5 per cent.). Hesperidin—a colourless, tasteless, crystalline glucoside that occurs in several other species of *Citrus*—isohesperidin, hesperic acid (colourless, tasteless crystals), a bitter resin, and bitter aurantiamaric acid, have also been isolated from bitter orange peel, but appear to be of secondary importance. The peel yields from 3.5 to 6.5 per cent. of ash.

Substitutes.—The peel of the sweet orange is said to be frequently mixed with that of the bitter orange; it may be distinguished by being thinner, paler, and more yellow in colour

and much less bitter in taste. Lemon peel (dried) scarcely changes colour with strong hydrochloric acid.

Other products from *Citrus Aurantium*, var. *Bigaradia*.—The delightfully fragrant flowers of the bitter orange yield by distillation with water a small percentage of volatile oil, *oil of neroli*; a saturated solution of this oil in water, obtained by the distillation of the fresh flowers with water, is official under the name of *Aqua Aurantii Floris* (orange-flower water).

The volatile oil of the bitter orange peel is known in commerce as oil of bigarade; that from sweet orange as oil of Portugal.

Uses.—Bitter orange peel possesses both aromatic and bitter properties, and is used as a tonic and as an agreeable flavouring agent.

LEMON

(*Fructus Limonis*)

Source &c.—The lemon is the fruit of *Citrus Medica*, Linné, var. β *Limonum*, Hooker filius (N.O. *Rutaceæ*), a small tree which, like the orange, is probably a native of northern India. It is cultivated in all countries bordering on the Mediterranean, especially in Sicily and southern Italy, in Spain and Portugal, and in the Riviera.

The fruits are gathered whilst they are still green; the finest are wrapped in paper and exported in cases of 200 (Murcia lemons) to 360 (Messina lemons), but less sightly fruits are packed in barrels and preserved with salt water. The finest lemons are those imported from Sicily (Messina and Palermo); those from Murcia are also of high quality, while Naples and Malaga lemons are less esteemed.

Description.—The lemon resembles the orange in development and in structure, but it is easily distinguished by its more elongated, ovoid shape and pale yellow colour; at the apex it is crowned by a distinct nipple. The pulp has a strongly but agreeably acid taste; the peel is aromatic and bitter.

The following parts of the fruit are official: the peel, the juice, and the volatile oil obtained from the peel.

1. *Lemon peel*, which is official in the fresh state only, is pale yellow in colour and more or less rough on the outer surface, and whitish on the inner. The transverse section

shows numerous large oil-glands embedded in the tissue. The peel has a strong fragrant odour and aromatic, bitter taste. It contains volatile oil and hesperidin, and is used chiefly as an agreeable flavouring agent.

2. *Lemon juice*.—Fresh lemons yield about 30 per cent. of juice, which, for pharmaceutical use, should be pressed from the fresh fruit. It is a turbid yellowish liquid with a characteristic odour and acid taste. The principal constituent is citric acid, of which it contains from 6·7 to 8·6 per cent. (30 to 40 grains in each fluid ounce). The amount of citric acid in the juice is largest in lemons imported in December and January, and smallest in August, both the fruit and the juice itself gradually diminishing in acidity when kept.

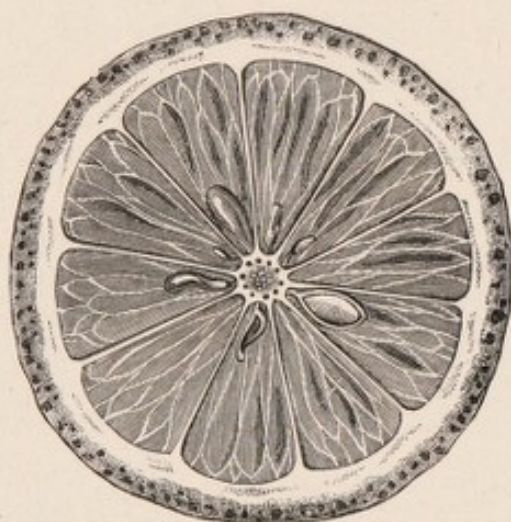


FIG. 62.—Lemon. Transverse section.
(Planchon and Collin.)

Large quantities of lemon juice are pressed in Sicily from the pulp that is left in the production of the volatile oil, the residual cake being used as cattle food. The juice is concentrated to a specific gravity of 1·233 to 1·235 and exported, chiefly to England, for the manufacture of citric acid; or the citric acid is precipitated as calcium citrate from which the citric acid is subsequently regenerated.

3. *Oil of Lemon*.—Various methods are used for the production of essence of lemon, but the following appears to be largely adopted in Sicily, whence most of the essence of lemon is exported.

The lemons are first cut lengthwise into three or four pieces, the pulp removed and pressed, and the peel set aside in a cool place for some hours. The workman holds in his left hand a medium-sized sponge, smaller ones being placed between the fingers. With the right hand he takes a piece of peel and squeezes it in such a way as to break the oil-glands and discharge their contents on the sponges. When sufficient has accumulated the sponges are pressed; the liquid thus obtained separates on standing into a lower watery stratum and an upper clear oily layer which can be poured off. The oil thus obtained is

filtered and exported in coppers of varying sizes. This hand-pressed peel is then pickled in brine and sold to the manufacturers of candied lemon peel. This method of separating the volatile oil from the peel is termed the 'sponge' process; 1,000 lemons yield about 800 gm. of volatile oil. That which is obtained during the winter from lemons that are not fully ripe is considered the best.

In the south of France a different procedure is adopted, of which the following description has been given: 'The object being to set free and to collect the oil contained in the vesicles of the peel, an apparatus is employed which may be thus described: a stout saucer or shallow basin of pewter, about 25 cm. in diameter, with a lip on one side for convenience of pouring; fixed in the bottom of this saucer are a number of stout, sharp, brass pins standing up about half an inch; the centre of the bottom is deepened into a tube about an inch in diameter and five inches in length, closed at its lower end. This vessel, which is called an *écuelle à piquer*, has therefore some resemblance to a shallow, dish-shaped funnel, the tube of which is closed below.

'The workman takes a lemon in the hand and rubs it over the sharp pins, turning it round so that the oil-vessels of the entire surface may be punctured. The essential oil which is thus liberated is received in the saucer, whence it flows down into the tube; and as this latter becomes filled it is poured into another vessel that it may separate from the turbid aqueous liquid that accompanies it. It is finally filtered, and is then known as *Essence de Citron au Zeste*' (Flückiger and Hanbury).

A machine (scorzetta), constructed on a similar principle, has been devised by which the scarification of the lemons is much more rapidly effected than is possible by the tedious hand process, and by which at the same time an increased yield of oil is obtained; it has not, however, as yet been generally adopted.

Oil of lemon is also prepared by distilling the peel with water, but this distilled essence is inferior in fragrance to that prepared by either of the foregoing processes.

Oil of lemon is a pale yellow liquid of sp. gr. 0.857 to 0.860 and optical rotation $+59^{\circ}$ to 63° , consisting of about 90 per cent. of the terpene limonene and about 4 per cent. of the aldehyde citral,

$C_{10}H_{16}O$, the latter being the chief odorous constituent of the oil. Other odorous constituents are citronellal, geranyl acetate, linalyl acetate, octyl and nonyl aldehydes, &c.). 'Terpeneless' essence of lemon is prepared by distilling off the terpene in vacuo, and consists mainly of citral (50 per cent.) together with the above-mentioned esters and aldehydes.

RAISINS

(Uvæ Passæ)

Source &c.—The grape vine, *Vitis vinifera*, Linné (N.O. *Ampelidæ*), probably a native of the Caucasian provinces of Russia, is cultivated in numerous varieties in most of the warmer parts of temperate regions where the mean summer temperature ranges from 21° to 25° C., particularly in central and southern Europe, California, and Australia.

When the grapes are ripe most of the leaves are stripped from the vine, and the stalk of the bunch is cut half through or twisted; the grapes are then allowed to dry by the heat of the sun. This process, which occupies two or three weeks, is often hastened by cutting the bunch off when partially dried, sterilising the fruits by dipping them into a boiling alkaline solution and drying on wicker trays in the sun.

Description.—The ovary of the grape vine is superior and two-celled, each cell containing two ovules. As the fruit reaches maturity the interior becomes pulpy, the dissepiment disappears, and the ripe fruit may be regarded as a superior berry. It is usually ovoid or nearly globular in shape, and varies in colour according to the variety. Within the thin skin is a very juicy pulp containing few seeds or none at all. The dried fruits present a more or less shrivelled appearance, are of a purplish black or brownish colour, and have an agreeable odour and a sweet pleasant taste.

Constituents.—Raisins contain in the pulp dextrose (grape sugar) and acid potassium tartrate, both of which may be found crystallised in small granular masses in old raisins. The skin and the seeds contain tannin, and the latter a fixed oil in addition. As raisins are used officially for the sake of the sweetness they impart, the seeds are directed to be separated.

Varieties.—*Muscateles*: these are considered the best and are exported from Malaga and Valencia; the clusters of purplish black fruits are usually packed in boxes in layers.

Valencias: these are also exported from Valencia, but are generally picked from their stalks; they are of a rather dark golden brown colour.

Turkish: a light brown, elongated raisin.

Sultanas: a seedless variety grown in Turkey, Greece, and Persia; exported chiefly from Smyrna.

Currants: a small seedless variety grown on the Ionian Islands and in the Grecian archipelago.

Uses.—Raisins possess demulcent, refreshing, and nutrient properties, and are also slightly laxative.

CASSIA PODS

(Purging Cassia, *Fructus Cassiæ Fistulæ*)

Source &c.—Cassia pods are the ripe fruits of *Cassia Fistula*, Linné (N.O. *Leguminosæ*), a tree of moderate size, indigenous to India, but naturalised in other tropical countries, being often cultivated as an ornamental plant (Indian laburnum). The tree bears a pendulous raceme of fragrant flowers, each with a one-celled many-seeded ovary, which develops into a long, leguminous fruit. As the latter ripens the seeds become separated from one another by the formation of numerous thin, transverse, spurious dissepiments, and the fruit, which was originally one-celled, becomes spuriously many-celled. It differs from a typical legume in being indehiscent as well as many-celled, and may be described therefore as a many-celled indehiscent legume.

Description.—The ripe pods, as met with in commerce, are long, nearly straight, cylindrical fruits of a dark chocolate-brown colour. They attain commonly 45 to 60 cm. in length and 20 to 25 mm. in thickness. The surface, which appears smooth and shining to the naked eye, is seen under a lens to be marked with minute transverse striations; both the dorsal and ventral sutures are evident but not prominent. To one end of the fruit a short stalk is attached; the other terminates very abruptly in a short point.

The pericarp, although thin, is hard and woody. The

interior of the fruit is divided into a number of compartments by transverse dissepiments placed about a quarter of an inch apart. Each compartment contains a single seed attached to the

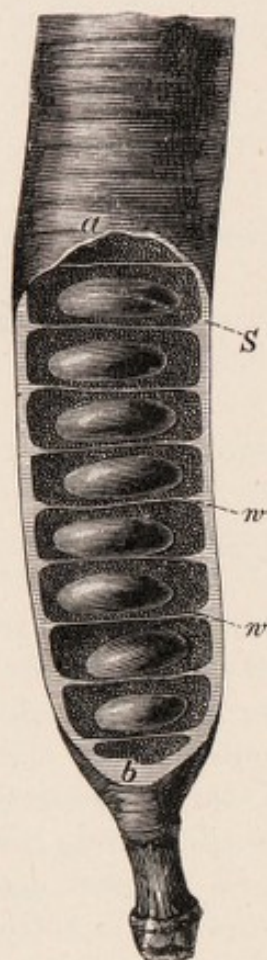


FIG. 63.—*Cassia Fistula*. Lower portion of a pod partly opened to show the seeds. *S*, seed; *w*, transverse dissepiments; *b*, pericarp of fruit. (Moeller, after Wiesner.)

ventral suture by a long, dark, thread-like funiculus. A thin layer of nearly black firm pulp, which in the fresh fruit is soft and fills the compartment, adheres to each side of the membranous dissepiments. In very dry pods the pulp is often so much contracted that the seeds lie loose in the cavity and rattle when shaken.

The seeds are flattened-ovoid in shape, of a shining reddish brown colour, smooth, and extremely hard. When cut transversely they exhibit a curved yellow embryo obliquely crossing a whitish horny endosperm. The pulp has a sweetish taste and a somewhat sickly odour.

The pods are exported from the West Indies (Dominica) and from Java. From the West Indies they arrive in cylindrical baskets made of plaited split canes.

The student should observe

- (a) The smooth surface and long cylindrical shape,
- (b) The spurious dissepiments with adhering pulp,
- (c) The odour and taste.

Constituents.—The pulp, which is the only official part of the fruit, is separated by crushing the fruits, macerating them with water, straining the liquid, and evaporating it to a soft extract. According to the analysis of Henry (1826), upwards of half its weight consists of sugar. It is not known to what constituent of the pulp its laxative action is due.

Substitutes &c.—The pods of *Cassia grandis*, Linné (Brazil and Central America), and of *Cassia moschata*, Humboldt, Bonpland, and Kunth (New Granada), are occa-

sionally imported. The former (horse cassia) are usually longer, thicker, and heavier than those of *C. Fistula*; the surface is rough and the fruit laterally compressed, exhibiting therefore an elliptical outline in transverse section. It has one prominent ridge on the dorsal and two on the ventral suture. The pulp has a disagreeable odour and a bitter, astringent taste.

The pods of *C. moschata* are smaller and narrower, and the pulp, which is paler in colour, exhales a musky odour when warmed.

Use.—Cassia pulp is laxative, but is seldom administered alone.

TAMARINDS

(*Tamarindus*, *Fructus Tamarindi*)

Source &c.—The tamarind tree, *Tamarindus indica*, Linné (N.O. *Leguminosæ*), a large and handsome tree indigenous to tropical Africa, is cultivated throughout India and the West Indies; to the inhabitants of these countries it forms a valuable article of diet. The Arabian name of the fruit (Tamare Hindi, or Indian date) would indicate that the Arabians became acquainted with it from the Hindoos, and probably introduced it into Europe.

The tree produces an erect raceme of flowers succeeded by indehiscent legumes from 5 to 20 cm. in length. The epicarp of the legumes is rough, brownish, firm, but easily broken and separated from the pulp; the latter (mesocarp) is juicy and acid, and traversed by a number of stout branching fibro-vascular bundles passing from the stalk towards the apex of the legume. The seeds are few in number and enclosed in a leathery membrane (endocarp).

In the West Indies tamarinds, exported from Barbados and Antigua, are collected when ripe, and prepared for the market by removing the epicarp, packing them in barrels, and preserving them with hot syrup. In India the pulp is simply pressed into cakes, with or without the addition of 10 per cent. of salt as a preservative. Small quantities of tamarinds are also exported from other countries (Egypt &c.).

Description.—The official tamarinds are the fruits preserved with syrup, as above described. They form a reddish

brown, moist, sugary mass, in which, without difficulty, the branching fibres and the seeds enclosed in the leathery

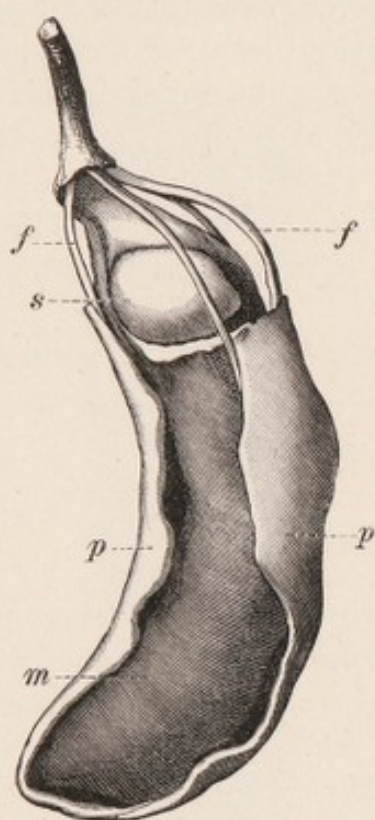


FIG. 64.—Fruit of the Tamarind tree with part of the pericarp removed, showing s, seed; f, fibres; p, epicarp; m, pulp. Natural size. (Vogl.)

endocarp can be found. The seeds are of a reddish brown colour, hard and shining, and of a flattened-ovoid or obscurely quadrangular shape. Such tamarinds have an agreeable odour and a pleasant sweet and acid taste.

From India tamarinds are sent in the form of firm black cakes consisting of the pulp of the fruit, together with the fibres, seeds, and small portions of the epicarp. Although not official it is frequently employed, and yields a good pulp. The cakes have scarcely any odour, but a rather strongly acid taste.

Constituents.—Tamarind pulp, though varying in composition, contains about 10 per cent. of free tartaric acid, about 8 per cent. of acid potassium tartrate, and from 25 to 40 per cent. of invert sugar. The total acidity varies from 11 to 16 per cent. West Indian tamarinds contain much added sugar and proportionately less acid.

Uses.—Tamarinds are a pleasant acid refrigerant and gentle laxative.

PRUNES

(*Prunum*)

Source &c.—The prune, or French plum, is the dried fruit of *Prunus domestica*, Linné, var. *Juliana*, de Candolle (N.O. *Rosaceæ*), a variety of the plum tree cultivated in France, especially in the valley of the Loire. Many varieties of the plum are known, but this is considered to be the proper prune and the best for medicinal use.

The fruits, large ovoid purple drupes, are collected when ripe, and dried by exposing them to the sun for a day or two, after

which the drying is completed in an oven or drying apparatus, the temperature being raised in stages from 45° to 90° C. A more rapid process consists in drying in a special 'evaporator' on wicker trays.

Description.—Prunes are of irregular flattened-ovoid shape, and about 30 cm. long. The surface is shrivelled and nearly black; the pulp, which should be soft and fleshy, is dark-coloured and surrounds a hard oval flattened stone; the latter is broadly rounded at one end and provided at the other with a shallow, slightly oblique depression. They have an agreeable odour and sweet fruity taste.

The student should direct his attention to the shape of the stone, as by that means the prune may be distinguished from other varieties of dried plums that are occasionally substituted for it.

Varieties.—The best prunes are the French from the Loire districts, but California now exports large quantities of excellent fruit, and smaller amounts come from Bosnia, Spain, and Portugal.

Constituents.—The pulp contains about 40 per cent. of dextrose, about 2 per cent. of vegetable acids (malic, tartaric, &c.), and about 30 per cent. of water, the composition varying with the season, degree of ripeness, &c.

Uses.—The prune is nutritive, demulcent, and slightly laxative; it is frequently ordered as an article of diet in habitual constipation.

HIPS

(*Fructus Rosæ Caninæ*)

Source &c.—Hips are the fresh, ripe fruits of the dog rose, *Rosa canina*, Linné (N.O. *Rosaceæ*), and other indigenous allied species.

Description.—The fruit of the dog rose consists of the hollowed thalamus (to which the calyx-tube is united), on the inner surface of which a number of achenes are borne, each provided with a style and stigma, the whole forming a spurious fruit distinguished by the name 'cynarrhodon.'

The ripe fruit is ovoid, smooth and shining, and scarlet or red in colour. It is crowned with five calyx-teeth, beyond which a dense tuft of hair-like styles slightly protrudes. Cut

longitudinally it is seen to consist of a fleshy, deeply concave receptacle, on the inner surface of which are borne a number of hairs as well as small, very hard, hairy achenes. The fleshy receptacle has an agreeable acid taste, and is separated for pharmaceutical use from the achenes &c. by beating the fruits in a mortar and rubbing the pulp through a hair-sieve.

The only other wild rose sufficiently common to serve as a source of the fruit is the field rose, *R. arvensis*, Hudson; it is distinguished from the dog rose by its trailing habit and globular fruits, from which the styles protrude in the form of a distinct column.

The student should observe

- (a) The *fleshy hollow receptacle*,
- (b) The *small hard hairy achenes* within it.

Constituents.—The pulp contains citric and malic acids (3 per cent.), invert sugar (11 to 15 per cent.), and tannin (2 per cent.).

Uses.—Confection of hips is occasionally used as a pill excipient, or mixed with water to form an agreeable acid cough linctus.

PIMENTO

(Allspice, *Fructus Pimentæ*)

Source &c.—The pimento tree, *Pimenta officinalis*, Lindley (N.O. *Myrtaceæ*), is a handsome tree indigenous to and common in the West Indies, and found also in Central America and Venezuela. It is cultivated, especially in Jamaica, in plantations known as pimento walks.

The tree bears large panicles of fragrant white flowers with two-celled inferior ovaries, each cell containing a single ovule. The flowers are succeeded by small fruits; as soon as these have attained their full size, but before they ripen, the whole panicle is collected and dried in the sun, during which the green colour changes to a reddish brown. The stalks are then separated and the fruits are ready for packing. Had they been allowed to ripen they would have become dark purple and filled with a sweet pulp, but would have lost much of their aroma; hence they are collected whilst unripe.

Pimento berries appear to have been long known to the Mexicans, who used them, together with vanilla, for flavouring

chocolate; through them the Spaniards became acquainted with the spice towards the end of the sixteenth century, and introduced it into Europe, where great quantities were consumed. It was supposed to possess the combined flavour of cloves and other spices; hence its name of 'allspice.' It is also called Jamaica pepper.

Description.—Pimento berries are small, nearly globular fruits about the size of peas, varying from 5 to 8 mm. in diameter. They are of a dull rusty or reddish brown colour, have a rough surface, and are crowned with the remains of the calyx in the form of a raised ring, in which the four calyx-teeth are scarcely discernible; in the centre of this ring are the short remains of the style. The pericarp is thin, woody, and brittle. At the base a small scar indicates the point of attachment of the pedicel.

Cut transversely, the fruit is seen to be two-celled, each cell containing a single flattened or irregularly plano-convex, nearly black seed, within which there is a dark coiled embryo but no endosperm.

The thin pericarp contains a large number of oil-glands embedded in it; many are situated just below the outer epidermis, and elevate it at intervals, thus producing the roughness of the pericarp; these glands are just visible in a transverse section when examined with a lens. The seeds also contain oil-glands, but are much less aromatic than the pericarp.

The odour of pimento berries is agreeably aromatic; it is especially perceptible when the fruits are crushed. The taste is warm and aromatic, resembling, but distinct from, that of cloves.

The student should observe

- (a) *The remains of the calyx crowning the fruit,*
- (b) *The two cells, each containing a single seed;*

and should compare these fruits with

- (i) *Cubebs*, which are one-celled, dark greyish black or greyish brown in colour, and reticulated on the surface,
- (ii) *Black pepper*, which is one-celled and one-seeded.

Constituents.—Pimento berries contain from 3 to 4.5 per cent. of volatile oil (sp. gr. 1.040 to 1.055; O.R. = -2°) con-

sisting principally of eugenol, which is also the chief constituent of oil of cloves. They contain, further, a notable quantity of tannin and yield from 2·5 to 5 per cent. of ash.

Substitutes.—Dark (nearly ripe) fruits have been coloured with bole or brown ochre and passed off as genuine; the fraud may be detected by boiling them for a few moments with hydrochloric acid, filtering, and testing with potassium ferrocyanide, when at most a bluish green colour should be produced.

The fruits of *Pimenta acris*, Wight (compare p. 70), may be distinguished by their five calyx teeth. Mexican allspice, the fruits of *Eugenia Tabasco*, G. Don, are larger than the genuine, but neither so dark or so aromatic. Both are of rare occurrence.

Uses.—Pimento is used as a flavouring agent and as an aromatic stimulant, resembling cloves in its action.

POMEGRANATE RIND

(Cortex Fructus Granati)

Source &c.—The pomegranate tree, *Punica Granātum*, Linné (N.O. *Lythraceæ*), is a shrub or small tree indigenous to north-western India, but cultivated generally in the warmer parts of the temperate regions, especially in the countries bordering on the Mediterranean. More than one variety is known, but that producing crimson flowers is the commonest. The flowers are succeeded by handsome reddish fruits, about the size of a large orange, much esteemed for their agreeable juicy contents. The leaves and flowers, as well as the fruits, were employed in medicine by the ancients; the Romans used the peel of the fruit for tanning, and in the south of Europe it still serves the same purpose.

Description.—The pomegranate is a large handsome fruit of sub-globular shape and brownish yellow colour, passing into dull crimson red. It is crowned with a large, deeply five-toothed, tubular, coriaceous calyx, within which are the remains of the stamens and style. The pericarp, the outer surface of which is granular in appearance, is about 1·5 mm. thick, hard, and coriaceous. The large cavity is divided by thin membranous dissepiments into a number of cells, each of which is completely filled with numerous seeds.

When cut longitudinally the fruit is seen to be divided by a membrane into an upper and lower portion. Transverse sections show the former to be divided by radiating dissepiments into six cavities, in each of which the placentation of the seeds is parietal, whilst in the lower portion from three to five cavities are irregularly arranged. The seeds are about 12 mm. long, subpyramidal in shape, and contain a sweetish acidulous juice in a translucent outer portion. The fruit is a berry sometimes distinguished by the special name 'balausta.'

The peel of the fruit, separated from the seeds, was formerly much used as an astringent. It occurs in thin curved fragments, granular and brownish yellow or reddish on the outer surface, uniformly yellowish brown within, and there exhibiting distinct, shallow, angular depressions left by the seeds; to some fragments the remains of the coriaceous calyx are attached. It breaks with a short granular fracture, has little odour, but a powerfully astringent taste.

The student should observe

- (a) The *astringent taste*,
- (b) The *impressions of the seeds*,
- (c) The occasional *fragments of the superior calyx*;

and should compare the peel with pieces of Indian bael.

Constituents.—The principal constituent is gallotannic acid, of which it contains as much as 28 per cent. (Kramer, 1883), and a yellow colouring matter; whether the peel contains any alkaloids allied to, or identical with, those of the bark of the stem and root, is not known.

Use.—The drug is sometimes used as an astringent in the form of a decoction.

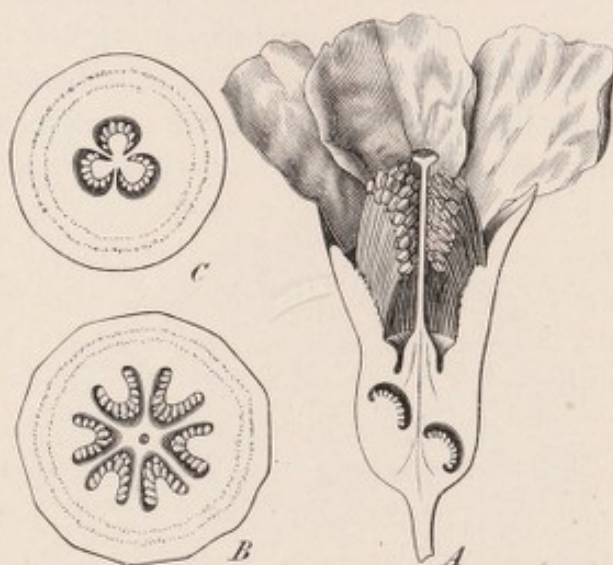


FIG. 65.—Pomegranate (*Punica Granatum*). A, flower cut vertically; B, transverse section of the upper part of the ovary, showing six loculi, magnified; C, transverse section of lower part, showing three loculi, magnified. (Luerssen.)

BITTER APPLE

(Colocynth, Fructus Colocynthidis)

Source &c.—The colocynth plant, *Citrullus Colocynthis*, Schrader (N.O. *Cucurbitaceæ*), is, like many other members of the same natural order, a scabrous prostrate plant with a perennial root. It enjoys an extensive distribution throughout northern Africa, Syria, and north-western India. In the African and Egyptian deserts it frequently occurs in enormous quantities; it is cultivated in Syria, Spain, Cyprus, and the north-western provinces of India.

The remarkable properties of this fruit must necessarily have attracted attention very early. Dioscorides and Pliny were both acquainted with it, and so also were the Arabian physicians, by whom probably its use was introduced into Europe.

The fruit, which is about the size of an apple, is at first green, but changes to yellow as it ripens; it is collected when ripe, dried and then freed from the thin rind by peeling with a sharp knife, the peeled fruits being often termed 'apples.' Persian colocynth is peeled before drying and consequently shrinks considerably. Mogadore colocynth is imported unpeeled and commonly used for filling the show-jars in the pharmacist's window.

Description.—The fruit of the colocynth plant is, when young, three-celled and bears numerous ovules attached to axile placentas. The placentas, however, grow from the centre towards the circumference of the fruit, and when they have nearly reached the pericarp divide in two, each half curving inwards and bearing numerous seeds on its margins. During these changes the carpellary walls disappear, and the fruit, originally three-celled, becomes spuriously one-celled. The pulp consists largely of the fleshy placentas; they usually split in a radial direction throughout the greater part of their length, and in the dried fruit they are deeply fissured.

As seen in commerce, colocynth fruits form more or less broken white balls, 5 cm. in diameter and light in weight. The rind has generally been carefully peeled off, and the outer surface is formed by part of the thin whitish mesocarp, which, however, has in places itself been removed, disclosing the

yellowish or nearly brown seeds or the fleshy placentas. If a fruit is cut transversely the placentas will generally exhibit radiating fissures dividing the fruit into three portions, in each of which, near the periphery, a half of each placenta curves inwards and bears on its inner margin several vertical rows of seeds. These number from 200 to 300, and constitute about three-quarters of the weight of the fruit; they vary in colour from yellowish white to dark brown according to the degree of ripeness. They have a flattened ovoid shape, possess a hard seed-coat, and contain a small oily kernel which, however, strange as it may seem, forms, when properly prepared, a valuable addition to the scanty diet of certain tribes of Arabs.

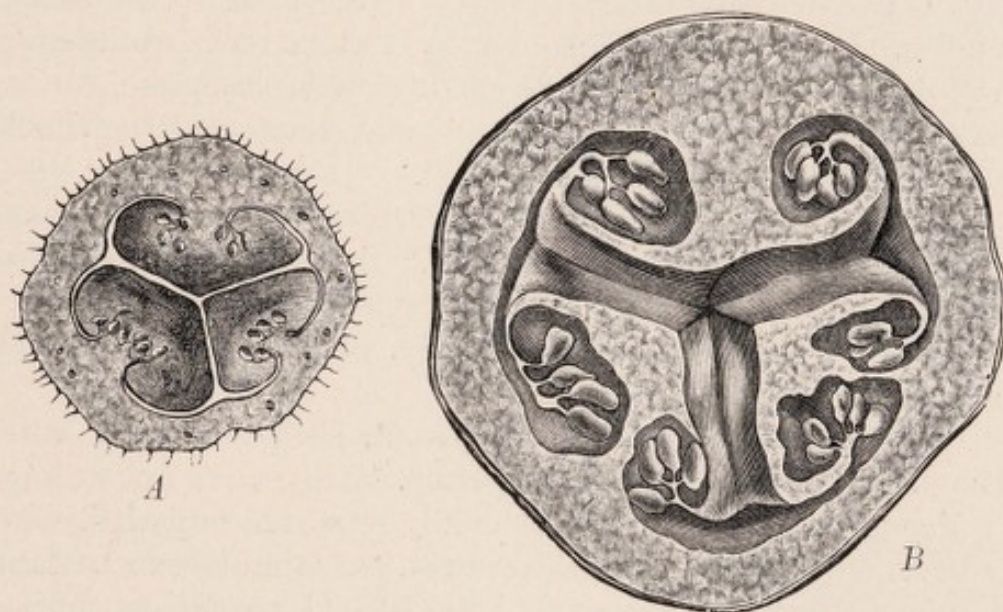


FIG. 66.—Colocynth fruit. *A*, transverse section of young fruit, showing the placentas dividing near the margin and curving inwards; *B*, ripe fruit, showing each placenta fissured. (Moeller.)

For medicinal use the light, whitish, spongy, pith-like pulp, the bulk of which is furnished by the placentas, should be freed from the seeds, as the pulp alone is official. It possesses a slight odour, but an intensely bitter taste, the seeds when quite free from pulp being almost tasteless. Much of the colocynth at present imported consists of the pulp free from the seeds; for the latter some use, possibly the production of fixed oil, has apparently been found.

Constituents.—Colocynth pulp contains a pale yellow intensely bitter crystalline glucoside, colocynthin, which is hydrolysed by dilute acids yielding yellow amorphous colo-

cynthein, dextrose, and a white crystalline substance resembling elaterin in its colour-reactions. The drug also contains a colourless crystalline body, colocynthetin, from 1.0 to 1.3 per cent. of fixed oil, and yields from 7 to 13 per cent. of ash. It contains no starch.

The small amount of fixed oil and the large amount of ash have been utilised to distinguish the powdered *fruit* from the powdered *pulp*. The seeds contain from 15 to 17 per cent. of oil, and yield only 2.5 to 3.0 per cent. of ash. Powdered fruits yield from 4 to 6 per cent. of ash and about 10 per cent. fixed oil. Microscopical examination of the powder yields more definite results. Colocynth pulp consists of very large thin-walled parenchymatous cells with occasional fibro-vascular bundles, which are accompanied by tubular cells containing the colocynth, but no sclerenchymatous cells are present in it, whereas the seed-coats abound in sclerenchymatous tissue which can be readily detected and identified.

Varieties.—*Turkey colocynth*, which is the most esteemed, is imported from Syria, Cyprus, &c.; the fruits are carefully peeled, nearly white, and contain a larger proportion of pulp.

Spanish colocynth is less sightly, often discoloured, and contains less pulp.

Persian colocynth occurs in small, shrunken balls with little pulp; it is now seldom imported.

Mogadore colocynth is occasionally imported unpeeled.

Uses.—Colocynth is a gastro-intestinal stimulant or irritant and one of the most powerful of the official purgatives, acting as a hydragogue cathartic. It is employed as an occasional purgative to produce free evacuation of the bowels in bilious derangements or chronic constipation, but as it causes griping is seldom prescribed alone.

CARAWAY FRUITS

(Fructus Carui)

Source &c.—Caraways are the ripe fruits of *Carum Carvi*, Linné (N.O. *Umbelliferae*), an erect biennial herb distributed over central and northern Europe. The plant is found in Britain, apparently wild, but possibly only naturalised. It is cultivated principally in Holland, but Sweden, Norway, Russia,

Germany, and Morocco also produce caraways, whilst a small quantity is grown in England. When the fruit ripens, the plant is cut and the caraways are separated by thrashing.

Description.—The ovary of the caraway is inferior and two-celled; as it ripens it develops into a schizocarp, that is, a fruit which separates into its component carpels by their splitting away from the central axis (carpophore), to which, however, they remain attached. Each complete fruit is termed a cremocarp (a variety of schizocarp), and each half-fruit a mericarp, the mutually apposed inner faces of which are the commissures or commissural surfaces.

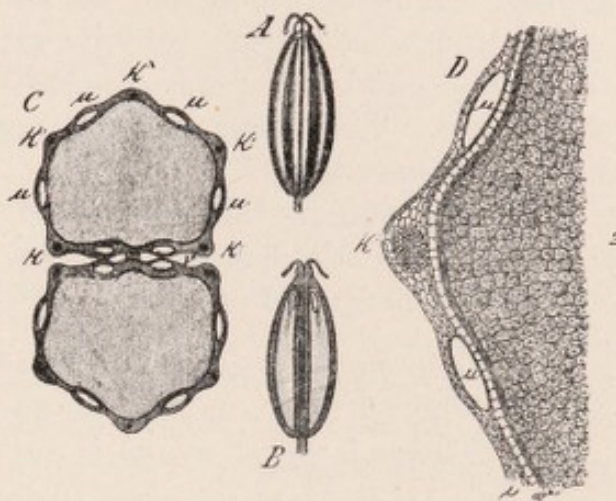


FIG. 67.—Caraway fruit. A, entire fruit, side view, magnified 3 diam. B, longitudinal section, magnified 3 diam. C, transverse section: μ , vittæ; κ , ridges, magnified 14 diam. D, portion of the same, further enlarged. (Berg.)

The cremocarp of the caraway easily separates into its constituent mericarps, and the commercial drug consists almost entirely of separate mericarps, about 4 to 6 mm. long, very narrow, tapering at each end, and slightly curved. They are quite glabrous, brown in colour, and traversed from base to apex by five narrow raised yellow ridges or 'costæ' (fig. 67, C and D, κ). Each of these (primary) ridges contains a fibro-vascular bundle, and this distinguishes them from other (secondary) ridges which some Umbelliferous fruits (coriander) possess. In caraway fruits no secondary ridges are present. In the depressions ('intercostal regions') between these ridges, embedded in the pericarp of the fruit and extending from base to apex, lie elongated oil-glands (vittæ, fig. 67, C and D, μ). In the caraway there are four such vittæ on the dorsal and two



FIG. 68.—Caraway fruit. Mericarp, magnified. 6 diam.

on the commissural surface of each mericarp. Very many Umbelliferous fruits contain six vittæ, but some contain more (anise), whilst others contain none at all (hemlock). They are generally best seen in transverse section under a strong lens, when they appear as dark brown minute spots or cavities (compare fennel, in which they are conspicuous).

The transverse section exhibits also a narrow pericarp and a large oily endosperm, the commissural surface of which is not grooved. The small embryo lies near the apex of the fruit. (Compare fig. 67.)

Caraways exhale, when crushed, an agreeable aromatic odour, and possess a pleasant aromatic taste.

The student should observe

- (a) The *glabrous surface* of the fruit,
- (b) The *six vittæ* on the transverse section,
- (c) The *endosperm, which is not grooved*.

Constituents.—Caraways yield by distillation from 3.5 to 7.0 per cent. of volatile oil, the principal constituent of which is carvone (50 to 60 per cent.). They also contain fixed oil (in the endosperm) and yield about 6 (not over 8) per cent. of ash.

The volatile oil should have a sp. gr. 0.907 to 0.920 and O.R. + 70° to + 85°; at least 55 per cent. should distil at a temperature over 200° C. Oil from which part of the carvone has been removed ('decarvolised' oil) has a lower sp. gr., lower optical rotation, and yields less than 55 per cent. boiling above 200° C.

Varieties.—*Dutch*: Holland produces and exports far larger quantities of caraways than any other country; they are of medium size, dark colour, and clean appearance, and yield from 4.0 to 6.5 per cent. of oil.

English: these are produced in small quantity only; they are similar to the Dutch but brighter in colour.

Adulteration.—Caraways and other Umbelliferous fruits used in the production of volatile oil are distilled either ground or entire; in the former case the yield is increased, and the exhausted fruits are used as cattle food; but entire fruits yield less oil, and the exhausted drug after drying may be mixed with the genuine fruits. These exhausted fruits may be recognised by their dark colour, deficiency in aroma, and low yield of aqueous extract; they often also sink at once in

water (fennel), whereas the genuine float for a considerable time.

Use.—Caraways, or the volatile oil obtained from them, are extensively used as an aromatic carminative.

HEMLOCK FRUITS

(Fructus Conii)

Source &c.—The common or spotted hemlock, *Cōnium*¹ *maculatum*, Linné (N.O. *Umbelliferae*), is a biennial plant widely spread throughout temperate Europe and generally distributed over Great Britain. It is distinguished by its smooth hollow stem with purple spots, the general and partial involucre on the inflorescence, its glabrous, decomposed leaves and ovoid fruit without vittæ but with deeply grooved endosperm (compare also the details given under 'Hemlock Herb'). This plant was in all probability the one employed by the Greeks in the preparation of poisonous draughts. It was used in Anglo-Saxon medicine, but has latterly lost much of its reputation owing to the uncertain action of its preparations. Modern researches have indicated the reason of this and suggested a remedy.

The fruits should be gathered from wild plants when full-grown, but before they ripen—that is, before the colour changes from green to yellow—and thoroughly dried; and if carefully preserved quite dry they will long retain their activity unimpaired.

Description.—Hemlock fruits, gathered when unripe, possess after drying a distinct greenish grey colour, which changes by long keeping to yellowish grey. They are small, being only about 3 mm. long, broadly ovoid in shape and slightly compressed laterally. They are crowned with small stylopods bearing the remains of the stigmas. In the commercial drug the mericarps are usually separate and freed from the stalks. Each mericarp is glabrous and exhibits five paler sharply prominent primary ridges, which, from the presence of small protuberances, are irregularly crenate and wavy, a character not equally well shown by all fruits, and more conspicuous in the fresh than in

¹ This pronunciation, though well established, is not strictly correct. The word is derived from the Greek κώνιον, hemlock, and should be pronounced Cōnium.

the dried. Cut transversely and examined with a strong lens, the endosperm exhibits a deep furrow or groove on its commissural surface (fig. 69, *C*). This furrow, being filled with the tissue of the pericarp, is not visible on the commissural surface of the mericarp, but only on the transverse section; its presence should be carefully noted, as it indicates that the fruits are derived from a plant belonging to the suborder *Campylospermeæ*, and distinguishes them at once from anise, fennel, &c., that have an endosperm nearly flat on its commissural surface (suborder *Orthospermeæ*), and from coriander and other fruits that have an endosperm strongly curved in both

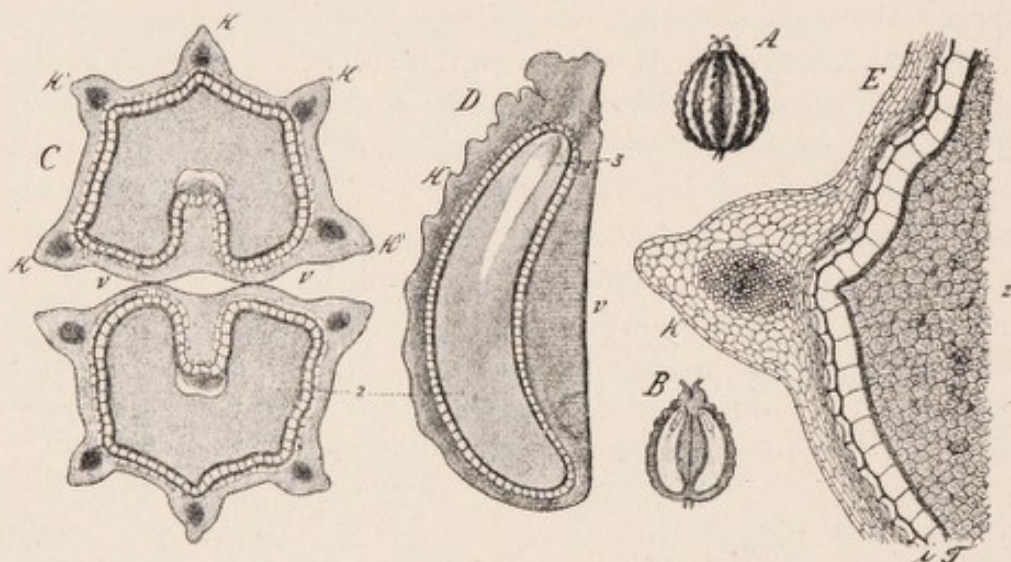


FIG. 69.—Hemlock fruit. *A*, side view of entire fruit. *B*, longitudinal section of the same, showing endosperm and embryo, magnified 3 diam. *D*, half of the same, further enlarged. *C*, transverse section: *v*, commissural surface; *κ*, ridges; magnified 14 diam. *E*, portion of the same, further enlarged. (Berg.)

radial and transverse section (suborder *Cælospermeæ*). The pericarp contains no vittæ, and this is also an important character, but one that can be ascertained only by subjecting a transverse section to examination under the microscope.

The fruit has scarcely any odour or taste, but when to the crushed fruit a solution of caustic potash is added a strong mouse-like odour is developed.

The student should observe

- (a) The *glabrous surface*,
- (b) The *irregular crenate ridges*,
- (c) The *grooved endosperm*, and, if possible, under the microscope, the *absence of vittæ*;

and should compare the fruits with anise fruits, which are distinguished by the short bristly hairs with which they are provided, by the presence of numerous vittæ, and by the endosperm, which is not grooved, the latter being the most definite character visible under a lens.

Constituents.—The principal constituent of hemlock fruits is the poisonous, volatile, liquid alkaloid coniine, of which they may contain, when collected at the proper time and dried, as much as 2.77 per cent. (Farr and Wright, 1904), the average being 1.65 per cent. This alkaloid is the source of the strong odour produced when hemlock fruits are crushed and mixed with caustic potash, the alkali liberating the alkaloid which was previously combined with vegetable acids.

The proportion of coniine present attains its maximum when the fruits are full- or nearly full-grown, but before the colour changes from green to yellow; during this change (the ripening of the fruit) the proportion of coniine rapidly diminishes. Commercial fruits yield from 0.5 to 1.3 per cent. of coniine.

Pure coniine ($C_8H_{17}N$ or α -propyl-piperidine) is a colourless, oily, very poisonous liquid with an extremely unpleasant odour. It boils at $166^\circ C.$ without decomposition in an atmosphere free from oxygen; but exposed to the air, even at ordinary temperatures, it rapidly assumes a brown colour. It yields crystalline non-volatile salts.

It is accompanied in the fruit by small quantities of methylconiine, which is oily and resembles coniine, and by conhydrine, which is colourless and crystalline. Ethyl piperidine and pseudoconhydrine are also present.

Coniine may be produced from α -picoline, $C_5H_4(CH_3)N$, one of the constituents of coal tar, by heating it to $250^\circ C.$ for 10 hours with acetic aldehyde, by which it is converted into α -allyl pyridine $C_5H_4(C_3H_5)N$; this by reduction with sodium yields coniine $C_5H_9(C_3H_7)NH$. Coniine thus prepared is, however, optically inactive, whereas natural coniine is dextro-rotatory; it can be separated into the dextro- and lævo-rotatory alkaloids by inducing crystallisation of the tartrate by means of a crystal of natural coniine tartrate.

Assay.—Percolate 10 gm. of the finely produced fruit with 70 per cent. alcohol until exhausted, add 20 c.c. $\frac{N}{10}$ sulphuric acid and

evaporate off the alcohol. Transfer to a separator, wash twice with chloroform, make alkaline with solution of potash and shake out with three successive 5 c.c. of chloroform. Transfer the alkaloids to acidulated water and back to chloroform. Repeat this purification twice. Finally shake the chloroformic solution of the alkaloids with three drops of fuming hydrochloric acid, wash the separator with a little alcohol, evaporate dry at 90° C. and weigh. The weight of the alkaloidal hydrochlorides multiplied by 0.777 gives the weight of alkaloid in 10 gm. of the fruit.

Uses.—Hemlock is used in spasmodic and convulsive diseases, such as tetanus, chorea, and epilepsy; in asthma, whooping-cough, and spasmodic affections of the larynx. Coniine depresses the medulla and motor nerve endings, excessive doses resulting in death from respiratory paralysis.

CORIANDER FRUITS

(Fructus Coriandri)

Source &c.—The coriander, *Coriandrum sativum*, Linné (N.O. *Umbelliferae*), is an erect herbaceous annual that has become naturalised throughout temperate Europe. It is cultivated principally in Russia, Thuringia, Moravia, and Hungary, as well as in northern Africa, Malta, and India. The whole plant, and especially the unripe fruit, is characterised by a strong disagreeable odour, whence the name coriander (from the Greek *κόρις*, a bug). As the fruit ripens, this gives place to an agreeable aroma, and the plant is then cut and thrashed. It has been cultivated for many centuries for use as a spice.

Description.—The two mericarps of which the fruit consists remain firmly united by their margins, and enclose between them a small cavity, the cremocarp being nearly globular in shape. The fruit is of small size, averaging only about 5 mm. in diameter, of a uniform brownish yellow colour, and quite glabrous. It is crowned by the remains of the calyx-teeth and styles, and bears on each mericarp five inconspicuous wavy primary ridges (containing fibro-vascular bundles) and four more conspicuous, straight, secondary ridges alternating with the primary. Both transverse and radial sections show a curved endosperm (suborder *Celospermeae*), and on the former

only two vittæ, both of which are situated on the commissural surface, can be discerned. In addition to these, however, the young ovary contains vittæ on the dorsal surface; as the fruit ripens these become compressed and break down into tangentially elongated cavities, the outer portion of the pericarp being finally thrown off.

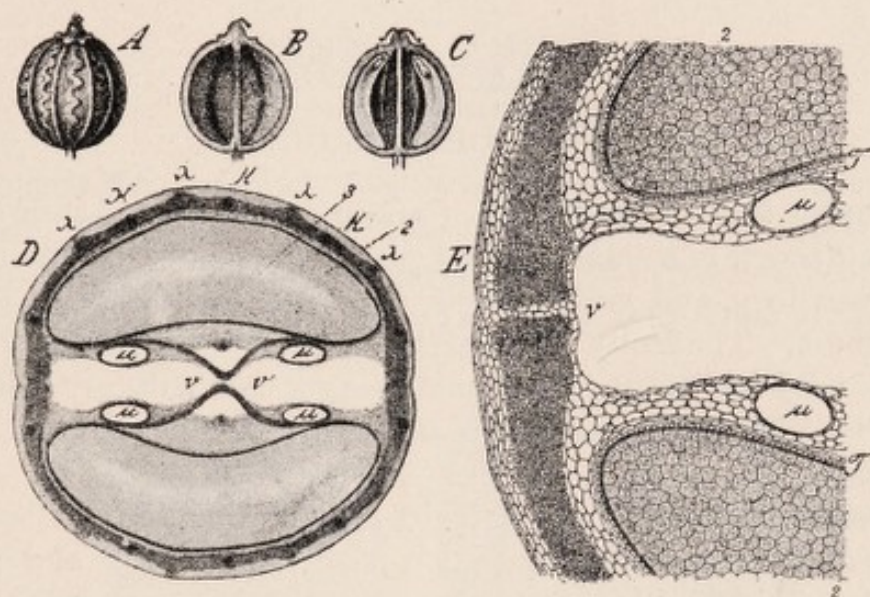


FIG. 70.—Coriander fruit. A, whole fruit (cremocarp), magnified 3 diam.; B, commissural surface of half-fruit (mericarp), showing the vittæ as dark lines; C, longitudinal section through both mericarps, showing the endosperm and embryo, magnified 3 diam.; D, transverse section, showing the vittæ, μ , magnified 14 diam.; E, portion of the same, further enlarged. (Berg.)

The odour of the bruised fruit is aromatic, and the taste agreeable and spicy.

The student should observe

- (a) The *firmly united mericarps*,
- (b) The *wavy primary and straight secondary ridges*,
- (c) The *two vittæ on each commissural surface*.

Constituents.—Coriander fruits of good quality yield from 0·8 to 1·0 per cent. of volatile oil (sp. gr. 0·870 to 0·885, chief constituent 90 per cent. of the alcohol coriandrol). That distilled from unripe fruit has a fetid odour, which, however, disappears on keeping.

Varieties.—*English*: these are grown in Essex, and said to have the finest flavour, though not specially rich in oil.

Russian and German: these are the richest in oil, yielding up to 1·0 per cent.

Mogadore, which are the largest and brightest of all, but contain only 0·2 to 0·3 per cent. of oil.

Bombay, which are distinguished by their oval shape; they yield only 0·15 to 0·2 per cent. of oil.

Use.—The fruit and the oil distilled from it are used as aromatic carminatives.

CUMMIN FRUIT

(Fructus Cumini)

Source &c.—The cummin, *Cuminum Cyminum*, Linné (N.O. *Umbelliferae*), is a small annual plant indigenous to the upper Nile territory, and cultivated in Morocco, Sicily, Malta, Syria, and India. The fruits were well known to the ancients, and were much used in Europe in the middle ages as a culinary spice.

The plants are cut down when the fruits are ripe, and thrashed.

Description.—Cummin fruits are brown in colour, of elongated oval shape, tapering towards both base and apex, and somewhat laterally compressed. In the commercial drug the mericarps are sometimes united and attached to a short stalk; sometimes they are free. Each mericarp is nearly straight, about 6 mm. in length, and furnished with five yellow, smooth or scabrous primary ridges. In the depressions between the primary ridges are secondary ridges, which, being furnished with short bristly hairs, are conspicuous when the fruit is examined with a lens.

The transverse section of a mericarp exhibits an oily endosperm, which is not deeply grooved, and six vittæ—four on the dorsal surface below the bristly secondary ridges and two on the commissural.

Cummin fruits resemble caraways in appearance, odour, and taste. The mericarps differ, however, in being nearly straight instead of curved (as caraways usually are), and in being bristly instead of smooth. The odour and taste, though similar to those of caraways, are by no means so agreeable.

The student should observe

- (a) The *straight mericarp*,
- (b) The *bristles on the secondary ridges*,
- (c) The *characteristic odour*.

Constituents.—Cummin fruits yield from 3 to 4 per cent. of *volatile oil* (sp. gr. 0.972; O.R. + 25.5°; chief constituent cuminic aldehyde).

Uses.—The fruits have been used as a stimulant and carminative; they are now chiefly employed in veterinary medicine.

FENNEL FRUITS

(Fructus Fœniculi)

Source &c.—Fennel, *Fœniculum capillāceum*, Gilibert (*F. vulgare*, Miller; N.O. *Umbelliferae*), is apparently indigenous to the shores of the Mediterranean, extending eastwards, but is cultivated for medicinal use in the south of France, in Saxony

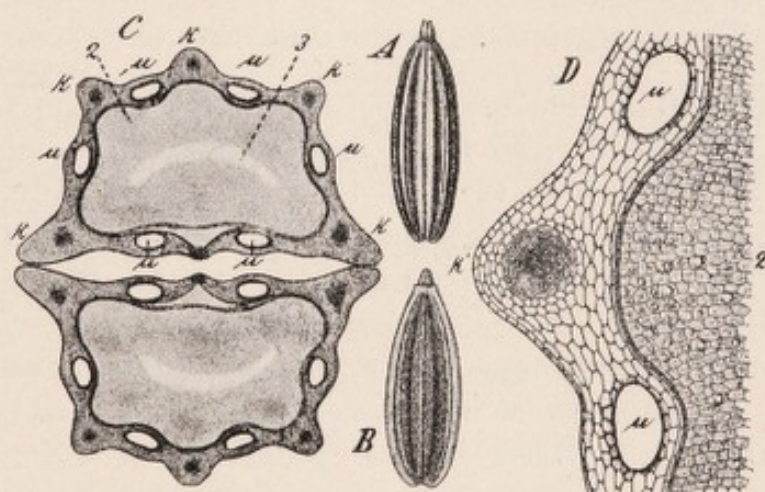


FIG. 71.—Fennel fruit. *A*, entire fruit, side view, magnified 3 diam. *B*, half-fruit, showing commissural surface, magnified 3 diam. *C*, transverse section: μ , vittæ; κ , ridges; magnified 14 diam. *D*, portion of the same, further enlarged. (Berg.)

and Württemberg, in Russia and Galicia, and also in India, Japan, &c. Like other aromatic umbelliferous fruits, fennel was well known to the ancients, and was largely used in Europe during the middle ages. For medicinal use the fruits of cultivated plants, especially those grown in Saxony (Saxon fennel), are to be preferred, as it has been shown that they yield most volatile oil, and that the latter contains fenchone (see below).

Description.—Fennel fruits occur in several commercial varieties, varying considerably in size and appearance. Saxon

fennel fruits, which may be regarded as the best, are of a greenish or yellowish brown colour, and oblong in shape, varying from 8 to 10 mm. in length, and 3 to 4 mm. in width. The mericarps frequently remain united and attached to a pedicel about the same length as the fruit. They are glabrous, and bear five paler primary ridges that are so prominent as to render the fruit almost winged. In a transverse section four large vittæ can be distinguished by the naked eye on the dorsal surface, and two on the commissural surface of each mericarp; the endosperm is dark in colour, oily, and not deeply grooved. They have an aromatic odour, recalling anise, and a sweet, very camphoraceous taste.

The student should observe

- (a) The *very prominent ridges*,
- (b) The *large vittæ*,
- (c) The *characteristic odour and taste*.

Constituents.—The best varieties of fennel (Saxon, Galician, and Russian) yield from 4 to 5 per cent. of volatile oil (sp. gr. 0.960 to 0.980; O.R. + 6° to + 12°; solidifying-point 5° C. to 20° C.), the principal constituents of which are anethol ($C_{10}H_{12}O$, 50 to 60 per cent.) and fenchone ($C_{10}H_{16}O$, 18 to 20 per cent.).

Anethol is also the chief constituent of anise oil (compare p. 145). Fenchone is a colourless liquid possessing a pungent, camphoraceous odour and taste; it probably contributes materially to the medicinal properties of the oil, hence only such varieties of fennel as contain a good proportion of fenchone are suitable for medicinal use.

Varieties.—The following are the chief commercial varieties of fennel fruits:

1. *Saxon*: as above described; they yield 4.7 per cent. of volatile oil containing 22 per cent. of fenchone.

2. *Russian, Galician, and Roumanian*: these closely resemble one another; they vary from 4 to 6 mm. in length and 1 to 2 mm. in width, and yield from 4 to 5 per cent. of volatile oil, of which about 18 per cent. is fenchone. They have a very camphoraceous taste.

3. *French Sweet or Roman*, 7 to 8 mm. long, 2 to 3 mm. wide, often arched; pale yellowish green in colour, with a sweet, anise taste. Yield of oil 2.1 per cent., free from fenchone.

4. *Indian*, 6 to 7 mm. long, brownish, stalky, with sweet anise taste. Yield of oil 0.72 per cent., containing 6.7 per cent. of fenchone.

5. *Japanese*, 3 to 4 mm. long, 2 to 3 mm. wide, ovoid, not curved, pale greenish brown in colour; taste camphoraceous and very sweet. Yield of oil 2.7 per cent., containing 10.2 per cent. of fenchone.

6. *French Bitter*, 4 to 5 mm. long, 2 mm. wide, scurfy in the furrows, ridges less prominent, and colour darker than the sweet.

Adulteration.—Fennel is said to be specially subject to admixture with exhausted fruits. These include the fruits partially exhausted of their oil by distillation in a current of alcohol vapour in liqueur-making, as well as the residues obtained in the distillation with water or in a current of steam. Fruits exhausted by water or steam are darker, contain less oil, and sink at once in water, but those exhausted by alcohol still retain 1.0 to 2.0 per cent. of oil, and are but little altered in appearance; they acquire, however, a peculiar fusel oil odour. Recoloured fennel may be detected by rubbing the fruits between the hands.

Uses.—Fennel is used as an agreeable aromatic and carminative.

DILL FRUITS

(Fructus Anethi)

Source &c.—The dill, *Peucedänum gravëölens*, Benthams and Hooker filius (N.O. *Umbelliferae*), is a short erect annual herb indigenous to the Mediterranean districts and southern Russia, but cultivated in England, Germany, and Roumania. The plant was formerly placed in a separate genus, *Anethum*, whence the name 'Fructus Anethi'; it is now included in the genus *Peucedanum*.

The drug has been in use in this country from very early times.

Description.—In the commercial drug the two mericarps of which the fruit is composed are usually separate and freed from the pedicel; they are broadly oval in outline, and so strongly dorsally compressed as to be nearly flat. They average about 4 mm. in length and 2.5 mm. in breadth.

Each mericarp is glabrous, brown in colour, and traversed from base to apex by five primary ridges, of which the three

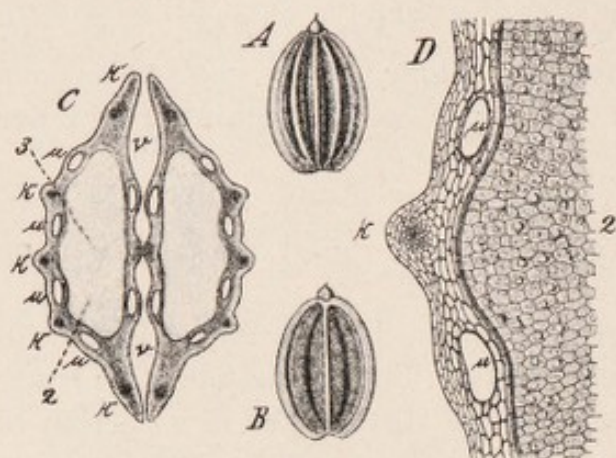


FIG. 72.—Dill fruit. *A*, entire fruit, side view, magnified 3 diam. *B*, commissural surface of mericarp, showing the vittæ as dark lines, magnified 3 diam. *C*, transverse section: μ , vittæ; κ , ridges; magnified 14 diam. *D*, portion of the same, further enlarged. (Berg.)

dorsal are only slightly raised, and are brown, filiform, and inconspicuous; whilst the lateral are prolonged into thin, yellowish, membranous wings. The transverse section exhibits under the lens six vittæ, viz. four on the dorsal and two on the commissural surface; the endosperm is oily, and is not grooved on its commissural surface either in transverse or longi-

tudinal section. Both the odour and taste are agreeably aromatic.

The student should observe

- (a) The *very flat shape of the mericarp*,
- (b) The *inconspicuous dorsal ridges*, and the *prominent lateral ones* (wings),
- (c) The *mericarps, usually separate and free from the pedicel*.

Constituents.—Dill fruit contains from 3 to 4 per cent. of volatile oil (sp. gr. 0.905 to 0.915; O.R. + 75° to + 80°), consisting of carvone ($C_{14}H_{10}O$, 40 to 60 per cent.), a colourless liquid with strong dill odour, and limonene associated with phellandrene and other terpenes.

Substitutes.—Considerable quantities of dill fruit are imported from India and Japan; they are the fruits of a species of *Peucedanum* that has been considered by some botanists entitled to rank as a distinct species (*P. Sowa*, Kurz), but is included by others in the species *P. graveolens*. The mericarps of Indian dill are frequently united and attached to a pedicel of about the same length as the fruits; the dorsal surfaces are more convex than in European dill, the ridges are

paler and more conspicuous, and the mericarps are rather narrower and less prominently winged. The oil differs from that of genuine dill in having a higher sp. gr. (0.948 to 0.968) and lower optical rotation (+ 47.5 to 50.5); it contains from

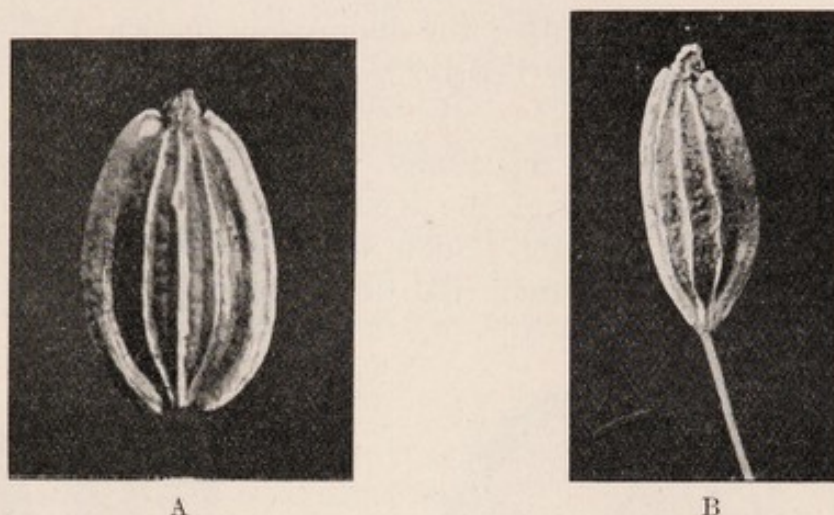


FIG. 73.—Dill fruit. A, English; B, Indian. Magnified 6 diam.

40 to 50 per cent. distilling above 230° C., whereas European dill contains only from 2 to 5 per cent. Hence Indian and Japanese dill should not be substituted for the official.

Uses.—Dill is employed as an aromatic stimulant and carminative.

ANISE FRUITS

(Aniseed, Fructus Anisi)

Source.—The anise, *Pimpinella Anisum*, Linné (N.O. *Umbelliferae*), is an annual plant indigenous to Greece, Egypt, and Asia Minor, but cultivated largely in southern Russia, and also in Spain and Bulgaria. Aniseed is one of the oldest of medicines and spices; it was cultivated by the ancient Egyptians, and was known to Dioscorides and Pliny; in this country it has been in use since the fourteenth century. The drug consists of the ripe fruits.

Description.—Anise fruits are greyish brown in colour, ovoid or pear-shaped, and somewhat compressed laterally. They are broad near the base, and taper gradually towards the apex, which is crowned with a stylopod and two short diver-

gent styles. The fruit averages about 5 mm. in length. The mericarps usually remain united and attached to a pedicel longer than the fruit. Each mericarp possesses five distinct but not prominent primary ridges which are usually slightly wavy, but do not exhibit the prominent crenations characteristic of hemlock fruits; the depressions between them are more or less distinctly bristly from the presence of short, stout hairs.

The vittæ branch repeatedly, and the transverse section taken from the middle of the fruit exhibits under the microscope from thirty to forty such branches in each mericarp; these, however, are so small that they are scarcely visible under

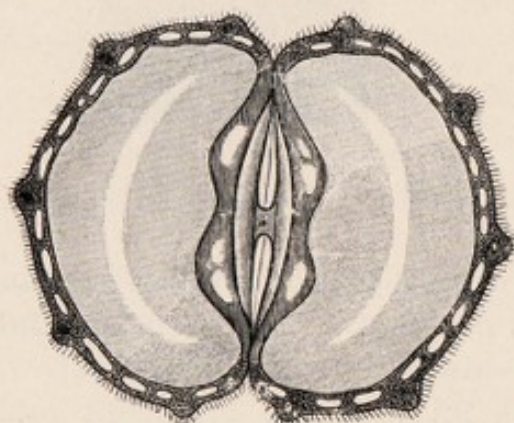


FIG. 74.—Anise fruit. Transverse section, indicating the position of the vittæ, not all of which (about forty in each mericarp) are shown. Magnified. (Moeller.)



FIG. 75.—*a*, Anise fruit. *b*, Hemlock fruit. Magnified. (Vogl.)

even a powerful lens. The endosperm is slightly concave on the commissural surface, but is not deeply grooved.

Anise fruits possess a sweet aromatic taste, and exhale, when crushed, an aromatic odour.

The student should observe

- (a) The *short, stout, bristly hairs*, which are sometimes inconspicuous,
- (b) The *united mericarps* and the *pedicel* attached to them,
- (c) The *absence of any deep groove in the endosperm*,
- (d) The *characteristic odour and taste*,
- (e) The *absence of prominent crenations on the primary ridges*, which are themselves not conspicuous;

and should carefully compare the fruits with those of *Conium maculatum*, noting the absence of any deep groove in the endosperm, this being the best macroscopic diagnostic feature.

Constituents.—The fruits yield from 1.5 to 3.5 per cent. of volatile oil (sp. gr. 0.980 to 0.990; O.R. 0° to +2°), of which anethol, present to the extent of about 90 per cent., is the principal aromatic constituent. Anethol, $C_{10}H_{12}O$, forms a white, crystalline solid melting at 22° C.; it has a strong anise odour.

Varieties.—*Spanish*, exported from Alicante; the fruits are distinguished by their large size (4 mm.), grey or brownish grey colour, and slender tapering shape; they yield about 3 per cent. of oil.

Russian fruits are smaller, darker, and rather more ovoid in shape; they are exported in very large quantities, and are the variety generally used for distillation.

Italian anise fruits are frequently contaminated with hemlock fruits, which may be identified by their glabrous surface, by the irregularly crenate ridges, by the absence of the pedicel, and (best of all) by the deep groove in the endosperm.

Use.—Anise is employed as an aromatic and carminative.

CAPSICUM FRUITS

(Cayenne Pepper, Chillies, Fructus Capsici)

Source &c.—The capsicum fruit official in the British Pharmacopœia is derived from *Capsicum minimum*, Roxburgh (N.O. *Solanaceæ*), a small erect shrub with spreading branches, producing oblong-conical fruits commercially known as chillies. It is apparently a native of Southern India, where at least it grows freely as a common weed of cultivation; it is also cultivated in other tropical countries, especially in Eastern and Western Africa, in South America, &c. Not only does the plant itself show a great disposition to vary, but the fruits of other species are probably imported under the same name; hence the chillies of commerce vary exceedingly in their size shape, and pungency. In Hungary *C. annuum*, Linné, or a hybrid of this plant with *C. tetragōnum*, Miller, is widely grown, and produces the large fruits with a short peduncle

and conspicuous green calyx known as paprika. In Italy and Spain *C. grossum* is cultivated, but in tropical countries *C. minimum* and *C. frutescens*, Linné, are most largely cultivated; these yield smaller and more pungent fruits, those of *C. minimum* being alone official.

The fruits are collected when ripe, and dried.

Description.—The fruits of *C. minimum* have, when fresh, a scarlet colour which changes on drying to a dull orange red. They are oblong-conical in shape, and obtuse at the apex; they vary usually from 12 to 20 mm. in length, and do not exceed 7 mm. in diameter. They are superior, and not unfrequently remain attached to a small, inconspicuous, five-toothed, inferior calyx, and straight, slender peduncle, which is

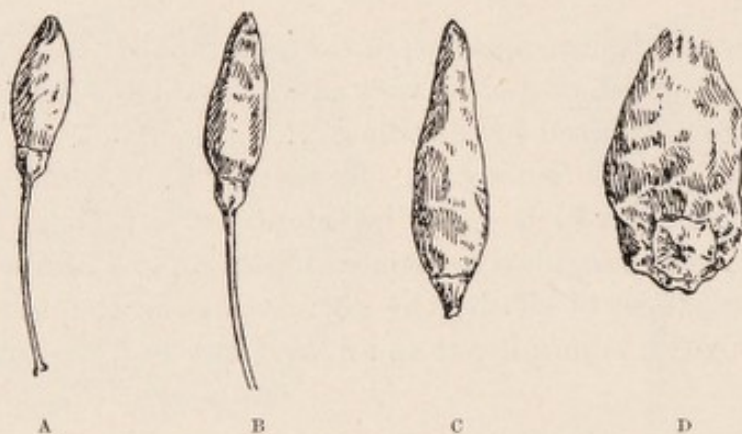


FIG. 76.—Capsicum fruits. A, Zanzibar; B, Sierra Leone; C, Japanese; D, Bombay. Natural size. (*Chemist and Druggist*.)

as long as, or rather longer than, the fruit itself. The pericarp is somewhat flattened, shrunken, and shrivelled. It is quite glabrous and shining, thin and leathery in texture, and more or less translucent.

Cut transversely, the fruit is seen to consist of two cells separated by a thin, reddish, membranous dissepiment. Each cell contains from five to ten small, flat, nearly circular, whitish seeds with a characteristic thickened margin; they were originally attached to the dissepiment, but are frequently found loose in the cavity.

Capsicum fruits have a characteristic but not powerful odour, and an extremely fiery, pungent taste. The latter resides principally in the membranous dissepiment that divides the fruit into two cells.

The student should observe

- (a) The *shape and size of fruit and peduncle*,
- (b) The *dissepiment* and its *pungent taste*,
- (c) The *shape of the seeds*

Constituents.—The most important constituent of capsicum fruit is the pungent principle capsaicin (0.02 per cent.), first isolated by Thresh (1876) in colourless, odourless crystals.

The fruit also contains a minute quantity of a liquid alkaloid which is not pungent, a fixed oil, and red colouring matter; the seeds may contain traces of starch.

Chillies yield about 5 (not over 6) per cent. of ash and from 20 to 25 per cent. of alcoholic extract known in commerce as capsin; the same name has also been applied to an ethereal extract as well as to a soft red substance extracted by ether from an alcoholic extract. All of these contain capsaicin associated with fixed oil, colouring matter, &c.

Capsaicin (capsacutin) is secreted by the epidermis of the dissepiments of the fruit, between the outer cell wall and the cuticle.

Thresh assigned to it the formula $C_9H_{18}O_2$, which Micko (1899) corrected to $C_{18}H_{28}NO_3$. The crystals melt at 63° C. and at higher temperatures are volatile, the vapour being extremely irritating; they are phenolic in character, dissolving in dilute solution of potassium hydroxide, but being reprecipitated by a current of carbon dioxide. The pungency is not affected by the alkali but is destroyed by oxidation with potassium bichromate or permanganate. Much interest is attached to this substance, as it is one of the very few pungent principles that have been isolated in a crystalline form, most of them being obtainable only in the state of oily liquids.

Microscopical Characters.—For the complete identification of the fruit of *C. minimum* the following histological characters are necessary in addition to the macroscopical characters detailed above. The outer epidermis of the pericarp consists of rectangular cells with a delicately striated cuticle and straight, thick, yellow, sparsely pitted walls abutting on parenchymatous tissue, the cells of which contain droplets of red oil and have thin cellulose walls. The inner epidermis of the pericarp exhibits groups of sclerenchymatous cells alternating with bands of thin-walled parenchyma, the whole forming a very characteristic tissue. The epidermis of the seed is composed of very large sinuous cells with thin outer walls, but strongly thickened and pitted radial and inner walls.

Varieties.—*Sierra Leone*: these are regarded as the most pungent of all. They have the macroscopical and microscopical characters detailed above. The pod is rather slender, bright in colour, with the stalk occasionally attached.

Zanzibar closely resemble the foregoing, but are usually duller in colour, more stalky, and the pod rather shorter and broader.

Nyassaland also closely resemble *Sierra Leone*, but are rather brighter and more free from stalk.

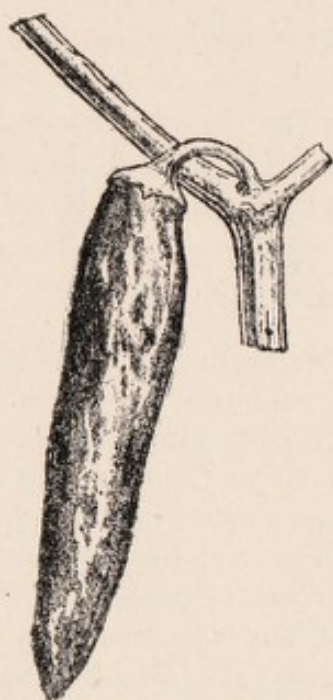


FIG. 77.—*Capsicum annum*, fruit. Natural size. (Bentley and Trimen.)



FIG. 78.—Natal capsicum fruit. Natural size. (Chemist and Druggist.)

Japanese: these are distinguished by their bright reddish colour and freedom from stalk; the cells of the epidermis of the pericarp have a *smooth* (not striated) *cuticle*, *strongly thickened walls and radiate lumen*; the cells of the single-layered hypoderma have rather thick, pitted, *cuticularised* walls. These fruits are less pungent than the African, but are valued for their very bright colour; they are derived from a distinct (not yet determined) species.

Bombay capsicums, the fruits of *C. annum*, Linné. They vary considerably in size and shape from nearly globular to

oblong; they are larger than the fruits of *C. minimum*, and have a less pungent taste. The stalk is usually bent, the calyx larger, the pericarp more leathery, and the dissepiment does not extend throughout the entire length of the fruit. The cells of the epidermis are *polygonal*, larger than those of *C. minimum* and with numerous pits, while the hypoderma consists of *several layers of cuticularised collenchymatous cells*.

Natal capsicums: these are much larger, averaging about 8 cm. in length, and are distinguished by their beautiful, transparent red pericarp.

Paprika, which is largely grown and used in Hungary, consists of the large fruits of a variety of *C. annuum* (sometimes considered a distinct species, viz. *C. tetragonum*, Miller); these are usually more or less distinctly tetragonal in shape.

Uses.—Cayenne pepper is applied externally as a stimulant and counter-irritant; internally it is used as a pungent stomachic carminative and stimulant, to dispel flatulence and rouse the appetite.

LAUREL BERRIES

(Bay Berries, Fructus Lauri)

Source &c.—Laurel berries are the ripe fruits of *Laurus nobilis*, Linn. (N.O. *Laurinææ*), a shrub that has already been referred to under the heading 'Laurel Leaves' (see p. 69).

Description.—The laurel produces one-celled, one-seeded, drupaceous fruits, which are collected when ripe, and dried. As seen in commerce, they are nearly black in colour and ovoid in shape, attaining about 15 cm. in length; they are slightly pointed at the apex, and bear at the base the scar of the peduncle. The surface is glabrous, shining, and coarsely wrinkled. The pericarp is thin and brittle, and encloses a single seed, the kernel of which lies loose in the cavity, the seed coats remaining closely adherent to the inner surface of the pericarp. The kernel is usually yellowish or brownish yellow in colour, and easily separable into two large firm cotyledons. It has an aromatic odour and aromatic bitter taste, the pericarp being less aromatic but much more bitter.

The student should observe

- (a) The *ovoid shape*,
- (b) The *loose kernel of the seed*,
- (c) The *aromatic odour and taste*;

and should compare these fruits with those of *Anamirta paniculata* (*Cocculus indicus*), which are reniform in shape and destitute of aroma.

Constituents.—Laurel berries contain about 1 per cent. of an aromatic volatile oil and upwards of one-fourth of their



FIG. 79.—1 and 2, Laurel berries, whole and cut transversely. 3 and 4, *Cocculus indicus*, whole and cut transversely. Slightly magnified. (Vogl.)

weight of solid fat. The latter, separated by hot pressure, is the *Oleum Lauri Expressum* of commerce; when pure it has a dull green colour, granular consistence, and aromatic odour. The principal constituent is laurostearin (glyceryl laurate), the odour being due to the volatile oil, and the green colour to chlorophyll, both of which are simultaneously extracted.

The volatile oil consists of cineol (eucalyptol, 50 per cent.), accompanied by eugenol, pinene, geraniol, &c.

The nature of the bitter principle contained in the pericarp of the fruit is unknown.

Uses.—The expressed oil is sometimes used as a stimulant in veterinary practice.

FIGS

(*Ficus*)

Source &c.—The fig tree, *Ficus Carica*, Linné (*N.O. Urticaceæ*), is a native of Persia and the surrounding countries. The fruits, figs, have long constituted an important article of food in Eastern countries; they have been found provided as food for the dead in Egypt as early as 2,400 years before the Christian era; from Egypt the tree was probably introduced into Greece and thence into southern Europe. It is now cultivated in most temperate and warm climates, and even ripens its fruit in England.

The fruit is produced by the abnormal growth of a lateral shoot, by which a green, hollow, pear-shaped body is produced, having a small aperture closed by bracts. On the inner walls of this hollow body numerous small flowers are borne; the wall itself is then fleshy and contains laticiferous vessels which, when wounded, discharge a milky latex. In this condition figs are inedible. As the fruit ripens the latex disappears, the fleshy wall fills with sugar and becomes pulpy, and the taste sweet and agreeable. They are then eaten in the fresh state, or are collected and dried in the sun, being sometimes previously sterilised by sulphuring or by dipping in a boiling alkaline solution. The dried fruits constitute the figs of commerce. If, without further manipulation, they are packed loose, retaining more or less their original shape, they are called 'natural' figs; but if subjected to a process of kneading by which they become supple and the skin translucent, they are called 'pulled' figs; the latter are usually packed into small boxes for exportation, and are considered the best. 'Pressed' or 'layered' figs are those which have been flattened by the pressure used in the packing.

Description.—The ordinary fig is too well known to need much description. The fruit, which is sometimes called a syconus, is a collective fruit formed from the enlarged, succulent, hollow, receptacle which bears on its inner wall very numerous, minute, one-seeded true fruits (achenes), commonly called the seeds. Figs are usually irregular in form, compressed, soft and tough, brownish or yellowish in colour, and sweet in taste.

Constituents.—The principal constituent of figs is sugar (dextrose), of which they may contain upwards of 50 per cent.

Varieties.—*Elémé* figs, exported from Smyrna either 'pulled' or 'layered'; they are distinguished by their thin skins and soft luscious pulp.

Spanish: from Malaga and Valencia, either 'layered' packed in boxes, or 'natural' packed in mats.

Greek: generally of small size and threaded on strings or packed in barrels; they have thicker, tougher skins, and less abundant pulp.

Uses.—Dried figs have agreeable demulcent, nutritive, and laxative properties, and are therefore sometimes prescribed as an article of diet in habitual constipation. They form one of the ingredients in confection of senna.

HOPS

(Lupulus, Humulus, Strobili Lupuli)

Source &c.—The hop, *Humulus Lupulus*, Linné (N.O. *Urticaceæ*), is a scabrous climbing plant with perennial root, widely diffused over the whole of Europe and common in England, growing in hedges and thickets. It is largely cultivated in England, Germany, Russia, California, &c.

The hop is dioecious, but the pistillate plant only is cultivated, since from that alone the fruits (hops) can be obtained; these are preferred with undeveloped seeds, to ensure which the staminate plants are usually excluded.

The axis of the pistillate inflorescence is a sympodium, and bears at intervals pairs of stipules. From the common axil of each pair a rudimentary branch arises, which divides into two branchlets. Each branchlet divides again into two, and each of the four ultimate divisions so produced bears a single flower

in the axil of a bract, there being thus four bracts to each pair of stipules. Both stipules and bracts develop into broadly ovate membranous leafy bodies which, crowded on the sympodial axis, form a cone-like collective fruit termed a strobile (fig. 80, *a*). These are picked from the plant when fully developed, and dried; they are frequently exposed to fumes of burning sulphur (sulphur dioxide), by which the colour is preserved and change in the aroma is said to be hindered. They are sometimes dried loose, but usually they are pressed into compact bales known as 'pockets.'



FIG. 80.—Hop. *a*, strobile of the Hop, natural size. *b*, bract enfolding at its base a small fruit, and showing lupulin glands, natural size. *c*, fruit magnified, showing lupulin glands. (Tschirch.)

Description.—The strobile of the hop averages about 3.5 cm. in length and is ovoid or rounded in shape, the most conspicuous part being the yellowish green imbricated membranous bracts and stipules. If these leafy organs are removed from the strobile, the axis will be seen to be hairy and have a zigzag course, bearing rudimentary branches on alternate sides. Some of the leafy bodies enfold at their

bases minute fruits: these are the bracts (fig. 80, *b*); others, the stipules, do not. The fruits are minute achenes, and are partially surrounded by a perianth (fig. 80, *c*). Both the minute fruits and the bases of the bracts are sprinkled over with yellowish shining translucent glands, which contain volatile oil and constitute, when separated, the drug lupulin.

The odour of fresh hops is strong and characteristic, although scarcely agreeable; the taste strongly aromatic and disagreeably bitter and acrid. By keeping, the aroma becomes less powerful but also less agreeable, the bracts and stipules turn yellow, and the glands acquire a brown colour.

The student should strip the bracts and stipules from the strobile and observe

- (a) The zigzag hairy axis,
- (b) The bracts enclosing fruits and bearing glands.

Constituents.—The odour of hops is due to a volatile oil (0.3 to 1.0 per cent.), consisting chiefly of the terpene humulene. The bitterness is due to two crystalline principles (Lindtner, 1904), viz. α -lupamaric acid (also called humulone) and β -lupamaric acid (lupulinic acid); both of these are extracted by petroleum spirit which also removes a powerfully antiseptic soft resin which by oxidation yields valerianic acid, a reaction that explains the change in the odour of hops when kept (Chapman, 1898). After exhaustion with petroleum spirit the drug yields to ether a hard resin.

Both bracts and stipules (but not the glands) contain about 5 per cent. of tannin. According to Heron (1897) the tannin in hops gradually disappears, changing first into phlobaphene and subsequently into gallic acid and other compounds.

Uses.—The volatile oil produces sedative and soporific effects, whilst the lupamaric acid is stomachic and tonic; hops accordingly improve the appetite and promote sleep.

CUBEBS

(Fructus Cubebæ)

Source &c.—Cubebs are the fruits of *Piper Cubēba*, Linné filius (N.O. *Piperaceæ*), a dioecious woody climber indigenous to Java, Sumatra, and Borneo, and apparently cultivated also



FIG. 81.—*Piper Cubeba*. A, fruiting branch, natural size. C, portion of the same magnified, showing the stalk-like elongation of the pericarp. B, branch of staminate plant, natural size. D, bract and stamens, magnified. E, fruit cut to show the endosperm and perisperm, magnified. F, portion of same, more highly magnified, showing the embryo, *e*, endosperm, *a*, and perisperm, *p*. G, *Piper nigrum*; portion of flowering spike, magnified. (Luerssen.)

in those islands, although exact information concerning the cultivation is difficult to obtain. The fruits have long been known in Europe, having being used as a spice, and as a medicine in the Middle Ages.

The pistillate inflorescence of the cubeb is a spike of sessile flowers. The young fruits are also sessile, but as they mature they become elevated on a slender stalk produced by an abnormal development of the pericarp of the fruit at its base (fig. 81, *C*). When the fruits are full-grown, but whilst they are still green and unripe, they are stripped from the rachis, bringing with them the stalk-like prolongation of the pericarp which remains permanently attached to them, whence the name 'tailed pepper' by which they are sometimes known. They are then dried in the sun, during which the green colour changes to a greyish black; they are bought up by Chinese traders and exported chiefly from Batavia to Amsterdam or from Singapore to London.

Description.—The commercial drug consists of nearly globular fruits, sometimes depressed at the base (immature fruits), measuring about 4 mm. in diameter, and usually of a greyish brown or nearly black colour. The pericarp is reticulately wrinkled (due to the shrinking as the fresh fruit dries) or, in very young fruits, shrivelled, and abruptly prolonged at the base into a slender stalk about 6 mm. in length which is usually rounded or slightly flattened. The apex of the fruit bears the minute remains of three or four stigmas.

Within the pericarp, which is thin and brittle, is a single seed attached by the base; frequently only the dark shrunken remains of a partially developed seed are to be found. The fully developed seed is reddish brown in colour. The embryo is very small and embedded near the apex of the seed in a somewhat scanty endosperm surrounded by a copious perisperm, which constitutes the greater part of the seed.

Cubebs exhale, when crushed, a strong, characteristic, spicy odour, and possess a strong, spicy, somewhat bitter taste. The crushed fruit, sprinkled upon the surface of concentrated

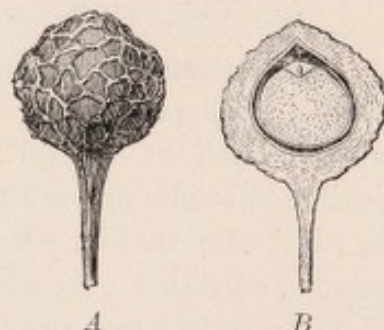


FIG. 82.—Cubeb. *A*, entire fruit, magnified. *B*, entire fruit, cut vertically, magnified. (Planchon and Collin.)

sulphuric acid, produces a crimson colouration. This reaction is an important one, as most of the substitutes for cubebs yield only a brownish red under the same conditions. It is especially valuable when taken in conjunction with the microscopical characters, for there is no substitute known that possesses an anatomical structure identical with that of genuine cubebs, and also yields the crimson colour with sulphuric acid (Hartwich, 1898).

Microscopical Characters.—Below the outer epidermis of the pericarp is an interrupted layer consisting of one or two rows of thick-walled sclerenchymatous cells. Distributed in the thin-walled parenchyma of the mesocarp are numerous large oil-cells. Within the inner epidermis of the pericarp is a second, uninterrupted layer of one or two rows of very thick-walled, radially elongated cells. The seed consists chiefly of perisperm, the cells of which are packed with small starch grains.

The student should observe

- (a) The *slender stalk*, which is not easily detached,
- (b) The *seed attached only by its base* to the pericarp,
- (c) The *characteristic odour and taste*,
- (d) The *reaction with sulphuric acid*.

Constituents.—Cubebs yield from 10 to 18 per cent. of volatile oil (sp. gr. 0.915 to 0.930; O.R. -25° to -40°), which is contained in oil-cells both in the pericarp and perisperm; similar oil-cells are contained also in the rachis, stem, leaves, &c., but the rachis, which is frequently found mixed with the cubebs, contains only about 1.7 per cent. of volatile oil.

Cubebs contain further an indifferent substance, cubebin, an acid resin, cubebic acid, and an indifferent resin. They afford about 6 per cent. of ash and yield to ether about 22 per cent. of oleo-resin.

Cubebin has been obtained in colourless crystals, yielding with sulphuric acid a cherry-red colour; it appears to be devoid of any remarkable physiological action.

Cubebic acid (0.96 per cent.) is white and amorphous; it gives with sulphuric acid a crimson colour, and together with the indifferent resin (2.5 per cent.) produces purely diuretic effects. These two principles may therefore be regarded as active constituents of cubebs.

Cubeb-camphor ($C_{15}H_{24}, H_2O$), found in old cubebs, is a crystalline but unstable hydrate of a sesquiterpene.

Adulterations &c.—The exportation of cubebs has been subject to considerable variation, and during times of scarcity the drug has been liable to adulteration and substitution. Many other plants belonging either to the same or to other natural orders produce fruits resembling cubebs in appearance, a fact which has doubtless facilitated sophistication. Genuine cubebs can, however, be easily distinguished by the crimson colour they impart to sulphuric acid, taken in conjunction with the anatomical characters of the pericarp as above described.

The fact that the fruits on the spike mature in succession from base to apex necessitates the presence in the drug of some immature fruits, but too many of these, which may be recognised by their small size and shrivelled appearance, should not be present. Portions of the rachis also find their way into the commercial drug; they too should not be present in large quantity, as they contain less cubebic acid and resin, and much less volatile oil.

Uses.—Cubebs have a stimulant and antiseptic action on the mucous membrane of the genito-urinary organs and are also diuretic. They are chiefly used in gonorrhœa and affections of the bladder, sometimes also in chronic bronchitis, the active constituents of the drug leaving the body by the kidneys and urinary passages, the skin and the respiratory organs.

BLACK PEPPER

(*Piper Nigrum*)

Source &c.—The pepper vine, *Piper nigrum*, Linné (N.O. *Piperaceæ*), is a perennial climbing plant indigenous to Southern India, but spread by cultivation over the islands of the Malay Archipelago and to the West Indies and South America. It is now cultivated chiefly in Sumatra, Singapore, Johore, the islands of the Rioux-Lingga Archipelago, Penang and Siam. Probably no drug or spice has been so sought after, or has played so important a part, as pepper. It was apparently brought to Europe soon after the expedition of Alexander the Great to India. During the middle ages the trade in it was concentrated in Venice, and the desire to divert so profitable a commerce acted as a direct inducement to the Genoese and Portuguese to seek a sea route to India, which resulted in the

discovery by Vasco da Gama in 1498 of the route round the Cape of Good Hope to India. At the present moment the centre of the pepper trade is Singapore, whence about one-half of the world's supply is exported (Tschirch, 1892).

The pepper vines are cultivated in gardens as hops are in England, but instead of poles being used, trees are planted to afford the necessary shade and support. The plant bears a pendulous spike of sessile flowers (fig. 81, *G*), which are succeeded by small drupaceous fruits; these do not become raised upon stalks as the cubebs do, but remain sessile. As soon as the lower berries on the spike begin to ripen, which is shown by their colour changing from green to red, the whole spike is picked and dried in the sun; during which the fruits turn black. They are then separated from the rachis, sorted, and constitute the black pepper of commerce.

For the production of white pepper the fruits are allowed to become nearly ripe; they assume a crimson colour, and the mesocarp acquires a pulpy consistence. They are then either heaped and allowed to ferment, or soaked in water, until the outer part of the pericarp is loosened; from this they are separated by rubbing between the hands or treading under the feet, after which they are washed free from the pulp and dried. White pepper is therefore the nearly ripe fruit from which the outer part of the pericarp has been removed.

Description.—Black pepper consists of small dark brown or nearly black spherical fruits, measuring about 5 mm. in

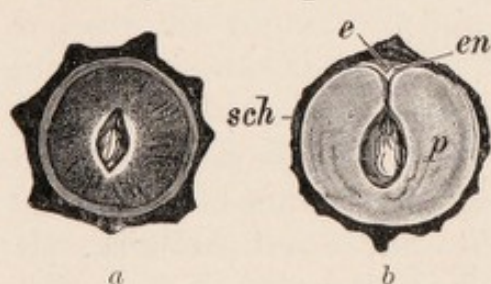


FIG. 83.—Black Pepper. *a*, transverse section. *b*, longitudinal section, showing pericarp, *sch*; perisperm, *p*; endosperm, *en*; and embryo, *e*. Magnified. (Tschirch.)

diameter, with a more or less regularly and deeply reticulate wrinkled surface. At the apex the remains of the sessile stigmas can be traced; the base bears a scar indicating the point of attachment to the rachis, but, the fruits being sessile, there is no stalk.

If a fruit be cut in halves and examined with a lens, the pericarp will be seen to be thin and dark and completely filled with a seed to which it is closely adherent. The seed is globular and covered with a brown seed-coat. It contains a small endosperm, near the apex of the fruit, in which the

minute embryo is situated ; but the major part of the seed is composed of perisperm, which is yellowish and horny near the periphery, whitish, mealy, and frequently hollow in the centre.

Both pericarp and seed have an aromatic odour and pungent taste ; they both contain oil-cells, visible under the microscope.

The student should observe

- (a) The *absence of stalk*,
- (b) The *seed completely filling the pericarp and adherent to it*,
- (c) The *characteristic odour and taste*,
- (d) In *white pepper the adherent inner part of the pericarp, with its fibro-vascular bundles*.

Constituents.—Both the seed and the pericarp contain numerous oil-cells in which a volatile oil (1·0 to 2·3 per cent.), a resin, and a crystalline alkaloid, piperine (5·0 to 8·25 per cent.), are contained. The volatile oil consists almost entirely of terpenes. The resin, which has been termed chavicin, and to which part of the pungency of the pepper is due, has not been sufficiently examined. The alkaloid piperine, $C_{17}H_{19}NO_3$, forms colourless and odourless crystals, which are at first tasteless, but subsequently pungent. Heated with alcoholic solution of potassium hydroxide it is split up into piperic acid and piperidine.

The seeds contain, further, a large quantity of starch in minute angular grains united into polygonal masses, and yield from 4·0 to 7·0 per cent. of ash.

Varieties &c.—White pepper is of about the same size and shape as black. The surface is greyish white in colour, and nearly smooth. From the base to the apex there run about sixteen light lines ; these are the fibro-vascular bundles that traverse the pericarp ; they are left, together with the inner part of the pericarp, attached to the seed when the outer part of the fruit is removed. By gently scraping white pepper the adherent part of the pericarp can be removed and the dark brown seed disclosed ; the latter possesses the characters above described. It contains from 4 to 6·5 per cent. of piperine.

Long Pepper.—Long pepper is the dried unripe fruit of *Piper officinārum*, Casimir de Candolle, and is exported chiefly

from Java. It consists of a large number of minute sessile fruits which, together with the bracts that support them, are crowded together on and partially embedded in an elongated axis so as to form a dense spike. Each spike is about 40 mm. long and 6 mm. thick; it is nearly cylindrical, tapering to a



FIG. 84.—Long Pepper.
(Planchon and Collin.)

rounded apex, and often covered with a greyish powder. When washed free from this the spikes are seen to be reddish brown in colour, and the minute fruits are then more easily visible; they are arranged in a close spiral, and each bears the remains of the stigma at its apex. Cut transversely, the section of the spike shows eight or ten fruits with starchy perisperm arranged around a central axis.

The taste and odour resemble those of black pepper, but are not so strong. The active constituents are the same, but they are present in smaller proportion (volatile oil 1.0 per cent., piperine 6.2 per cent.).

The student should cut long pepper transversely and observe the minute fruits, which appear white and starchy in section.

Uses.—Applied externally pepper acts as a rubefacient, anodyne, and counter-irritant. It is given internally as a local stimulant, and as a stimulant to the urethra and rectum; it increases gastric secretion and improves the appetite; it is also occasionally used for hæmorrhoids and other diseases of the rectum.

JUNIPER BERRIES

(Fructus Juniperi)

Source &c.—The juniper, *Juniperus communis*, Linné (N.O. *Coniferae*), is a small diœcious evergreen shrub with linear spreading prickly leaves, indigenous to Great Britain, and widely distributed over Europe.

In the axils of certain of the upper leaves small rudimentary branches are produced, each of which bears a number of minute bracts; in the axils of the uppermost whorl of three such bracts three ovules are produced, which, as in all

gymnosperms, are not enclosed in an ovary. After fertilisation the three supporting bracts increase in size, become fleshy, grow round, and finally, with the exception of a minute canal at the apex, completely enclose the three ovules. At the same time the ovules develop to seeds and become surrounded with hard coats developed partly from the integuments, partly from the tissue of the enclosing bracts. The fruit ripens in the second year, and forms then a purple berry-like fruit which is termed a 'galbulus.'

Juniper berries are collected in various parts of Europe, but especially in Italy and in Hungary.

Description.—Ripe juniper berries are of a dark purplish colour and nearly globular shape, measuring about 8 mm. in diameter. The apex bears a very distinct tri-radiate scar indicating the sutures of the three bracts by which the seeds are enclosed; at the base are (usually) six minute pointed



FIG. 85.—Juniper berry. *A*, entire fruit, magnified 3 diam. *B*, transverse section of the same: κ , seed. *D*, Seed, magnified 3 diam.: *l*, oil-gland. (Berg.)

bracts arranged in two whorls. The outer skin (corresponding to the epicarp) is thin and often covered with a bluish 'bloom'; the tissue corresponding to the mesocarp is loose and soft, of a yellowish brown colour, and contains embedded in it three hard triangular seeds. These usually bear, partly sunk in the hard tissue, large oil-glands filled with volatile oil, or, in old fruits, with yellowish transparent resin; they are often concealed by the soft surrounding tissue which adheres to the resinous secretion. Smaller oil-glands are present in the pulp of the fruit, but they are less conspicuous.

Juniper berries have an agreeable aromatic odour resembling turpentine, and a sweetish taste.

Whilst green and unripe they contain starch and are devoid of the sweet taste. According to the British Pharmacopœia the unripe fruits should be used for the distillation of the volatile oil, but for this purpose the ripe fruits are said to be usually employed; when the distillation is complete the

residue in the still is exhausted with water and the decoction evaporated to a soft extract (Succus or Roob Juniperi), which is much used in Germany (Schimmel, 1898).

The student should observe

- (a) The scar at the apex,
- (b) The minute bracts at the base,
- (c) The three hard seeds with oil-glands partly embedded in them.

Constituents.—Ripe Juniper berries yield about 1 per cent. of volatile oil (sp. gr. 0.865 to 0.890; O.R. -4° to -6°), consisting of pinene, cadinene, and juniper camphor, and contain a considerable quantity of sugar.

Uses.—The volatile oil is diuretic as well as being stomachic and stimulant. It is employed chiefly as a diuretic in certain forms of dropsy.

VANILLA

(Fructus Vanillæ)

Source &c.—The vanilla plant, *Vanilla planifolia*, Andrews (N.O. *Orchidææ*), is a climbing plant growing wild in the moist woods on the eastern coast of Mexico. It is now largely cultivated in the islands Réunion, the Seychelles, Mauritius, Java, &c., where the climate resembles in temperature and humidity that of its native country. The genus includes many species, but *V. planifolia* is the chief vanilla-yielding one.

Like other members of the same natural order, the fertilisation of the Mexican wild plant is effected by insects; but when the plant is cultivated in other countries, in the absence of these insects, the fertilisation is accomplished by hand. This is effected by introducing a pointed stick into flower after flower, selecting the strongest. Before the fruits ripen, when the colour begins to change from yellowish green to brown, they are picked and subjected to a process of 'curing,' during which certain aromatic principles are formed and the fruits acquire the well-known vanilla odour. This process, the details of which vary considerably, consists essentially in slowly drying the fruits by exposure to the warmth of the sun or to artificial heat. The change in the constituents is probably due to the action of enzyme ferments of which two, a hydrolysing ferment

and an oxydase have been detected, but the exact nature of the change or of the substances acted upon is not known. The cured fruits, which are of a dark brown or nearly black colour, are bound in bundles and packed in tins, in which they gradually become coated with minute crystals.

Description.—Commercial vanilla occurs in slender flexible stick-like pods about 15 to 20 cm. in length, and of a dark brown or nearly black colour. They have a flattened-cylindrical shape, due to the mutual pressure of the pods in the bundle, and taper towards both base and apex. The surface is longitudinally wrinkled and frequently more or less covered with

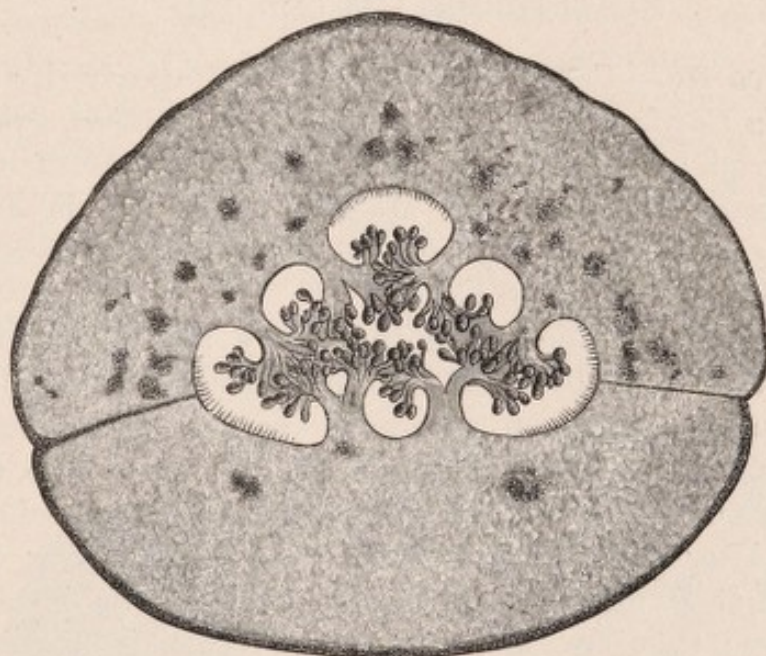


FIG. 86.—Vanilla. Transverse section of fruit, showing the placentas, seeds, and secreting hairs on inner epidermis of the pericarp. Magnified. (Moeller.)

numerous minute glistening crystals (of vanillin). The fruits are one-celled and contain innumerable, minute, black seeds embedded in a dark-coloured, aromatic, balsamic fluid secreted by the cells of the inner epidermis of the pericarp, which are developed into short hair-like processes projecting into the cavity of the fruit. The drug has an extremely fragrant odour and an agreeable aromatic taste.

Constituents.—The principal aromatic constituent of vanilla pods is vanillin, though probably other aromatic substances are present; it is contained in the fluid secreted by the inner epidermis of the pericarp, which gradually permeates the whole

fruit; and constitutes the crystalline deposit that slowly accumulates on the pods.

Vanillin, the aldehyde of methylprotocatechuic acid, can be obtained in colourless acicular crystals with a fragrant vanilla-like odour. It also occurs in balsam of Peru, balsam of Tolu, benzoin, and other drugs. It may be prepared from coniferin, a glucoside contained in the sapwood of pine trees, &c., or from eugenol, the principal constituent of clove oil.

CARDAMOMS

(Fructus Cardamomi)

Source &c.—Cardamoms are the dried, nearly ripe fruits of *Elettaria Cardamomum*, Maton (N.O. *Scitamineæ*), a perennial, reed-like plant that grows wild in the forests of southern India, especially near the Malabar coast. It is cultivated there as well as in Ceylon, the fruits of commerce being obtained from cultivated plants.

The plant produces near the root a long loose raceme of flowers, succeeded by small inferior capsular fruits, which are cut from the rachis in succession as they ripen, but before they are quite ripe; if they are left till quite ripe they are liable to spring open when they are dried and discharge the seeds. After collection they are cured by dipping them in water and drying them either in the sun or in a drying apparatus; they are also commonly bleached by sulphurous acid in a machine specially constructed for that purpose. The cured fruits are trimmed, freed from impurities by picking, and finally graded.

Cardamoms were well known to the Greeks and Romans, but probably not the species now under consideration.

Description.—Cardamom fruits differ considerably in size and shape. They vary usually from 1 to 2 cm. in length, the smallest variety being frequently nearly globular in shape, whilst the longer are more or less distinctly three-sided, with rounded angles and an ovate or oblong outline. They are of a pale buff or yellowish colour, and nearly smooth or longitudinally striated. To the base, which is rounded, is attached a short stalk; towards the apex they taper more or less abruptly, and are sometimes crowned by a short beak formed of the

remains of the calyx, from which, however, they have often been freed by trimming. They are three-celled, and contain in each cell two rows of small seeds attached to axile placentas. From good plump cardamom fruits the seeds usually separate in a cohering mass from each cell. They are of a dark reddish brown colour, about 3 mm. in length, and irregularly angular in shape; they are hard and marked with transverse wrinkles, which are very distinct when examined with a lens; unripe seeds are paler in colour and not so plump. The thin, colourless, membranous aril that covers the seed becomes more evident when the seeds are soaked in water. The hilum is depressed, and a channel, extending on one side from the base to the apex of the seed, indicates the position of the raphe.

Cut transversely, the seed exhibits a thin dark seed-coat, a whitish perisperm grooved on one side, and in the centre a small yellowish translucent endosperm and minute embryo.



FIG. 87.—Mysore Cardamoms. Natural size.

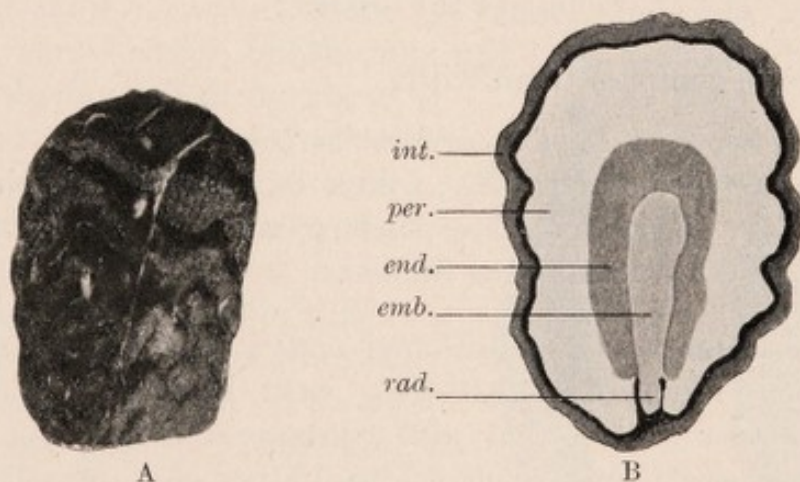


FIG. 88.—Cardamom seed. A, entire; B, longitudinal section; *int.*, integuments; *per.*, perisperm; *end.*, endosperm; *emb.*, embryo; *rad.*, radicle. Magnified 12 and 14 diam. respectively.

The seeds have a powerful aromatic odour and an agreeable pungent aromatic taste, but the pericarps possess neither aroma nor taste. The seeds of fruits which have partially opened are less aromatic, and such fruits ('splits') are less esteemed.

Microscopical Characters.—The most important tissues in cardamom seeds are (i) the epidermis, consisting of long, narrow, tapering cells with walls 3 to 4 μ thick; (ii) a single layer of large thin-walled oil-cells in the outer seed-coat; (iii) the inner seed-coat, consisting of dark brown, very strongly thickened, radially prismatic cells, each containing a small nodule of silica; (iv) the thin-walled parenchyma of the endosperm packed with minute starch grains and containing in the centre of each cell one or more small prismatic crystals of calcium oxalate.

The pericarps contain abundant empty parenchymatous cells, spiral vessels, and elongated sclerenchymatous cells and fibres, none of which occur in the seed.¹

The student should observe in the fruits

- (a) The *pale colour* and *plump appearance*,
- (b) The *abruptly tapering apex*;

and should compare them with Ceylon (wild) cardamoms (see below).

He should also observe in the seeds

- (a) The *dark reddish brown colour* and *aromatic taste*,
- (b) The *transverse wrinkles, depressed hilum and raphe*,
- (c) The characters of the *section*;

and should compare them with

- (i) Seeds of *Ceylon cardamoms* (see below),
- (ii) *Grains of Paradise*, which have a rich reddish brown colour, papillose surface, and bear the remains of a thick fibrous funicle.

Constituents.—The principal constituent of the seeds is the volatile oil, of which they yield from 2 to 8 (average about 5) per cent. They also contain abundance of starch. Good ripe seeds yield about 3.5 to 5.5 per cent. of ash, unripe seeds more; ripe fruits from 4 to 7 per cent.

Varieties.—*Mysore*: although bearing the name of an Indian province, these are imported from Ceylon; they constitute the chief commercial variety, and the one to which the official description most nearly applies. They are distinguished by their ovoid shape and cream-coloured, nearly smooth surface.

¹ Compare Greenish, *Food and Drugs*, p. 226.

Malabar: these are also imported from Ceylon; they are shorter, plumper, and often not so smooth as Mysore cardamoms.



FIG. 89.—Malabar Cardamoms. Natural size.

Mangalore, which closely resemble the Malabar variety, but are often rather larger, nearly globular, and have a roughish, almost scurfy coat; they are imported from India.



FIG. 90.—Mangalore Cardamoms. Natural size.

The seeds of these three varieties are practically indistinguishable from one another, though differing very slightly in flavour.

Long wild natives: these are the fruits of *E. Cardamomum*, var. β *major*, Smith, imported from Ceylon; they are readily distinguished by their elongated shape, shrivelled appearance, and greyish brown colour; the seeds closely resemble the foregoing, but have a slightly bitterish taste, different odour, and rather thicker epidermal cell walls (4.5 to 6.0 μ ; see above). They are used for the production of commercial cardamom oil, and also for making liqueurs and for flavouring.



FIG. 91.—Long wild native Cardamoms. Natural size.

Powdered cardamom seeds may be distinguished from the powdered fruits by the absence of the tissues of the pericarp (see above).

Uses.—Cardamoms are employed as an aromatic carminative and as an agreeable flavouring agent.

SECTION IV

SEEDS

The seed is the body produced from the ovule as the result of fertilisation. It consists ordinarily of two seed-coats, an outer or testa and an inner or tegmen, enclosing a kernel composed of the embryo with one or more cotyledons and in many cases an endosperm. Sometimes an outgrowth (arillus) is developed from the funicle or from the placenta which may extend so as to partially or even almost entirely enclose the seed.

Most seeds may be readily distinguished from one another on account of the great diversity in their size, shape, surface, structure, and contents. Those with which the student will have to deal may be very minute (black mustard, lobelia, henbane) or of considerable size (calabar bean, cola seed); they may be spherical, ovoid, reniform, &c.; the surface may exhibit a great variety in the sculpture of the outer wall, which may be pitted (mustard seed) or variously reticulate (poppy, henbane, lobelia), &c. Further, the epidermal cells may be prolonged into hairs (*nux vomica*, *strophanthus*), or contain mucilage (linseed, mustard seed), or offer other distinctive characters.

The internal structure of the seed-coats also possesses valuable diagnostic features, but these are only visible under the microscope. A section examined with a lens often exhibits the disposition of the cotyledons and radicle, and allows of the presence or absence of an endosperm being determined; the endosperm itself varies considerably in its nature, being oily, mucilaginous, horny, ruminant, &c.

In examining small seeds the student should constantly employ a hand lens with the aid of which the surface should be carefully observed. Transverse sections cut with the aid of a sharp penknife or razor should also be scrutinised. Large, hard seeds such as *nux vomica* should be soaked in hot water till they are sufficiently softened to be cut.

STAVESACRE SEEDS

(Semina Staphisagriæ)

Source &c.—Stavesacre, *Delphinium Staphisagria*, Linné (N.O. *Ranunculaceæ*), a stout erect herb attaining 4 feet in height, is indigenous to Asia Minor and southern Europe. The plant is cultivated in France and Italy, our supplies being chiefly derived from Trieste and from the south of Italy.

Stavesacre was well known to both the Greeks and the Romans. Dioscorides mentions it, and Pliny describes its use as a parasiticide. It continued to be extensively employed throughout the middle ages, but is now in much less demand.

The fruit consists of three follicles, in each of which a few seeds are closely packed; these are collected when ripe.

Description.—The seed, as seen in commerce, are of small size, averaging about 6 mm. in length and rather less in breadth. They usually appear to be dark grey in colour, but when freed from the dust with which they are covered are seen to be dark brown, and then the characteristic markings on the surface of the seed become more evident. In shape they are usually irregularly or obscurely four-sided, one side being curved and larger than the others, which are nearly flat or even depressed. The surface of the seed is more or less uniformly reticulate and entirely covered, both as to elevations and depressions, with minute papillæ which are visible when the seed is examined with a lens. One end of the seed is usually more pointed than the other; near the pointed end the hilum is visible as a narrow line. By soaking a seed in water and cutting it transversely just below the hilum, the minute embryo may be found embedded in a large whitish or often yellowish oily endosperm.

The seed-coat is nearly tasteless, but the endosperm is intensely bitter and acrid; the seeds have no marked odour.

The student should observe

- (a) The dull earthy colour of the seed,
- (b) The characteristic obscurely quadrangular shape,
- (c) The rough as well as pitted surface,
- (d) The bitter, oily endosperm.



FIG. 92.—Stavesacre seed, entire and cut longitudinally, showing embryo. Magnified 2 diam. (Maisch.)

Constituents.—The seeds contain several alkaloids (in all about 1 per cent.), the most important of which are delphinine, delphisine, and delphinoidine; less important are staphisagroine, of which traces only are present, and staphisagrine, which is probably a mixture.

Delphinine, $C_{31}H_{49}NO_7$, is crystalline and extremely poisonous. Delphisine is amorphous, but about twice as poisonous as delphinine, while delphinoidine, which is also amorphous, is much less toxic.

The seeds also contain from 30 to 35 per cent. of fixed oil, which may be extracted either by expression (expressed oil of stavesacre) or by solvents such as petroleum spirit &c.; in either case the oil carries with it the greater part of the alkaloids, including practically all the delphinine; these may be removed from the oil by shaking it with an aqueous solution of tartaric acid. The drug affords from 10 to 13 per cent. of ash.

Uses.—Stavesacre seeds are extremely poisonous, delphinine and delphinoidine resembling aconitine in action, but being weaker; the seeds are used only as a parasiticide to kill pediculi, chiefly in the form of the official ointment, the expressed oil, the powdered seeds, or an acid aqueous extract containing the alkaloids. Delphinine has also been employed similarly to aconitine both internally and externally for neuralgia &c.

BLACK MUSTARD SEEDS

(Semina Sinapis Nigræ)

Source &c.—The black mustard plant, *Brassica sinapioides*, Roth (*B. nigra*, Koch, N.O. *Cruciferae*), an erect annual plant attaining a height of 1 metre or more, is doubtfully a native of this country, although found apparently wild. It is now largely cultivated for the sake of its seed in Holland, England, Italy, Germany, and other countries. The fruits are smooth, erect, appressed siliques, which dehisce, when ripe, by both sutures, disclosing about ten or twelve minute dark seeds. These are separated when ripe, and dried.

Description.—Black, or, as they are sometimes termed, brown or red, mustard seeds are of a dark reddish brown or greyish brown colour, sometimes nearly black, and are

frequently partially covered with very thin whitish scales (dried mucilage from the epidermis, probably the result of damp). They are very small, being only about 1 mm. in diameter, and are nearly spherical or flattened-ovoid in shape. Under the lens the surface appears minutely pitted, and the hilum can be distinguished as a paler point.

Although the seeds are hard, the seed-coats are thin and brittle. The kernel is greenish yellow and oily, and consists of the two folded cotyledons embracing the small radicle. The position of cotyledons and radicle can be well seen by cutting a seed in halves midway between the hilum and the

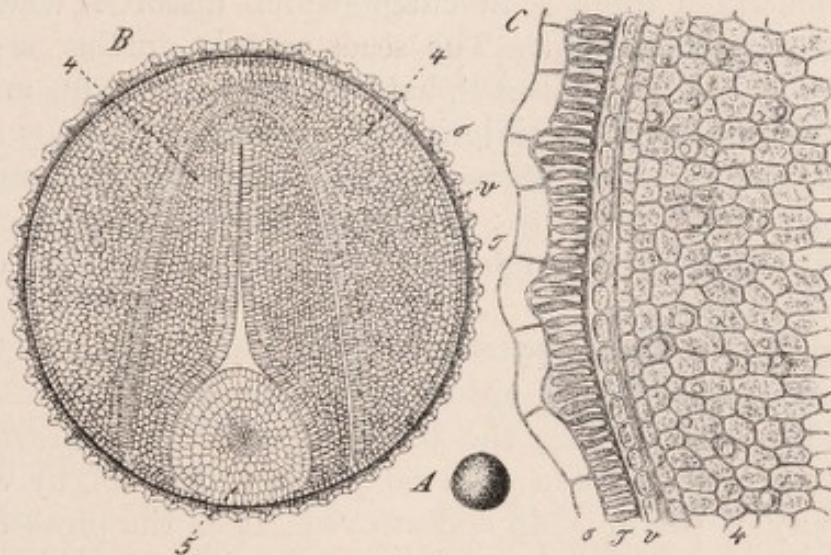


FIG. 93.—Black Mustard seed. *A*, entire seed, magnified 3 diam. *B*, transverse section, magnified 65 diam. : 4, 4, the two cotyledons; 5, the radicle. *C*, portion of the same, further enlarged : σ , epidermis containing mucilage. (Berg.)

apex. After the seed has been soaked in water, during which it surrounds itself with mucilage, the seed-coats can be easily removed, disclosing the cotyledons folded over and incumbent upon the radicle. No endosperm being present, the seeds are exalbuminous.

Black mustard seeds, even when powdered, have no marked odour. The taste is at first bitter, but rapidly becomes strongly pungent, and although the dry seeds are almost inodorous they develop, when moistened with water, a volatile substance of extreme pungency that rapidly attacks both the nostrils and the eyes. This volatile substance is not, however, developed if the seeds have been previously thrown into boiling water.

The student should observe

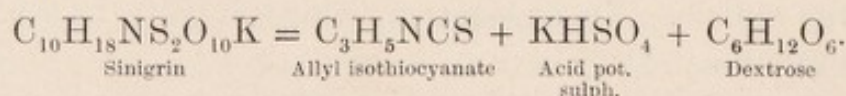
- (a) The *minute size and spherical shape*,
- (b) The *pitted surface*,
- (c) The *incumbent and folded cotyledons*,
- (d) The *pungent taste*;

and should compare these seeds with colchicum seeds, which are larger, rougher, and harder than black mustard, and have a bitter, not pungent, taste.

Constituents.—Black mustard seeds contain in the kernels about 27 per cent. of fixed oil, which can be extracted by crushing and pressing the seed. In the seed-coat (in the cells of the epidermis) there is mucilage, which dissolves when the seeds are soaked in water. The seeds contain, further, a small quantity of acid sinapine sulphate (compare p. 175), and in addition two substances, sinigrin and myrosin, which, by interaction in the presence of water, yield the volatile pungent body previously referred to; the latter is not a constituent of the seed, but is produced from two of its constituents under certain conditions.

Sinigrin (also called potassium myronate), $C_{10}H_{18}NS_2O_{10}K$, may be crystallised from either alcohol or water. It may be extracted by first boiling the powdered seeds (not previously defatted) for a short time with 80 per cent. alcohol, by which the activity of the myrosin is destroyed; from the pressed and dried seeds cold water then extracts the sinigrin, which may be obtained by evaporating the aqueous solution in the presence of barium carbonate, extracting with alcohol, concentrating and crystallising (yield about 0.6 per cent.).

Sinigrin, when submitted to the action of myrosin in aqueous solution, decomposes into allyl isothiocyanate, acid potassium sulphate, and dextrose:



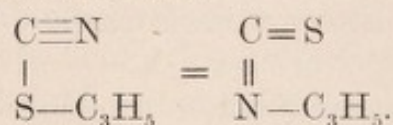
This reaction, however, does not take place in the seed, as the myrosin and sinigrin are stored up in separate cells.

Allyl isothiocyanate, or volatile oil of mustard, is a mobile volatile liquid with an extremely pungent taste and odour, and is the body to which the pungent taste and odour of black mustard seeds (after crushing and moistening with water) are

due. The power of the myrosin to effect this decomposition is destroyed by boiling water, and therefore the seeds that have been subjected to such treatment do not develop allyl isothiocyanate when treated with cold water.

The cake that is left after the fixed oil has been expressed from the seed contains both the sinigrin and the myrosin. From this cake volatile oil of mustard may be prepared by crushing it, macerating it in water for several hours, and distilling; a mobile liquid collects at the bottom of the distillate, and this, after redistillation, constitutes volatile oil of mustard. It consists of allyl isothiocyanate, associated with small quantities of other bodies such as allyl cyanide, C_3H_5CN , &c.

Allyl isothiocyanate can also be produced artificially by decomposing allyl iodide with potassium thiocyanate; allyl thiocyanate ($C_3H_5.S.C:N$) is formed, which on distillation is converted into the isomeric, pungent allyl isothiocyanate, $C_3H_5.N:C:S$ (allyl thiocarbimide)



The seeds yield about 0.7 to 1.3 per cent. of volatile oil, Dutch seeds being the best.

Many cruciferous plants, and some belonging to other natural orders, yield under similar conditions a pungent volatile oil, thus horseradish root yields allyl isothiocyanate; scurvy grass (*Cochlearia officinalis*, Linné), isobutyl isothiocyanate (C_4H_9NCS); radish (*Raphanus sativus*, Linné) and watercress (*Nasturtium officinale*, Linné), principally phenyl-ethyl isothiocyanate (C_8H_9NCS); and cress (*Lepidium sativum*, Linné), benzyl cyanide C_7H_7CN .

Black mustard seeds also contain about 29 per cent. of proteid matter and yield from 4.2 to 5.7 per cent. of ash. Starch, which is present in the unripe seed, is not found in any of the cells of the ripe seed.

Uses.—Applied externally, black mustard acts as a rubefacient and counter-irritant; this effect is followed by loss of sensibility in the part, and consequently relief from previous pain. Prolonged action may result in vesication. Internally, mustard is used as a condiment, and in full doses as an emetic.

WHITE MUSTARD SEEDS

(Semina Sinapis Albæ)

Source &c.—*Brassica alba*, Boissier (N.O. *Cruciferae*), the white mustard, is cultivated like the black mustard, which it closely resembles, but not to so large an extent. It differs from the black mustard in producing more or less horizontal hairy fruits, those of the black mustard being erect, appressed, and smooth. Each fruit contains from four to six seeds.

Description.—White mustard seeds are yellow in colour and nearly spherical in shape; they are distinctly larger than the black, measuring about 2 mm. in diameter. The seed-coat is very minutely pitted, the pits being so small that the seed appears smooth until examined with a lens. Internally the seed is yellow, and the oily kernel consists, as that of the black mustard seed does, of the two folded cotyledons embracing the small radicle; it becomes coated with mucilage when soaked in water, and can afterwards be easily deprived of its seed-coats.

White mustard seeds, either whole or powdered, are free from pungent odour, even when triturated with water. They have, nevertheless, a pungent taste.

The student should soak some white mustard seeds in water, remove the seed-coats, and observe the cotyledons and radicle, noting that the seed is exalbuminous; he should also crush the seeds, moisten them with water, and note that the taste is pungent, but the odour is not.

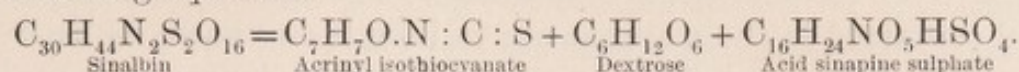
The student should observe

- (a) The *minutely pitted surface*,
- (b) The *incumbent, folded cotyledons*,
- (c) The *pungent taste*.

Constituents.—White mustard seeds contain a fixed oil (about 30 per cent.), mucilage (in the epidermis of the seed-coat), and proteids (about 25 per cent.). Starch is not present in the ripe seeds, which yield about 4 per cent. of ash.

They contain, in addition, a crystalline glucoside, sinalbin, and the same enzyme ferment as is found in the black mustard seed—viz. myrosin. Sinalbin is readily soluble in water and in boiling alcohol, but only very sparingly in cold alcohol; it

assumes an intense yellow colour when acted upon by alkalies. Under the influence of myrosin, and in the presence of water, it yields acid sinapine sulphate, dextrose, and acrinyl isothiocyanate. The decomposition may be represented by the following equation :



Of these three substances, acrinyl isothiocyanate is a yellow oily liquid with a pungent taste and powerful rubefacient action, but as it is not volatile it is destitute of pungent odour or pungent effect on the eyes. In this particular the pungent principle obtained from white mustard differs essentially from that yielded by black, and since this principle is not volatile, it is evident that volatile (or essential) oil of mustard can be obtained only from the black. It is very remarkable, considering the close relationship of the two plants and similarity in other constituents, that white mustard should contain no sinigrin and black no sinalbin.

Sinapine is an alkaloid which is so unstable that it has not yet been isolated ; the acid sulphate and other salts are crystalline and assume a bright yellow colour in contact with alkalies.

Black mustard is said to be frequently deficient in myrosin. White mustard seed contains myrosin in quantity sufficient to effect the decomposition not only of the sinalbin contained in it, but also of sinigrin added to it ; by mixing the powder of the two seeds the whole of the sinigrin is decomposed as well as all the sinalbin, and the maximum of pungency is ensured. Hence the official 'Mustard' is a mixture of both black and white mustard.

Uses.—White mustard possesses rubefacient and vesicant properties similar to those of black mustard.

LINSEED

(Flax Seed, *Semina Lini*)

Source &c.—The flax plant, *Linum usitatissimum*, Linné (N.O. *Linææ*), is a tall erect annual, spread by cultivation over all temperate and tropical regions. Not only has the plant been known and cultivated for so many centuries that its geographical origin cannot be identified, but the use of its fibre

can be traced back to the thirteenth or fourteenth century before the Christian era. Flax seeds, as well as cloth woven from flax, have been found in Egyptian tombs, and the process of weaving is depicted on their buildings. The seeds were used as a food; the medicinal use of the mucilage and the value of the oil contained in them appear not to have been known till later.

The flax plant bears a small globular capsular fruit containing ten seeds; these are separated when ripe. Holland, Russia, India, the United States, Canada, and Argentina furnish the principal supplies, the Dutch being the best.

Description.—The seeds are commonly dark brown in colour, smooth and shining. They are of an elongated ovoid outline

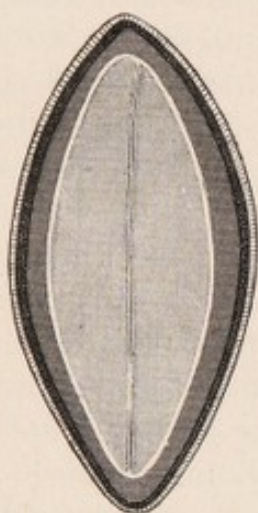


FIG. 94.—Linseed. Transverse section, showing the seed-coats, endosperm, and cotyledons. Magnified. (Moeller.)

and much compressed so that an acute edge is formed; in length they vary from 4 to 6 mm. One end of the flax seed is rounded, but the other has an oblique point, on one side of which, just below the apex, is a slight depression. In this depression both hilum and micropyle are situated, the seed being anatropous. The surface of the seed is glossy and appears smooth to the naked eye, but is seen under a lens to be minutely pitted.

Cut transversely and examined under a lens they exhibit a yellowish white oily kernel consisting of two large cotyledons surrounded by a narrow endosperm, the latter not being always distinctly visible. Soaked in water they become covered with mucilage, which gradually dissolves, the seeds at the same time losing their glossy appearance. They have but a slight odour, and an oily, mucilaginous taste.

Both in colour and size linseed exhibits notable variations according to its source. As a general rule, warm climates yield larger and paler seeds than cold climates.

The student should observe

- (a) The *glossy pitted surface*,
- (b) The *mucilage extracted by water*,
- (c) In the transverse section the *two oily cotyledons* and *narrow endosperm* (under a powerful lens).

Constituents.—Linseed contains from 30 to 40 per cent. of fixed oil, about three-fourths of which can be extracted by pressure. The epidermis of the seed-coat contains mucilage (6 per cent.), which, together with the proteids (25 per cent.) present in the seed and part of the oil, are left in the cake obtained when the seeds are pressed. The presence of oil, proteid, and carbohydrate (mucilage) in the cake renders it valuable as a cattle food. Unripe seeds contain numerous small starch grains, but the ripe seeds are free from starch.

The fixed oil (*Oleum Lini*, B.P.) consists chiefly of linolein, a mixture of the glyceryl esters of linolic, linolenic, and isolinolenic acids, the acids themselves being sometimes designated as linoleic acid; it also contains similar esters of oleic, stearic, palmitic, and myristic acids. On exposure to the air it slowly hardens to a varnish, a change due to the oxidation of the linolein. The oil is characterised by its high specific gravity (0.930 to 0.940) and high iodine value (not under 170).

The mucilage consists of a mixture of hexanes and pentanes corresponding to the formula $2(C_6H_{10}O_5), 2(C_5H_8O_4)$; it yields by hydrolysis the sugars galactose, dextrose, arabinose, and xylose.

The seeds are also said to contain a cyanogenetic glucoside, linamarin (compare p. 47).

Crushed linseed, *Linum contusum*, B.P., consists of the seeds reduced to a coarse powder without being deprived of any part of their constituents. It should, when mixed with water, have a bland, not pungent or rancid odour. Many cruciferous seeds, if present, would yield a pungent odour, whilst stale crushed linseed is usually rancid. It should yield not less than 30 per cent. of oil, indicating the absence of ground cake left after removal of part of the oil. It should not give the characteristic reactions with the tests for starch, nor leave, when incinerated, more than 5 per cent. of ash (absence of added starch and undue proportion of mineral matter). The presence of starch may be conveniently detected by microscopical examination or by applying the usual iodine test to a cooled decoction of the crushed linseed previously freed from oil by treatment with ether or carbon disulphide.

Uses.—Crushed linseed is used externally, in the form of a poultice, to convey heat and moisture to certain parts; the entire seeds are used to make a demulcent infusion containing a large quantity of mucilage.

COLA SEEDS

(Semina Colæ)

Source &c.—Cola seeds, sometimes called Cola or Kola nuts, Gooroo nuts, or Bissy nuts, are obtained from *Cola vera*, Schumann (N.O. *Sterculiaceæ*), a large and handsome tree resembling in habit the Spanish chestnut. It is a native of tropical Africa, growing wild in Sierra Leone, North Ashanti,



FIG. 95.—Bale of West African Cola nuts.

near the sources of the Niger River, &c., but is cultivated in other tropical countries, such as the West Indies, Brazil, Java, &c., our supplies being derived either from the west coast of Africa or from the West Indies.

The woody capsular fruit of the tree contains from five to fifteen large white or crimson seeds which are removed and deprived of their seed-coats, the kernels only being used. These are chewed whilst still fresh, either before or after germination, and have been highly

valued by the negroes for many centuries for their stimulating properties, in which they resemble tea, coffee, cocoa, &c.

Large quantities of the seeds are collected and consumed by the natives, who also carry on a considerable trade in them. Packed in baskets with the leaves of the cola tree they can be kept fresh, and in this state are brought chiefly from Lagos to Sokoto, Kano, and Timbuctoo, whence they are distributed to other parts of Africa. They are also occasionally exported in this state, but more commonly the kernels are separated

into the two large fleshy cotyledons and dried, during which the white or crimson colour changes to a dull reddish brown.

Description.—Dried cola seeds, as commonly seen in this country, consist of the kernels only of the seeds, sometimes entire, but more often separated into the two cotyledons. Externally, they have a dull dark brown or reddish brown colour; internally they are usually somewhat paler. They are hard and solid, and exhibit, when cut, a perfectly uniform section, no mucilage glands being observable. They vary in length from about 2 to 5 cm., and are rather less in breadth and in thickness. In shape, too, they exhibit considerable differences, being frequently flat on one side and curved on the other, or wedge-shaped or irregularly six-sided.

A shallow furrow encircles the kernel, dividing it into two cotyledons; transverse to this furrow at one end of the seed a distinct cleft may be found, partially separating each cotyledon into two portions. Complete kernels may easily be separated into their constituent cotyledons, and the small radicle will be found towards the bottom of this transverse cleft.

Fresh cola seeds have a bitterish astringent taste, which is scarcely perceptible in the dry seed; the latter are also destitute of any marked odour.

The student should observe

- (a) The *two large fleshy cotyledons* and *small radicle*,
- (b) The *absence of seed-coats*, the drug consisting of the *kernel only*.

Constituents.—The most important constituents of fresh kola seeds are caffeine (2 to 2.5 per cent.), kolatin (0.75 per cent.), and traces of theobromine. They also contain an oxydase ferment, together with fat, sugar, and abundance of starch.

Kolatin, $C_8H_8O_4$, is crystalline, slightly soluble in water, but readily in alcohol. During the drying of the seeds it is converted by the oxydase ferment into kola-red, a body allied to the phlobaphenes, which is therefore present in the dried drug to the exclusion of kolatin and imparts to it the characteristic colour. If, however, the seeds are boiled and the oxydase thus destroyed, the dried seeds retain the colour of the fresh and contain the kolatin. The fresh seeds may also be preserved by beating them into a pulp with an equal weight of loaf sugar.

Kolanin, a reputed constituent of the seeds, appears to be a mixture of kola-red and caffeine.

Uses.—Cola seeds have properties similar to those of tea, coffee, &c.; they are used as a nerve stimulant to prevent fatigue &c. Kolatin increases the energy of the cardiac contractions, and as this substance is not present in the commercial drug, it having been converted into kola-red, the therapeutical action of the dried seeds is somewhat different from that of the fresh; hence possibly the strong preference in Africa for the fresh seeds. The action of the dried *sterilised* seeds resembles that of the fresh.

Varieties.—Cola seeds were long supposed to be derived from *C. acuminata*, Schott and Endlicher, but this species has seeds with four cotyledons. It grows in the Cameroon and Congo States. The seeds are eaten like the genuine, and are sometimes imported, but they contain less caffeine and are less esteemed.

The seeds of a species of *Cola* named by M. Cornu *C. Ballayi*, sent from the Gaboon, have been offered as cola seeds; the seed has six cotyledons, and, as it contains very little caffeine, should be rejected.

Other seeds have from time to time been substituted for cola seeds, but the genuine are easily distinguished by the characters given.

COCOA SEEDS

(Semina Theobromatis)

Source &c.—The cocoa tree, *Theobroma Cacao*, Linné (N.O. *Sterculiaceæ*), is a native of tropical America, and is cultivated there as well as in other tropical countries, such as Java, Ceylon, the West Indies, &c.

The seeds had without doubt long been an important article of diet to the Mexicans when they were conquered by the Spaniards. Their use soon spread to Spain and thence over Europe.

The flowers of this tree are small, and spring directly from the trunk; they are succeeded by large orange or deep red fruits of the shape of a small pointed vegetable marrow and about 15 or 20 cm. in length. Each fruit contains forty

or fifty nearly colourless, fleshy seeds embedded in a scanty mucilaginous pulp. The seeds are separated and packed in boxes, in which they undergo a process of fermentation, considerable heat, which, however, should not be allowed to exceed about 42° C., being developed; they are then dried in the sun. During these processes the seeds acquire a reddish brown colour, and the taste, which at first is astringent and bitter, becomes mild and oily.

Sometimes the seeds are simply freed from the pulp and dried in the sun; they have then a more astringent and bitter taste and are less valuable.

Description.—Cocoa seeds, as they occur in commerce, are about 2.5 cm. in length and of a flattened-ovoid shape. The seed-coat is reddish brown or chocolate brown in colour, thin and brittle. It can easily be separated from the kernel, which consists mainly of two irregularly folded, chocolate-coloured cotyledons; the latter are so brittle that they easily separate into small angular fragments (cocoa nibs of commerce) which have a mild, agreeable oily taste.

Constituents.—Both the kernels and the shells contain the alkaloid theobromine, the former yielding as much as 2 per cent., the latter about 1 per cent. The kernels contain, further, about half their weight of solid fat, which is obtained as a by-product in the manufacture of cocoa essences and chocolate by submitting the heated seeds to strong pressure. It is official in the British Pharmacopœia under the name of *Oleum Theobromatis*.

Theobromine or dimethylxanthine, $C_5H_2(CH_3)_2N_4O_2$, has been obtained as a white crystalline powder very slightly soluble in cold water or alcohol, more readily in boiling. It sublimes at 290° C. and combines readily with alkalies and alkaline earths to form salts. By introduction of the methyl group it is converted into trimethylxanthine (caffeine).

Oleum Theobromatis is obtained as a by-product in the manufacture of cocoa and chocolate. It is a hard yellowish-white solid, melting at 31° C. to 34° C., consisting chiefly of the glycerides of stearic, (40 per cent.), palmitic, and oleic acids existing partly at least as mixed glycerides, *i.e.* glycerides in which two or more of these acids are combined with one glyceryl group.

Uses.—Cocoa is largely used as a more nutritious and less stimulating beverage than tea or coffee. Its principal active

constituent, theobromine, has an action similar to that of caffeine, but while its effect on the nervous system is less than that of caffeine its diuretic action is greater.

GUARANA

(Pasta Guarana)

Source &c.—The drug known as guarana is prepared from the seeds of *Paullinia Cupāna*, Humboldt, Bonpland, and Kunth (N.O. *Sapindaceæ*), an elegant climbing shrub indigenous to and common in Brazil, especially in the basins of the Amazon and its tributaries. It derives its name from the Guarinis, an aboriginal tribe of Indians. The difficulty of collecting the seeds from the wild plants, which though common are not easily accessible, has apparently led to their cultivation, the plants being trained to poles like hops. When the pods open to discharge the ripe seeds they are collected, and the seeds, which resemble small horse-chestnuts in shape and colour, are separated by shelling. They are first washed and then roasted to loosen them from a papery shell, from which they are freed by beating. The broken kernels are made into a dough with water; this is then divided into masses of varying size and shape, sometimes representing a fish or other animal, which are finally dried at a gentle heat by means of a slow fire. From the hard mass thus obtained portions are grated off with a large file and served in glasses of water, forming a refreshing drink.

Description.—Guarana commonly appears on the market in the form of extremely hard, heavy, sausage-shaped masses, varying from 10 to 30 cm. in length and from 2.5 to 4 cm. in thickness. The outer surface is dark chocolate brown in colour, and would be smooth and uniform were it not that small angular fragments, often of lighter colour than the rest, project slightly; these fragments are evidently the larger pieces of the broken seed. The fractured surface, smoothed with a knife, is reddish in colour, and exhibits, like the outer surface, small paler irregular fragments embedded in a darker reddish mass, but no definite structure is discernible. The powder, in which form the drug is administered, is of a pale red colour; it has a scarcely perceptible odour and slightly astringent bitter taste.

The student should observe

- (a) The extremely *hard heavy masses* in which the drug occurs,
- (b) The presence of *small, paler fragments* embedded in them.

Constituents.—Guarana contains from 2·5 to nearly 5 per cent. of caffeine, together with a little catechu-tannic acid. There is abundance of starch present also, but only a little fat.

Adulteration.—The detection of foreign substances in such a drug as guarana is attended with considerable difficulty. The amount of caffeine should not be less than 2·5 per cent. Microscopical examination has shown the presence of the seed-coats, which therefore are only imperfectly separated, and frequently of foreign starches; the latter, according to Schär (1897), are regularly present. Thoms (1894) found in guarana 8·63 per cent. of moisture, 1·68 per cent. of ash, and 2·68 per cent. of caffeine, the seeds themselves yielding closely concordant figures.

Uses.—Guarana is employed as a nervine stimulant in the same way that tea and coffee are, and produces similar effects. It has been long in common use in Brazil.

TONCO BEANS

(Semina Tonco)

Source &c.—Tonco or, as they are sometimes called, tonka or tonquin beans are the seeds of two species of *Dipteryx* (N.O. *Leguminosæ*), viz. *D. odorata*, Willdenow, and *D. oppositifolia*, Willdenow, both trees of considerable size, the former a native of Guiana, the latter of Brazil.

The tree produces an indehiscent drupaceous fruit about the size of an egg, with a fibrous pericarp containing a single brownish violet seed, about the size and shape of an almond; these are separated when ripe, and dried. Sometimes they are placed upon the market without further treatment, but large quantities are brought from South America to Trinidad, where they are prepared for the European and American markets. This preparation consists in steeping them in rum and spreading them on floors to a depth of about 25 cm., by which a

white crystalline crust is produced on the surface of the seeds; the latter may therefore occur 'black' or 'frosted'; when dry they are packed in cases or casks for shipment.

Description.—Tonco beans closely resemble a Jordan almond in size and shape; they are usually rather longer, varying from 3 to 4 cm. in length, and differ from the almond in having a very dark, nearly black, coarsely wrinkled surface which, in the frosted seeds, is covered with minute whitish crystals. The beans are rounded at one extremity, but terminate at the other in a broad flat point, just below which on the obtuse margin of the seed the micropyle may easily be discerned as a brownish scar. Internally they are dark yellow, yellowish brown, or nearly black, and consist of two large oily cotyledons, without endosperm, enclosing a plumule with two folded leaves and a short thick radicle.



FIG. 96.—Tonco bean.
Fruit cut vertically,
showing the seed.
(Planchon and Collin.)

Tonco beans have a powerful and agreeably fragrant odour and an aromatic pungent taste.

Constituents.—The seeds owe their fragrance to a crystalline substance, coumarin, of which they may contain as much as 3 per cent. It is this body that in the frosted seeds has been induced to crystallise on their surface and thus imparts to them their frosted appearance. It has been isolated from a variety of plants belonging not only to Leguminosæ, but several other natural orders, especially Gramineæ and Orchideæ. Cherry wood (*Prunus Mahaleb*, Linné), woodruff (*Asperula odorata*, Linné), and melilot (*Melilotus officinalis*, Desvaux) owe their pleasant aroma to coumarin.

Coumarin, coumaric or ortho-oxycinnamic anhydride, $C_6H_4(CH)_2OCO$, forms colourless, fragrant crystals melting at $67^{\circ}C$. It may be prepared synthetically by heating together salicylic anhydride, acetic anhydride, and anhydrous sodium acetate.

Varieties.—The chief varieties of tonco beans are the Angostura and the Pará, each of which may occur frosted

or black; the Angostura beans are the larger and more valuable.

Uses.—Tonco beans find their principal use in perfumery; they are frequently mixed with vanilla beans in the preparation of extract of vanilla.

CALABAR BEANS

(Semina *Physostigmatis*)

Source &c.—Calabar beans are the ripe seeds of *Physostigma venenosum*, Balfour (N.O. *Leguminosæ*), a woody climbing plant indigenous to the west coast of Africa, especially near the mouths of the Old Calabar and Niger rivers. It ascends trees and, drooping down, bears pendulous racemes of flowers. These are succeeded by legumes about 15 cm. in length, in each of which two or three large seeds are contained. Calabar beans have long been used on the west coast of Africa as 'ordeal' beans. They became known in England in 1840; their power of contracting the pupil of the eye was discovered by Fraser in 1862.

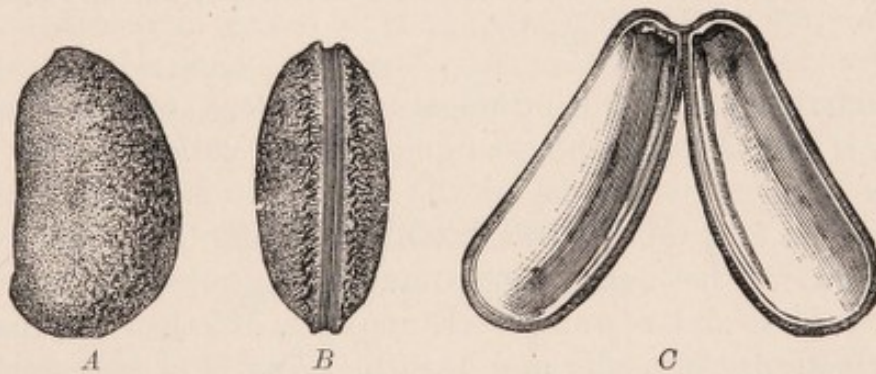


FIG. 97.—Calabar bean. A, side view, showing the sub-reniform shape. B, edge, showing the long hilum. C, seed split open, showing the concave cotyledons. (Maisch.)

Description.—Calabar beans are dark reddish brown or chocolate-brown in colour and of considerable size, averaging about 25 mm. in length and 12 mm. in thickness. They are usually oblong-reniform in shape, being nearly flat or only slightly convex on one side, but boldly curved on the other. Along nearly the entire length of the curved side, and passing completely round one end of the seed, runs a broad deep groove, the lips of which are thickened and paler in colour.

and the bottom of which is black and bears a distinct brown furrow in its centre. This deep groove is the hilum, and in it may frequently be found portions of a white papery funiculus; at one end a minute depression (the micropyle) can be detected.

The outer seed-coat (testa) is hard and thick, and appears nearly smooth to the naked eye, but under the lens is seen to be rather rough. After the seeds have been well soaked in water they can easily be split longitudinally, and exhibit then two firm white starchy cotyledons, which are curved so as to include between them a large lenticular cavity filled with air; this enables the seed to float when thrown on the surface of water. Near the micropyle is the small white radicle attached to one of the cotyledons; there is no endosperm.

The seeds have no marked odour or taste beyond those of an ordinary bean; they are nevertheless extremely poisonous.

The student should observe

- (a) The *reniform* (not cylindrical) *shape*, and the *hilum* *passing round one end of the seed*,
- (b) The *white cotyledons* and *small radicle* directed towards the micropyle.

Constituents.—The principal constituent of the Calabar bean is the alkaloid physostigmine (also called eserine from 'esere,' the native name of the bean); it is present in the cotyledons only and to the extent of about 0.2 (0.04 to 0.3) per cent. The bean also contains the alkaloids eseridine (Eber, 1888) and eseramine (Ehrenberg, 1894), a phytosterin (stigmasterin, Windaus and Hauth, 1906), and abundance of starch. Calabarine, which was formerly considered a constituent of the seed, is now believed to be non-existent. The drug yields about 4 per cent. of ash.

Physostigmine, $C_{15}H_{21}N_3O_2$, forms colourless rhombic crystals melting at $105^{\circ}C.$; the aqueous solution of its salts rapidly becomes pink, due to conversion of the physostigmine into rubreserine; it powerfully contracts the pupil of the eye.

Eseridine, $C_{15}H_{23}N_3O_3$, forms colourless crystals melting at $132^{\circ}C.$; when heated with dilute hydrochloric acid it is converted into physostigmine.

Eseramine crystallises in needles melting at $238^{\circ}C.$

Substitutes.—The only substitute bearing any resemblance to the Calabar bean is the seed of *P. cylindrospermum*, Holmes, which was imported in 1879. The seeds are, as the specific name of the plant indicates, nearly cylindrical (instead of subreniform), and the hilum is shorter; they are said to contain physostigmine. Other substitutes are the seeds of *Mucuna urens*, de Candolle (horse-eye beans), which are rounded and brownish in colour; of *Entada scandens*, Benthams (garbee beans), which are flattened, disc-like, and about 5 cm. in diameter; and of *Pentaclethra macrophylla*, Benthams, which are 7 cm. long and 5 cm. wide, and resemble a mussel in shape. They are all easily distinguished from Calabar beans.



FIG. 98.—Seed of *Physostigma cylindrospermum*, showing the shorter hilum. (Maisch.)

Uses.—Calabar beans are chiefly used as a source of the alkaloid physostigmine, which is much employed to produce contraction of the pupil of the eye. Both the drug and the alkaloid have been employed in tetanus, locomotor ataxy, and as an antidote in cases of strychnine poisoning; large doses produce an increase of blood-pressure, retardation of respiration, and finally death by asphyxia.

FENUGREEK SEEDS

(Semina Fœni-græci)

Source &c.—Fenugreek, *Trigonella Fœnum-græcum*, Linné (N.O. *Leguminosæ*), is an annual herb indigenous to the countries bordering on the eastern shores of the Mediterranean and largely cultivated in India, Egypt, and Morocco. It was well known to the ancients, who used the herb as cattle fodder and employed the seeds medicinally. Even the modern Egyptians roast and eat the seeds, whilst in India the young shoots form a favourite vegetable. In England the seeds are chiefly used in veterinary practice. They are contained in long, narrow, sickle-shaped pods, from which they are separated, when ripe, by thrashing. Our supplies are derived chiefly from Mogadore and Bombay.

Description.—Fenugreek seeds are small and hard, and although they vary somewhat in colour they are usually brownish yellow. The average length of well-developed seeds is about 5 mm., and they are about half as wide as they are long. They are flattened and have a very characteristic rhomboidal outline. Nearly in the centre of one of the long

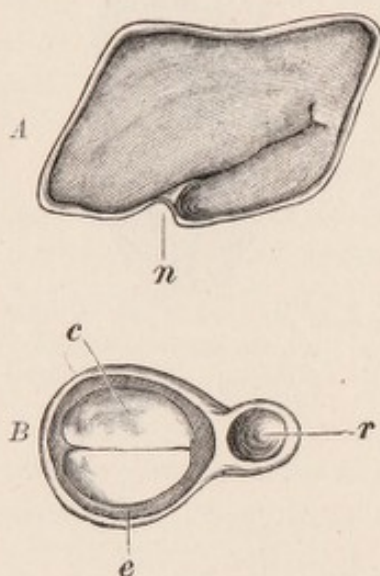


FIG. 99.—Fenugreek seed. A, vertical section, showing the radicle, one of the cotyledons, and hilum, *n*. B, transverse section, showing the radicle, *r*; both cotyledons, *c*; and endosperm, *e*. Magnified. (Moeller.)

narrow sides is a small depression in which both hilum and micropyle are situated, the former being distinctly visible as a whitish point; this depression is continued in the form of a furrow running diagonally across part of each of the adjoining sides, thus dividing the seed into two unequal lobes. If the seed is cut in a direction transverse to the side in which the hilum lies, so as to pass through both lobes of the seed (fig. 99, B), it will be found that the larger lobe contains two accumbent cotyledons—the smaller, the radicle; both are yellowish in colour and surrounded by a darker, horny translucent endosperm, which also separates the radicle from the cotyledons. Soaked in water the endosperm swells and yields mucilage to the surrounding liquid. Entire seeds macerated in warm

water burst their seed-coats by the swelling of the mucilage, and disclose the structure of the seed. (Compare fig. 99, A.)

The odour of fenugreek, especially if powdered, is strong and characteristic; the taste is disagreeable.

The student should observe

- (a) The characteristic *shape*,
- (b) The *cotyledons*, *radicle*, and *endosperm* (in transverse section),
- (c) The characteristic *odour*.

Constituents.—Fenugreek contains 28 per cent. of mucilage, which resides in the endosperm, not, as in the case of mustard and linseed, in the seed-coats. It contains, further, about 22 per cent. of proteids, 6 per cent. of fixed oil, and two

alkaloids, trigonelline and choline, the latter being a frequent constituent of both animal and vegetable substances.

Uses.—The seeds are now used in veterinary medicine and occasionally as a spice in curry powders.

SWEET ALMONDS

(*Amygdala Dulcis*)

Source &c.—The sweet almond is the seed of the sweet almond tree, *Prunus Amygdalus*, Stokes, var. *dulcis*, Baillon (N.O. *Rosaceæ*). The tree is a native probably of Persia and Asia Minor, but is cultivated in all the countries that border on the Mediterranean, and produces ripe fruit even in the south of England. The seeds—almonds—as well as the oil pressed from them, were well known in Greece and Italy long before the Christian era; during the middle ages they became an important article of commerce in Central Europe.

The almond tree produces in early spring handsome pink flowers, which are succeeded by green, velvety, drupaceous fruits about the size of a plum, but differing from it in possessing a firm, felt-like mesocarp. As the fruit ripens the mesocarp gradually dries, splits, and falls away (or is easily removed), carrying the thin epicarp with it, and leaving the seed, enclosed in the endocarp or shell, attached to the tree. Sometimes almonds are exported enclosed in their endocarps (almonds in the shell), but more frequently the shells are broken and the seeds alone exported.

Sicily and southern Italy are the chief almond-producing countries. Spain, Portugal, the south of France, the Balearic Islands, and Morocco also export considerable quantities.

Description.—The endocarp or shell of the almond is yellowish buff in colour and flattened-ovoid in shape, the outer

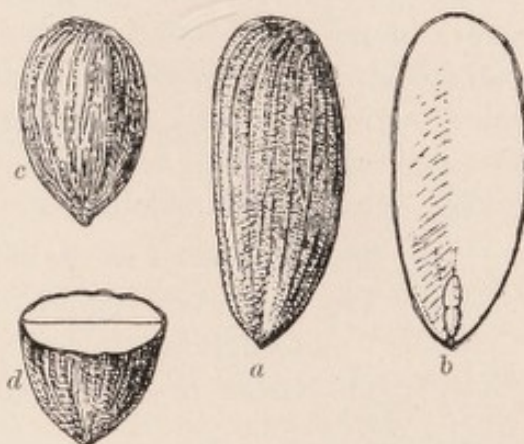


FIG. 100.—Almond. *a*, Sweet Almond; *b*, same, cut longitudinally. *c*, Bitter Almond; *d*, same, cut transversely. Natural size. (Holmes.)

surface being usually pitted with small holes; frequently it has a more or less fibrous nature. Sometimes it is thin and friable (soft-shell almonds), sometimes extremely hard and woody (hard-shell almonds). The seed is rounded at one end, pointed at the other, and covered with a thin, brown, scurfy seed-coat. The hilum is long, and situated on the acute edge of the seed near the pointed end; the raphé is distinguishable as a dark line running from the hilum to the broad end of the seed, where it terminates in a dark spot, the chalaza, from which a number of veins radiate.

After maceration in water the thin seed-coat is easily separated; the kernel consists of two, large plano-convex, oily cotyledons, enclosing a small plumule and radicle. The seed is exalbuminous, there being no endosperm. Sweet almonds have a bland nutty taste, and yield, when triturated with water, a white emulsion destitute of any marked odour. The latter character is important, as it is the only definite one by which the sweet almond can be readily distinguished from the bitter.

The student should observe

- (a) The *elongated shape* (of the Jordan almond),
- (b) The *thin seed-coats* and *two cotyledons without endosperm*,
- (c) The *bland taste and odour* (of the emulsion).

Constituents.—Sweet almonds contain about half their weight of a bland fixed oil, which can be obtained by pressing the seeds, and about 20 per cent. of proteids, amongst which is included an enzyme ferment, emulsin.

Emulsin may be isolated by infusing powdered blanched sweet almonds in water, straining, acidulating with glacial acetic acid, filtering, and precipitating with four volumes of alcohol. It is a mixture of ferments, containing lactase, gentiobase, and often invertin, and is capable of hydrolysing a large number of (lævo-rotatory) glucosides.

Almond oil is pressed both from the sweet and the bitter almond. It consists chiefly of olein accompanied by a small proportion of linolein &c.; it is characterised by its specific gravity (0.915 to 0.920), by the quantity of iodine it is capable of combining with (95 to 100 per cent.), by the melting-point of the mixed fat acids obtainable from it (not over 15° C.), and by the whitish colour when shaken with fuming nitric acid diluted with an equal volume of water. Drying oils such as cotton seed, &c., combine with larger proportions

of iodine; sesame, ground nut, and certain other oils yield fat acids, melting at a much higher temperature. Apricot kernel oil gives a reddish colour with nitric acid.

Varieties.—*Jordan* (French 'jardin') almonds, exported from Malaga, constitute the official variety; they are characterised by their narrow, elongated shape and thin skin.

Valencia: these are broadly ovoid, shorter, and have a thicker, dusty brown, scurfy coat.

Sicilian and *Barbary*: both of these closely resemble the Valencia, but are rather smaller; they occasionally contain admixtures of bitter almonds.

Uses.—Sweet almonds are demulcent and nutritive. They are used as a non-starchy food for diabetic patients.

BITTER ALMONDS

(*Amygdala Amara*)

Source &c.—The bitter almond tree (*Prunus Amygdalus*, Stokes, var. *amara*, Baillon) is indistinguishable from the sweet by any permanent botanical character, and enjoys the same geographical distribution, although it is not cultivated to so large an extent. It is remarkable therefore that the seeds should invariably contain a constituent—amygdalin—that is never present in the seed of the sweet almond tree. The poisonous properties of the water distilled from the bitter almond (and the cherry-laurel leaf), due to the presence and subsequent decomposition of the amygdalin, have long been known; it was the discovery of hydrocyanic acid in it that led to the recognition of the poisonous nature of this acid, which, curiously enough, had up to then (1802) escaped observation.

Bitter almonds are imported chiefly from northern Africa, from Sicily, and from the south of France.

Description.—In form and appearance bitter almonds closely resemble Valencia almonds, but they are usually smaller and less regular. They have, however, a bitter taste, and yield with water an emulsion easily distinguished from that of the sweet almond by its characteristic odour.

Constituents.—Bitter almonds resemble the sweet in containing both a bland fixed oil and proteids, the former of which is obtained by crushing the almonds between horizontal, grooved

rollers and pressing in powerful, hydraulic presses. But they differ essentially from the sweet in containing a colourless crystalline glucoside, amygdalin, of which the sweet are entirely destitute. This substance is left in the cake obtained after the oil has been expressed, and can be extracted from it by digestion with alcohol. It has a bitter taste and is odourless, but when an aqueous solution is mixed with an emulsion of sweet almonds a characteristic odour due to the presence of hydrocyanic acid and benzaldehyde is rapidly developed. These substances are produced by a decomposition of the amygdalin that may be represented by the following equation :



This change is effected by the emulsin contained in the sweet almond. The same ferment is also contained in the bitter almond itself, but, being localised in particular cells of the seed, is unable to act upon the amygdalin until the seeds are crushed and water added. When therefore bitter almonds (or the cake left after the oil has been expressed) are crushed and mixed with water, the characteristic odours of benzaldehyde and hydrocyanic acid are developed. If, after standing a few hours, the mixture is subjected to distillation, an oily liquid of strong bitter-almond odour is obtained, together with a quantity of watery distillate ; the oil is volatile or essential oil of bitter almonds, and consists of benzaldehyde and hydrocyanic acid, partly in the free state and partly combined as benzaldehyde-cyanhydrin. It is, of course, extremely poisonous, on account of the hydrocyanic acid it contains. From this it can be freed by shaking it with milk of lime ; all the hydrocyanic acid, both free and combined, forms calcium cyanide. The addition of ferrous sulphate then converts the cyanide into calcium ferrocyanide, and the oil can be obtained free from hydrocyanic acid by redistilling in a current of steam. No benzaldehyde or hydrocyanic acid is developed by the sweet almond, because it contains no amygdalin.

Bitter almonds yield from 0.5 to 0.8 per cent. of volatile oil and about 0.25 per cent. of hydrocyanic acid.

Many other Rosaceous plants contain amygdalin, such as the peach, apricot, plum, &c., not only in the seed, but also in the young shoots and flower-buds.

Amygdalin is closely allied to, but not identical with, prunlaurasin, and is also distinct from a similar glucoside that occurs in the bark of *Prunus serötina*, Ehrhart (compare also p. 46).

Benzaldehyde is also prepared from benzyl chloride, $C_6H_5 \cdot CH_2Cl$, or benzal chloride, $C_6H_5 \cdot CHCl_2$, and sold as oil of bitter almonds; it has a less pleasant odour than that obtained from bitter almonds.

Uses.—Bitter almonds are sedative, but as the poisonous hydrocyanic acid yielded by them varies in quantity they are unreliable. They are also employed for flavouring, but they should for a similar reason be used with caution.

Substitutes.—Apricot kernels contain constituents similar to those of the bitter almond. They are imported in large quantities from Syria and California and are often used by confectioners in the place of bitter almonds. The fixed oil expressed from them is commonly sold as 'Oleum Amygdalæ Persicum' or 'peach kernel oil.' From the cake an essential oil is distilled as from bitter almond cake.

STROPHANTHUS SEEDS

(Semina Strophanthi)

Source &c.—The official strophanthus seeds are obtained from *Strophanthus Kombé*, Oliver (N.O. *Apocynaceæ*), a climbing plant of considerable size, indigenous to eastern tropical Africa, near the Nyanza and Tanganyika lakes, the Shiré river, &c. An extract prepared from them (and possibly from the seeds of other species of strophanthus) is used in Africa as an arrow poison. Specimens of this extract were sent to England in 1861-64 and recognised by Sharpey (1862) as a cardiac poison. The seeds were examined by Fraser (1885), who isolated the active principle strophanthin, and subsequently recommended the seeds as a substitute for foxglove leaves.

The fruit of the plant consists of two follicles about 30 cm. in length and 2.5 cm. in breadth, slightly narrowed at the base and tapering at the apex. Each follicle contains, closely packed together, a large number of seeds provided with long awns. The fruits are collected when ripe, and are sometimes exported after having been freed from their epicarp and fleshy mesocarp. More commonly the seeds, separated from the fruits

and deprived of their awns, are sent into commerce, being exported chiefly from Somba, Quilimane, Inhambane, Chinde, and other East African ports.

Description.—These very beautiful seeds are remarkable for the long plumose awn of white silky hairs that is attached to them. The integuments of the seed are prolonged at the apex to a slender brittle extension, which is terminated by a handsome feathery tuft of hairs about 5 cm. long and the same in breadth, the entire seed measuring about 10 cm. in length; these awns are commonly removed before the seeds are exported. The seeds as seen in commerce measure from 12 to 20 mm. in length and about 5 mm. in breadth. They are of an elongated oval shape, acuminate towards the apex, and narrowed towards the base, which is obtuse. They are flattened and provided on one side with a ridge running from the centre to the apex of the seed, and terminating in a broken point left by the removal of the awn. In colour they vary from greyish green to fawn; they are covered with satiny appressed hairs that impart to them a conspicuous sheen.

The seeds break easily; the transverse section exhibits a white oily kernel consisting of two straight cotyledons surrounded by a narrow endosperm. Moistened with concentrated (or 80 per cent.) sulphuric acid the section assumes at least in the endosperm, but sometimes in the cotyledons, a deep emerald green colour. The same reaction is afforded by the kernels from which the seed-coats have been removed after soaking in water. The seed-coats thus separated, warmed on a slide with a little saturated solution of chloral hydrate and examined under the microscope, are seen to be free from crystals of calcium oxalate. The odour of the crushed seed is characteristic, though not very powerful; the taste is intensely bitter.

The student should observe

- (a) The colour of the seed and the satiny hairs,
- (b) The straight cotyledons and narrow endosperm,
- (c) The green reaction with sulphuric acid.

Constituents.—The active constituent of strophanthus seeds is the glucoside strophanthin, of which they contain from 8 to 10 per cent. This substance, which is the source of the green reaction with sulphuric acid, is present in the endosperm, and frequently also in the cotyledons.

The seeds contain, in addition, about 30 per cent. of fixed oil, together with kombic acid, choline, and trigonelline. They yield about 4 per cent. of ash on incineration.

Strophanthin, $C_{40}H_{66}O_{19}$, forms colourless, intensely bitter, very hygroscopic crystals freely soluble in water and dilute alcohol, sparingly soluble in absolute alcohol, and almost insoluble in ether or chloroform. Warmed with a dilute mineral acid it is hydrolysed into strophanthidin and a sugar (strophanthobiosemethylether). Strophanthidin is also crystalline, but almost insoluble in water, and separates in crystalline form when strophanthin is hydrolysed.

It must, however, be observed that commercial strophanthin has been shown to vary considerably in toxicity, and that the strophanthin prepared by different chemists from (as far as can be ascertained) the same variety of seed, viz. *S. Kombé*, have shown differences in the melting-point, in the hydrolysis, in the products yielded by the hydrolysis, and in other respects, so that they appeared to be different substances. It must, therefore, be admitted that the chemistry of this body has not yet been sufficiently investigated.

Assay.—The chemical methods that have been proposed for the assay of strophanthus seed depend upon the extraction of the glucoside, and conversion into strophanthidin which is weighed and from which the strophanthin present is calculated. They are, however, all unsatisfactory. The drug may be standardised by the bio-chemical method which consists in determining the quantity of tincture which, after dilution with an equal volume of water, will kill a normal frog of about 25 gm. weight within an hour when injected into the dorsal lymph sac. The amount required has been designated a 'unit.' The seeds or their preparations may be compared in activity by determining experimentally the quantity that represents a unit.

Uses.—The action of strophanthus seed, which is due to the strophanthin they contain, resembles that of foxglove leaves. It raises the blood-pressure, is an efficient diuretic, and a powerful cardiac poison. It is not cumulative, and less liable than foxglove to produce gastro-intestinal irritation; hence is sometimes substituted for foxglove when this remedy has failed or disagreed.

Varieties.—The official strophanthus seed often occurs in commerce mixed with or replaced by the seeds of other species

of *Strophanthus* which resemble them more or less closely. The following are the most important.

S. hispidus, de Candolle. The seeds of this species are exported from West Africa; they are smaller than the official, although similar in shape, are brownish in colour, bear scattered hairs, and give with sulphuric acid a green reaction. They contain strophanthin (h-strophanthin; see below).

S. Courmontii, Sacleux. This is an East African species; the seeds usually have a brownish tinge, but often closely resemble the official, from which, however, they may be distinguished by their rather smaller size, lanceolate shape, less bitter taste, red reaction with sulphuric acid, and abundant calcium oxalate crystals in the seed-coat. The active constituent is unknown.

S. Nicholsoni, Holmes. The seeds of this species are whitish and woolly, the hairs project beyond the apex of the seed, and the reaction with sulphuric acid is red; they have been exported from Natal. The active constituent is unknown.

S. gratus, Franchet. The seeds are brown and glabrous; they give a red reaction with sulphuric acid, and contain the glucoside ouabain, which was first isolated from the wood of *Acokanthera Schimperi*, Oliver, and is much more toxic than strophanthin. For this glucoside the distinctive name of 'g-strophanthin' has been proposed (Thoms, 1900); its use has been advocated as a substitute for the official drug, as the seeds are readily obtainable and easily recognised.

S. Emini, Aschers. The seeds are greyish green, but they contain cluster crystals of calcium oxalate, and give a red reaction with sulphuric acid. They contain the glucoside e-strophanthin (Thoms), which is distinct from the strophanthin of Kombé seed (k-strophanthin) and also from that of the seed of *S. hispidus* (h-strophanthin).

QUINCE SEEDS

(Semina Cydoniæ)

Source &c.—The quince is the fruit of *Pyrus Cydonia*, Linné (N.O. *Rosaceæ*), a small tree indigenous to Persia, but distributed by cultivation throughout central Europe and other warm countries. They are imported chiefly from Cape Colony.

The fruit, which resembles a pear, contains five carpellary cavities, in each of which there are about twenty seeds closely packed in two vertical rows. These seeds are separated from the ripe fruit and dried; being coated with mucilage they adhere more or less firmly together.

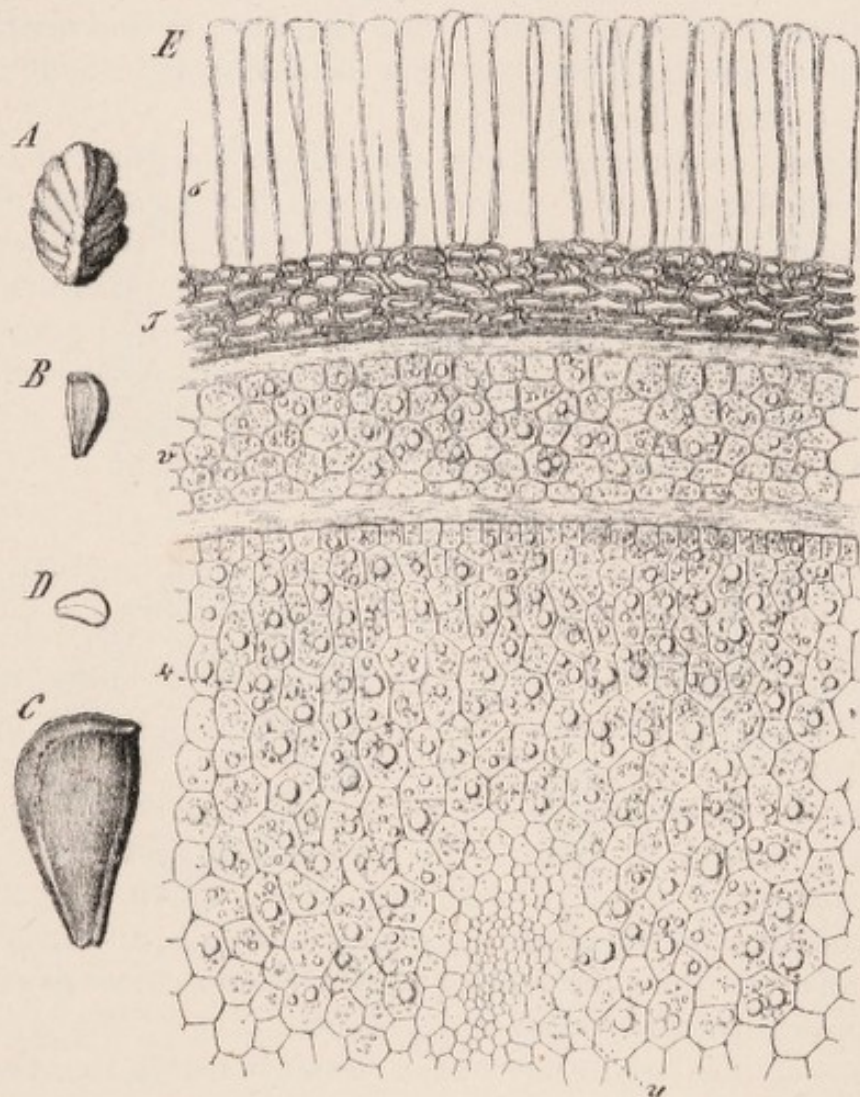


FIG. 101.—Quince seed. *A*, the seeds cemented together by mucilage, natural size. *B*, a single seed, natural size. *C*, the same, softened in water and magnified 3 diam. *D*, transverse section of *B*. *E*, portion of the same, magnified 190 diam.: σ , the epidermis, in which the mucilage is secreted; *v*, endosperm. (Berg.)

Description.—Quince seeds bear a general resemblance to apple pips. They are of about the same size, and of a similar mahogany-brown colour. By the mutual pressure to which they are subjected in the fruit, quince seeds, however, are distinctly flattened on the two larger sides, whilst of the two

narrow sides or edges one is obtuse and boldly arched, the other only slightly curved and often provided with a distinct acute ridge. They frequently adhere firmly to one another in small irregular masses or in two more or less regular rows, being cemented together by dry mucilage, which is visible in the form of whitish flakes on the surface of the seeds and in the interstices between them. This mucilage is derived from the cells of the epidermis of the seed-coat in which it is stored. (Compare fig. 101, *E*.)

The seeds are pointed at one end, where the hilum may be distinguished as a minute paler spot, and obtuse at the other (the chalazal extremity). Transverse sections through the seed, which is rather hard, exhibit two firm yellowish white cotyledons with a very narrow endosperm. The kernel possesses a taste resembling that of bitter almonds, but much fainter. The seed-coats, when chewed, are simply mucilaginous.

The student should observe

- (a) The *angular shape of the seed*,
- (b) The *dry mucilage* which cements them together,
- (c) The *taste of the kernel and seed-coats*.

Constituents.—The principal constituent of quince seeds is the mucilage, of which they are said to yield as much as 20 per cent. It is contained in the cells of the outer epidermis of the seed-coat, and swells and dissolves when the seeds are soaked in water. The seeds also contain about 15 per cent. of fixed oil and probably a small proportion of amygdalin and of emulsin (or a ferment allied to it), since they evolve an odour resembling that of bitter almonds when they are crushed and mixed with water.

Use.—Quince seeds have been employed as a demulcent, but are not now much used in this country.

NUX VOMICA

(Semina Strychni, Nux Vomica)

Source &c.—The nux vomica tree, *Strychnos Nux-vomica*, Linné (N.O. *Loganiaceæ*), is a small tree indigenous to India, where it is widely distributed, and occurring also in Ceylon, Siam, and northern Australia. Notwithstanding the wide dis-

tribution of the tree, and the poisonous properties of the seeds, the Hindoos appear to have been unaware of its medicinal action. It was introduced into Europe in the sixteenth century, but was not much used in medicine, being chiefly employed to poison dogs, cats, crows, &c.

The ovary of the flower is two-celled, with numerous ovules in each cell, but the ripe fruit, which resembles an orange, is one-celled and contains usually from three to five

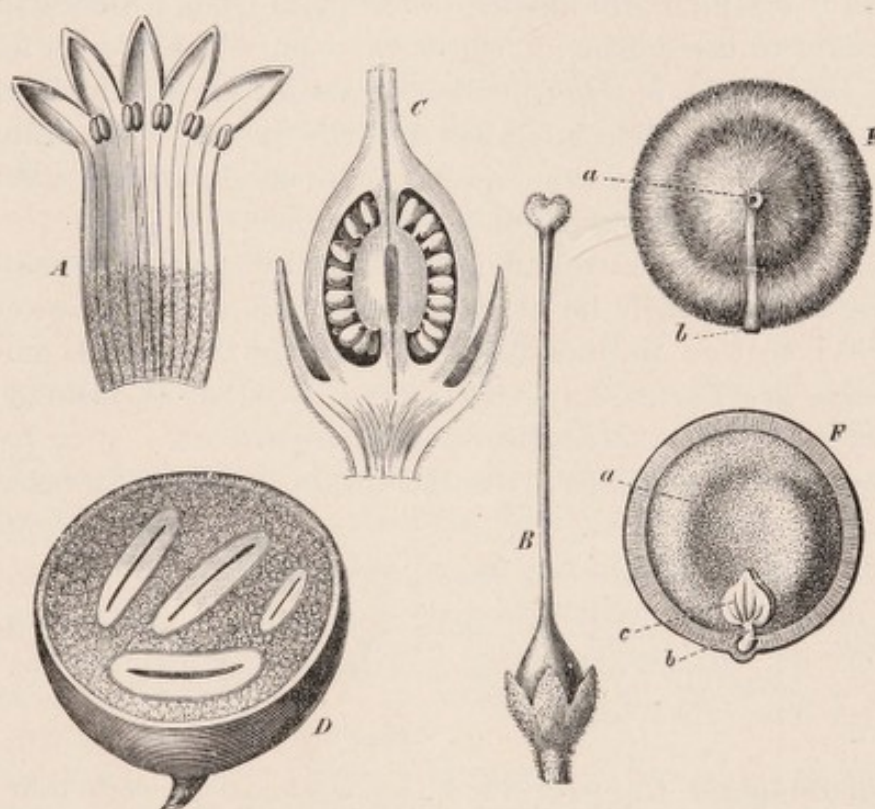


FIG. 102.—*Nux Vomica*. A, corolla opened, magnified. B, ovary with style, magnified. C, ovary cut longitudinally, more highly magnified. D, ripe fruit, cut transversely, showing seeds; reduced to about one-half. E, seed entire, natural size: *a*, hilum; *b*, micropyle. F, the same, cut vertically: *a*, endosperm; *b*, radicle; *c*, plumule. (Luerssen.)

seeds embedded in a bitter whitish pulp, which is, in part at least, derived from the dissepiment between the two cells. The seeds are washed free from adhering pulp, dried in the sun and sorted. They are collected extensively in the Eastern Ghat Mountains and in the Travancore Hills, and are exported from various Indian ports (Madras, Bombay, Cochin, Coconada, &c.).

Description.—The seeds have the shape of small discs, 20 to 25 mm. in diameter and about 4 mm. thick, of an ash-grey

or greenish grey colour, and possessing a distinct sheen. They are usually not quite flat, being a little depressed on one side and arched on the other, or sometimes irregularly bent so as to be less conspicuously disc-shaped. They are covered with numerous closely appressed hairs, radiating from the centre to the circumference, to which the satiny sheen of the seeds is due. The edge of the seed is sometimes rounded, sometimes acute, according to the variety; at one point on the margin there is a distinct prominence (micropyle) from which a raised line passes to the centre of the seed. This line does not exist in the fresh seed, but makes its appearance during the drying; it has frequently been mistaken for the raphé. The hilum is in the centre of either the raised or depressed surface, and may be recognised by the scar left by the funicle.

The dry seed is hard and horny, but by soaking in water it softens, and can then be conveniently examined; it can easily be split into two thinner discs exhibiting the small embryo consisting of a radicle and two leafy cotyledons embedded in a copious grey, translucent, horny endosperm.

The seeds are almost odourless, but have an intense and persistently bitter taste.

The student should not fail to observe

- (a) The *characteristic shape and satiny appressed hairs*,
- (b) The *horny endosperm and small embryo*,
- (c) The *bitter taste*.

Microscopical Characters.—The seed-coat is very thin and consists of a narrow layer of brown collapsed parenchyma covered with an epidermis, the cells of which have developed into hairs. These are bent near the base and thus lie close to the surface of the seed. The base is thick-walled and marked with oblique pits; above it passes into a tubular hair bearing longitudinal rod-like thickenings. The endosperm consists of large cells with very thick walls which swell in boiling water or in solution of potassium hydroxide. These cells contain the alkaloids.

In powdered nux vomica the hairs are broken up into the thick-walled bases and rod-like fragments of the upper part.

Constituents.—The principal constituents of nux vomica are the two alkaloids, strychnine and brucine, in addition to which they contain a small percentage of a glucoside, loganin, which is much more abundant in the pulp, and an acid that has been

termed igasuric acid, but is probably identical with caffeotannic acid. The alkaloid strychnine which occurs in the leaves may also occur in minute quantity in the commercial drug (Boorsma, 1902).

The cell-wall of the endosperm, which is very thick, appears to consist of galactan and mannan, the former preponderating; it yields by hydrolysis galactose and mannose.

The seeds contain, further, about 3 per cent. of fatty and waxy matter which appears to reside chiefly in the hairs. A trace of copper is also invariably present, and passes into solution when the seeds are exhausted with alcohol, giving rise to the often observed green reaction when the diluted tincture is mixed with ammonia.

The proportion of total alkaloid varies from 1.84 to 5.3 per cent., averaging in seeds of good quality about 2.8 per cent. This total alkaloid contains a variable proportion, ranging from 35 to 50 per cent. of strychnine, the average amount of strychnine in the drug being 1.23 per cent., and of brucine 1.55 per cent. As the toxicity of brucine is only one-eighth that of strychnine, the drug and its preparations are assayed for strychnine and not for the total alkaloid present.

Strychnine, $C_{21}H_{22}N_2O_2$, crystallises in colourless, odourless prisms melting at 265° C. and having an intensely bitter taste, though very slightly soluble in water (1 in 7,000). The hydrochloride crystallises in needles which are soluble in water, but less soluble in water acidulated with hydrochloric acid.

Brucine, $C_{23}H_{26}N_2O_4 \cdot 4H_2O$, is also crystalline and more soluble in water than strychnine (1 in 320); melting-point 178° C.

Assay.—Mix 20 gm. of the seeds in fine powder with 200 c.c. of a mixture of 137.5 vols. of ether, 44 of chloroform, 15 of absolute alcohol, and 5 of ammonia; shake frequently during an hour and set aside for 12 hours. Decant 100 c.c. into a separator and carefully shake out first with 15 c.c. and afterwards with successive quantities of 5 c.c. of normal sulphuric acid until exhausted. To the mixed acid solutions add excess of ammonia and shake out with 25, 15, and 15 c.c. of chloroform. Evaporate the chloroform solution nearly to dryness, add 2 c.c. of amyl alcohol, dry and weigh, the weight is that of the total alkaloid in 10 gm. of the seeds. To determine the strychnine dissolve the alkaloid residue in 15 c.c. of 3 per cent. sulphuric acid by warming on a water-bath; adjust the temperature to 50° C., add 3 c.c. of a mixture of equal volumes of nitric acid (sp. gr. 1.42) and water, set aside for ten minutes. Make strongly

alkaline with solution of potassium (or sodium) hydroxide, shake out with chloroform, evaporate to dryness, adding a little amyl alcohol towards the end, dry at 100° C. and weigh.

Action and Uses.—*Nux vomica* is largely used as a bitter stomachic and tonic, its action being practically identical with although slower than that of the alkaloid strychnine. It stimulates the muscular coat of the intestine, increasing peristalsis, and hence is given in constipation from an atonic condition of the intestine. It increases the blood pressure, and is therefore valuable in certain cases of cardiac failure. In large doses the excitability of the motor nerve cells is so much increased that violent convulsions may occur; these involve the respiratory muscles, and death ensues from asphyxiation.

IGNATIUS BEANS

(*Semina Ignatii*)

Source &c.—Ignatius beans are the seeds of *Strychnos Ignatii*, Bergius (N.O. *Loganiaceæ*), a stout climbing plant with woody stem, indigenous to the southern Philippine Islands. It became known to Europeans through a Jesuit, Father Camellus, towards the end of the seventeenth century, and the seeds were called *Fabæ Sancti Ignatii*, in honour of Ignatius Loyola, the founder of the order. The large ovoid or nearly globose fruit contains about twelve seeds embedded in a pulp, from which they are separated and dried. When fresh they are covered with whitish satiny hairs, resembling those of the *nux vomica*; these, however, are very easily rubbed off, and in the commercial drug are mostly lost, together with much of the thin seed-coats.

Description.—Ignatius beans are of a dull dark grey colour, and vary considerably in shape. In general they have an irregularly ovoid outline, and measure about 25 mm. in length and rather less in breadth and thickness. Frequently there is one large curved side and three or four smaller flattish surfaces with rounded angles, but some seeds are irregularly sub-angular. Here and there are patches of the dull ash-grey seed-coat, which under a lens is seen to be covered with appressed hairs, but these, unlike the hairs of *nux vomica*, are not so regularly

arranged and are destitute of any satiny sheen. Usually, however, the seed-coat, which is very thin, has been removed by the friction of the seeds against one another, and the surface presented to view is that of the dark translucent horny endosperm. The hilum is generally distinguishable with ease at one extremity of the seed.

To facilitate the examination of the seeds it is desirable to soak them in warm water until they are thoroughly softened.



FIG. 103.—Ignatius Beans. Natural size. (Bentley and Trimen.)

The large endosperm can then be divided into two portions, enclosing between them a cavity in which lies the embryo with its small radicle and leafy cotyledons. The seeds are inodorous, but have an extremely bitter taste.

The student should observe

- (a) The *irregular shape*,
- (b) The *dark endosperm* with *patches of seed-coat*.

Constituents.—Ignatius beans contain strychnine and brucine to about the same extent as *nux vomica*, viz. 2.5 to 3 per cent. of total alkaloid, of which from 46 to 62 per cent. is strychnine.

Uses.—The drug possesses a medicinal action similar to that of *nux vomica*, over which it has no evident superiority.

STRAMONIUM SEEDS

(Thornapple Seeds, *Semina Stramonii*)

Source &c.—The leaves of the thornapple, *Datura Stramonium*, Linné (N.O. *Solanaceæ*), have already been described (p. 57), and the attention of the student has been directed to the white flower and spiny fruit. The latter is, when ripe, about the size of a walnut, and dehisces septifragally, the four

walls separating from apex to base. The fruit is two-celled in its upper part, but, from the presence of spurious dissepiments, four-celled near the base. It contains a large number of seeds, which are collected when ripe.

Description.—Stramonium seeds are of a dull dark brown or, more commonly, nearly black colour, flattened and distinctly reniform in outline, averaging about 3 mm. in length. The hilum is distinct in the form of a light spot on the concave edge. The seed-coat is marked with distinct, but not sharp, reticulate depressions, and under a lens the whole surface of the seed, both depressions and ridges, is seen to be minutely pitted.

If the seed is split parallel to one of the flattened sides, the crook-shaped embryo may be distinguished embedded in



FIG. 104.—Thornapple seed. A, showing the pitted surface; B, longitudinal section, showing curved embryo. Magnified. (B, after Moeller.)

an oily endosperm; in transverse section the embryo appears rounded, and will, owing to its curved shape, be cut at two, or possibly three, different points.

The odour of the seeds is scarcely perceptible until they are crushed, then it becomes rather disagreeable; the taste is bitterish and oily.

The student should observe

- (a) The *size, reniform outline, and dark colour,*
- (b) The *reticulated and pitted surface,*
- (c) The *curved embryo embedded in an oily endosperm.*

Constituents.—In 1833, two years after the discovery of atropine, Geiger and Hesse extracted from stramonium seeds an alkaloid to which they gave the name of daturine. *Planta*

proved this alkaloid to be atropine, and Schmidt subsequently showed that these seeds contain the alkaloid hyoscyamine, associated with a small proportion of atropine and scopolamine (hyoscine). Farr and Wright found English grown seed to yield from 0.16 to 0.28 (average 0.22) per cent. of alkaloid, but as much as 0.5 per cent. has been recorded. In addition, the seeds contain from 15 to 30 per cent. of fixed oil containing daturic and other acids. The drug yields about 2 per cent. of ash.

Uses.—In this respect stramonium seeds resemble stramonium leaves. An extract of the seeds is given in spasmodic affections of the respiratory organs.

HENBANE SEEDS

(Semina Hyoscyami)

Source &c.—The henbane plant, *Hyoscyamus niger*, Linné (N.O. *Solanaceæ*), has been already alluded to (p. 60). The fruit of the plant is a small two-celled capsule, which dehisces transversely, the upper part separating from the lower like the lid of a box (pyxis). Within the fruit is a large number of minute seeds; these, separated when ripe, form the commercial drug.

Description.—Henbane seeds are of a dark grey colour and very small size, averaging barely 1.5 mm. in length. In shape they are flattened and obscurely reniform, being slightly pointed at one extremity (the hilum). Under a strong lens the surface, which appears dull to the naked eye, is seen to be marked with very characteristic reticulations. Cut longitudinally, parallel to the flat surface, the seed exhibits a coiled embryo embedded in an oily endosperm.

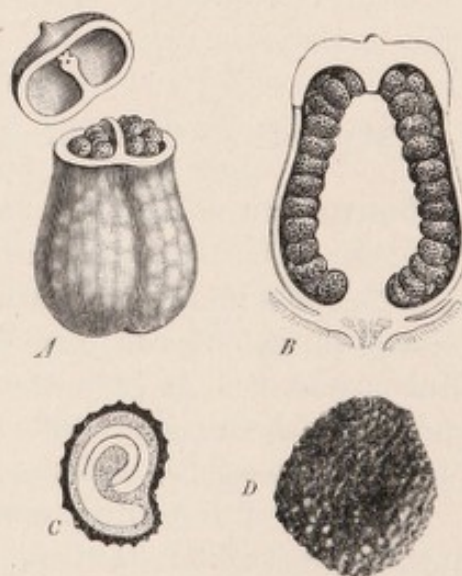


FIG. 105.—Henbane seed. A, entire fruit, showing dehiscence. B, the same, cut vertically. C, seed, cut longitudinally. (Luerssen.) D, seed, showing reticulated surface. Magnified.

The seeds have no odour and only a slightly bitter taste. The student should carefully observe

- (a) The *small size and flattened sub-reniform shape*,
- (b) The *reticulate surface* ;

and should compare them with

- (i) *Poppy seeds*, which are distinctly reniform, and have larger and shallower reticulations on the surface,
- (ii) *Thornapple seeds*, which are much larger and darker.

Constituents.—The principal constituent of henbane seed is the alkaloid hyoscyamine with which is associated a small proportion of scopolamine (hyoscine).

The total amount of alkaloid is 0.058 per cent. (Ransom, 1891). In addition, the seed contains about 20 per cent. of fixed oil.

Uses.—Henbane seeds are comparatively seldom used in medicine. Thrown upon hot coals they form a domestic remedy for toothache, the vapour that arises being allowed to enter the mouth. They have been used as a source of the alkaloid scopolamine.

NUTMEGS

(*Myristicæ Semina*, *Myristicæ*, *Nux Moschata*)

Source &c.—The nutmeg tree, *Myristica fragrans*, Van Houtte (N.O. *Myristicaceæ*), is indigenous to the Molucca Islands and a few neighbouring islands, as well as north-western New Guinea, but has been introduced into Penang, Sumatra, Malacca, as well as Java, the West Indies, and Ceylon, nutmegs and mace being exported from the Malay Archipelago, the Straits Settlements, and the West Indies.

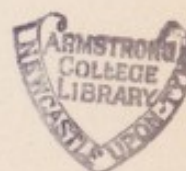
The use of the spice was introduced into Europe probably during the twelfth century. The Banda Islands, where they were produced, were discovered about 1506, and passed into the possession of the Portuguese, and finally of the Dutch, who, in this case as in that of cloves and cinnamon, made every endeavour to restrict the cultivation of the trees to the islands of Banda and Amboyna, and thus create a profitable monopoly. The nutmeg trees of adjacent islands were destroyed, and the nutmegs themselves soaked in a mixture of slaked lime and

water to render them, it was said, incapable of germination, a precaution that was quite unnecessary, as the vitality of the seed was destroyed by the simple process of drying. For some time these efforts were successful, and the nutmeg trade remained in the hands of the Dutch; but eventually the trees were successfully introduced into Malacca, Ceylon, and Jamaica.

The fruit is a fleshy drupe resembling a small peach in size and shape. As it ripens the fleshy pericarp splits longitudinally and discloses a crimson, lobed arillus surrounding a brown seed (fig. 106). The fruits are collected, the pericarps removed, and the crimson arillus (mace) stripped off and dried, during which the crimson colour changes to a reddish yellow.

The seeds are then carefully dried, a process that requires several weeks. When quite dry the kernel rattles in the thin, brittle, brown shell. The latter is broken and the kernel removed. They are frequently dusted over with slaked lime, or washed in milk of lime and dried, before they are exported; this protects them from the attacks of insects, to which they are otherwise very liable. Very probably the original 'liming' of nutmegs was intended to protect them from insects and not to destroy the vitality of the seeds, as has been often assumed (Tschirch, 1898). They are usually imported in cases which, on arrival in this country, are opened and the contents bulked. The nutmegs are then thrown on to a coarse iron riddle, the broken and otherwise damaged picked out and the sound ones sorted according to their size which is indicated by the number (65, 80, 110, &c.) required to make up a pound weight. Some of these are sold without further treatment, but many are limed (or re-limed), limed nutmegs being preferred in Holland and in the United States. The damaged nutmegs are sold for the production of the volatile and expressed oil.

Description.—Nutmegs are broadly ovoid in shape and about 2.5 cm. in length; they are usually of a greyish brown colour and marked with shallow reticulate furrows. The hilum lies in a little circular depression surrounded by a raised ring, and from it the raphé can usually be traced in a furrow extending to the chalaza at the apex. When examined with a powerful lens the surface is seen to be very finely pitted and marked with minute reddish points and larger dark reddish



brown lines and irregularly elongated spots. The nutmeg, which is easily cut, has a waxy consistence, and exhibits in the interior dark reddish brown wavy lines alternating with pale brownish or greyish interspaces, in a manner resembling the areca nut. The greater portion of the nutmeg consists of the



FIG. 106.—Nutmeg. *A*, fruiting branch of *Myristica fragrans*, showing fruit dehiscing. *B*, stamens of staminate flower; magnified. *C*, pistillate flower cut longitudinally; *p*, perianth; *g*, ovary; magnified. *D*, Nutmeg surrounded by the arillus (mace). *E*, the same cut longitudinally, showing the embryo, *e*. (Luerssen.)

ruminated albumen, the ruminations being produced by the infolding of part of the perisperm and deposition in its cells of dark colouring matter. These infoldings occur near the fibro-vascular bundles, and produce the depressed lines on the surface of the nutmeg corresponding to the branching bundles.

The cut surface easily yields oil when indented with the nail. The odour is strong and aromatic, the taste aromatic and bitterish.

Constituents.—The chief constituents of nutmegs are volatile oil (8 to 15 per cent.) and solid fat (about 40 per cent.); they contain in addition as reserve material amyloextrin, a substance intermediate between starch and dextrin.

The volatile oil (sp. gr. 0.865 to 0.920; O.R. + 14° to + 28°) consists chiefly of terpenes together with myristicin, $C_{12}H_{14}O_3$, which possesses an intense odour of mace and passes over in the last portions of the distillate.

Expressed oil of nutmeg is an orange yellow, very aromatic solid, melting at about 45° C., obtained from imperfect or broken nutmegs by hot pressure; it contains about 6 per cent. of the volatile oil together with the glycerides of myristic, palmitic, and oleic acids.

Amyloextrin occurs in granules of irregular shape which are coloured reddish brown by iodine (distinction from starch); it can be obtained in a crystalline form, and appears to be an intermediate product between starch and maltose (or dextrose).

Varieties.—*Penang nutmegs* are broadly ovoid and very aromatic.

Singapore nutmegs are more deeply and minutely wrinkled and frequently show marks of scorching.

West Indian nutmegs are somewhat elongated and frequently have dark marks on them.

All the above varieties may, however, be of small size, shrivelled, or otherwise defective.

Substitutes.—Of the other species of *Myristica* yielding seeds resembling nutmegs, only one, viz. *M. argentea*, Warburg, the Macassar or Papua nutmeg, yields an aromatic seed; this is, however, longer, narrower, and less aromatic than the official; it has, moreover, a distinctly acrid taste.

Bombay nutmegs (*M. malabarica*, Lamarck) are also long and narrow, but are destitute of aroma.

Factitious nutmegs, made from exhausted or damaged nutmegs mixed with mineral matter (clay) and pressed into moulds, have several times been detected; they yield from 11 to 18 per cent. of ash, whereas genuine nutmegs do not afford over 4 per cent.; they also yield less volatile oil (1.76 per cent.), and the section is not regularly reticulated.

Uses.—Nutmegs have stimulant and carminative properties; in large doses they are toxic, producing convulsions. The expressed and volatile oils have been used externally in chronic rheumatism.

MACE

Mace is the dried arillus of the nutmeg. It has its origin in a thickening of the funiculus extending to the outer integument of the seed near the exostome; it is therefore intermediate in nature between an arillus and arillode. As it develops and surrounds the seed it divides into branching lobes which approach one another near the apex of the seed. It is carefully separated from the seed and dried, and then forms flattened lobed pieces about 25 mm. or rather more in length, somewhat less in breadth, and about 1 mm. thick. When soaked in water and restored to its original form, it is seen to be cup-shaped. It is of a dull reddish colour, translucent and brittle. The strong and fragrant odour and aromatic taste resemble those of nutmeg.

Mace contains from 4 to 15 per cent. of volatile oil which appears to be identical in all essential particulars with that obtained from the nutmeg.

Varieties.—*Bombay mace* (*M. malabarica*), considerable quantities of which are imported, is in longer, narrower pieces of dark red colour, dividing into numerous narrow lobes which are twisted together at the apex. It is devoid of aroma and valueless as a spice. The powder can be distinguished from that of genuine mace by the large amount of substances yielded to ether after exhaustion with petroleum spirit (30 per cent., as against 3.5 from genuine mace).

Macassar or *Papua mace* (*M. argentea*) is in dull, brownish fragments with a dusty surface; the lobes are few, broad and widely separated, ultimately uniting to a compact cap; the taste is distinctly acrid.

CASTOR SEEDS

(Castor-oil Seeds, *Semina Ricini*)

Source &c.—The castor-oil plant, *Ricinus communis*, Linné (N.O. *Euphorbiaceæ*), is a native of *India*, but is diffused now over all tropical and subtropical countries. In *India* it may attain a height of 40 metres and be a perennial tree, but in cooler climates it is either a shrub or an annual herb. The plant, and with it the seed, is subject to much variation, the larger, arborescent forms yielding large seeds, the small, annual varieties small seeds.

The oil pressed from the seeds was well known to the Egyptians, Greeks, and Romans, and employed both as a medicine and illuminant, as well as for various technical purposes. It was used in Europe during the early middle ages, but subsequently fell into disuse, being reintroduced from the West Indies towards the end of the last century. The supplies of seeds came then chiefly from Jamaica, but the exports from India increased with great rapidity. The market is now chiefly supplied from India and South America, but considerable quantities of the seed are raised in other countries, as, for instance, in Italy.

The fruit of the plant is a three-celled, three-seeded, thorny capsule. These are collected when ripe; as they dry, they open and discharge the seeds.

Description.—Castor seeds are oblong in outline, somewhat flattened, and vary from about 8 to 15 mm. in length. The seed-coat is quite smooth and glossy, and varies in colour from a greyish brown to a beautiful grey marbled with reddish brown or black spots and stripes. The dorsal surface is arched, the ventral nearly flat; at one extremity is a prominent, usually pale caruncle, from which

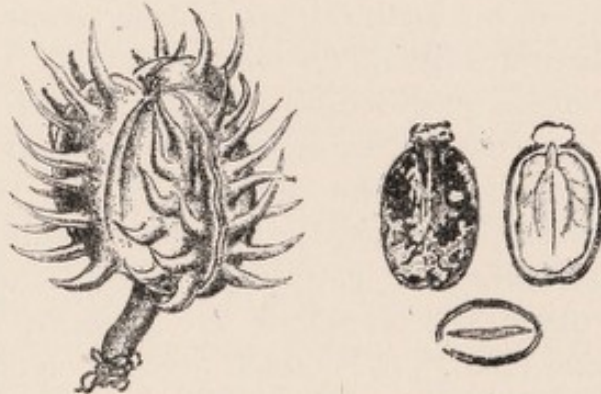


FIG. 107.—Fruit and seed of *Ricinus communis*.
Natural size. (Bentley and Trimen.)

a distinct line (raphe) runs along the ventral surface to the other extremity of the seed, where it terminates in a raised point (chalaza), branches and disappears. The caruncle can be easily removed, disclosing a dark spot (hilum) beneath.

The seed-coat is thin and brittle. The marbled outer layer, which, especially after soaking in water, can easily be scraped off, is succeeded by a hard dark layer. Within is the kernel, consisting of a large yellowish white oily endosperm enclosing a small embryo with two papery cotyledons, which can readily be seen if the kernel is split parallel to one of its larger surfaces. Surrounding the kernel is a delicate silvery white membrane.

Castor seeds have an almost imperceptible odour and very slightly acrid taste.

The student should observe

- (a) The *glossy, mottled seed-coat*,
- (b) The *small caruncle*,
- (c) The *oily endosperm* and *papery cotyledons*;

and compare the seeds with croton seeds, which have a uniform dull brown surface.

Constituents.—The most important medicinal constituent of castor seed is the fixed oil. It exists in the seed to the extent of about 50 per cent., and may be obtained by pressing the unshelled or shelled seed without heat ('cold drawn castor oil'). Much is thus produced in Italy, Marseilles, London, Hull, Belgium, &c. Considerable quantities are also produced in India and elsewhere by pressing the seeds between hot plates, or by boiling the crushed seeds and skimming off the oil, but such oil has a dark colour and disagreeable odour, and is unsuitable for medicinal use. Castor oil consists chiefly of the glycerides of ricinoleic, isoricinoleic acid, dihydroxystearic, and other acids. It owes its purgative action in all probability to the ricinoleic acid. It is characterised by its specific gravity (0.958 to 0.966), solubility in alcohol (1 in 3.5), insolubility in petroleum spirit, which, however, disappears if other vegetable oils are present, and by its high acetyl value (150). It is much used for dyeing, tanning, lubricating, and illuminating, as well as medicinally.

The cake left after the expression of the seeds contains ricinine (Tuson, 1864), a crystalline principle melting at 201.5° C., but present in small quantity only (about 0.2 per cent.), and ricin (Stillmark, 1889), a toxin similar in nature to the bacterial toxins. Ricin is extremely poisonous, 0.002 of a milligramme per kilo. being fatal to rabbits. It is capable of producing an anti-toxin (antiricin) in the body, and it is interesting to note that Ehrlich's researches on this property led to the preparation of antidiphtheritic and other sera (Müller, 1899). Ricin is probably identical with Bubnow and Dixon's ricinone (Finnemore and Deane, 1905); its activity is destroyed by heating to 100° C.

Both castor seeds and the cake left after the expression of the oil act as violent purgatives, a property probably due to the ricin contained in them.

Use.—The oil expressed from the seeds is valuable as a simple purgative, at once rapid and certain, mild and painless. On account of their violent action the seeds themselves are never employed in this country, though in some countries they are said to be a favourite purgative.

CROTON SEEDS

(Semina Crotonis)

Source &c.—Croton seeds are the seeds of *Croton Tiglium*, Linné (N.O. *Euphorbiaceæ*), a small tree indigenous to and cultivated in India. They were used medicinally in the seventeenth century, but fell into disuse owing probably to the violence and uncertainty of their action. The oil was introduced from India about 1819, and was found to be in certain cases a valuable cathartic.

The tree produces a three-celled, three-seeded capsular fruit resembling that of the castor plant, but devoid of spines. The seeds are exported, and the oil pressed from them in this country.

Description.—Croton seeds are of a dull cinnamon-brown colour and oblong outline; they are about 12 mm. in length, and resemble castor seeds in size and shape, though they are rather more angular in transverse section, the ventral and dorsal surfaces being separated by a prominent line. The caruncle which the seed possesses is easily detached, and is therefore seldom to be found in the drug; the hilum is less distinct than in castor seed, and from it the raphe runs along the ventral surface of the seed, terminating in a dark chalaza at the opposite extremity. The outer dull brownish layer is easily removed, disclosing a hard dark coat; in many commercial specimens the friction of seeds against one another has been sufficient to partially effect this, giving the seeds a mottled appearance instead of the uniform brown colour natural to them.

The kernel of the seed is yellowish and oily, and consists of a large endosperm enclosing papery cotyledons and a small radicle.

The taste of the kernel, in ascertaining which great caution is necessary, is at first oily, but this is succeeded by an unpleasant acidity; the seeds have no marked odour.

The student should compare these seeds with castor seeds and observe

- (a) The *dull brownish outer layer*,
- (b) The *prominent line* separating the ventral from the dorsal surface.

Constituents.—Croton seeds contain rather more than half their weight of fixed oil, which is obtained from them by pressure. This oil possesses violent cathartic and vesicant properties, which are due to a resinous constituent, croton-resin (Dunstan, 1895). It is soluble in less than its own volume of absolute alcohol, but on further addition of alcohol two layers are formed, the active constituent of the oil being contained in the alcoholic layer. The solubility appears to depend on the proportion of free acid present and to increase with the age of the oil.

The seeds also contain toxic albumoses resembling ricin; they remain in the press-cake left after the expression of the fixed oil.

Uses.—Croton oil is a powerful irritant, producing, when applied to the skin, a burning sensation and redness, followed by severe pustules; it is used, diluted, as a counter-irritant. Internally it is a very rapid drastic cathartic, and is given in certain cases of apoplexy.

GRAINS OF PARADISE

(Guinea Grains, Grana Paradisi)

Source &c.—Grains of paradise are the seeds of *Amomum Melegueta*, Roscoe (N.O. *Scitamineæ*), a herb attaining about 1.5 metres in height, indigenous to the west coast of Africa. These seeds were much esteemed as a spice in the twelfth and thirteenth centuries; the country from which they were derived being unknown, they were called 'grains of paradise.' At that time they were imported from Tripoli, whither they had made the land journey from West Africa. Subsequently they were brought direct from the west coast of Africa to Portugal by Portuguese traders. They are now imported from West Africa.

The plant produces an ovoid pointed fruit about 10 cm. long, containing a large number of small seeds.

Description.—Grains of paradise are small, hard, shining seeds of a rich reddish brown colour. They vary much in shape but are frequently sub-pyramidal with rounded or obtuse angles, and average about 3 mm. in length; the surface is seen under a lens to be minutely but distinctly papillose. Attached to one extremity of the seed are usually the paler fibrous remains of the funiculus, which project in the form of a beak. Cut transversely near the hilum, they exhibit a copious white starchy perisperm surrounding a yellowish horny endosperm in which a minute paler embryo is embedded. The longitudinal section also exhibits the perisperm, endosperm, and embryo, the radicle of the latter being directed towards the funiculus. The crushed seeds have a faintly aromatic odour, but the taste is intensely pungent, rivalling that of capsicum fruit.



FIG. 108.—Grain of Paradise.
(Magnified.)

The student should observe

- (a) The *rich, reddish brown colour*,
- (b) The *papillose surface*,
- (c) The *large projecting funiculus*,
- (d) The *pungent taste*;

and should compare them with cardamom seeds (see page 165).

Constituents.—Grains of paradise contain a little (0·3 per cent.) volatile oil and a yellowish pungent oily body, paradol. To the latter the intensely pungent taste of the seeds is due; Thresh considers it capable of crystallising, but prevented from doing so by the presence of a trace of impurity.

Uses.—The seeds possess stimulant properties, and were formerly employed as a condiment; now they are chiefly used in veterinary medicine.

COLCHICUM SEEDS

(Semina Colchici)

Source &c.—The meadow saffron, *Colchicum autumnale*, Linné (N.O. *Liliaceæ*), is widely distributed over Europe, and abundant in some parts of England in moist meadows and pastures.

The plant produces in the autumn a conspicuous reddish purple flower that springs from the side of an enlarged contracted stem (corm) several centimetres below the surface of the ground. The ovary, which is superior, lies also at about the same depth in the ground. The leaves appear soon after the flower, and attain in the spring a length of 20 or 25 cm. The ovary is then raised to the surface by the elongation of the peduncle, after which the leaves wither. The fruit, a three-celled capsule, ripens in the summer, dehiscing septicidally and disclosing numerous seeds which, when quite fresh, are pale in colour, but darken as they dry, becoming at the same time covered with a saccharine exudation. These were introduced into medicine about 1820 to replace the corm, which was considered uncertain in action.

Description.—*Colchicum* seeds as met with in commerce are small, very hard seeds of a dull dark reddish brown colour. They are about 2.5 mm. in diameter and nearly spherical, the remains of a thick funiculus rendering them somewhat pointed. Under a lens the surface is seen to be rough from the presence of minute pits. They are extremely hard and tough, and are difficult to cut until they have been soaked in water; the section exhibits a yellowish oily endosperm, in which, near the margin and removed from the hilum, the minute embryo is embedded. They are odourless, but have an unpleasantly bitter taste.

The student should observe

- (a) The rough surface and hard nature of the seed,
- (b) The remains of the thick funiculus;

and should compare them with

- (i) *Black mustard seeds*, which are much smaller,
- (ii) *Henbane seeds*, which are reniform in outline.

Constituents.—All parts of the plant contain an alkaloid, colchicine, which has been obtained in the form of an amor-



FIG. 109.—*Colchicum autumnale*. A, flowering plant, much reduced. B, lower part of the same, natural size. C, corm, cut vertically: *k*, corm; *k'*, young corm for the next year; *k''*, bud destined to reproduce the plant after *k'* has developed. D, portion of the same, showing *h*, the leaves enveloping the corm. E, upper part of perianth, halved. F, ovary, *o*, with the three styles. G, ovary, magnified. H, fruit. J, the same, cut transversely, showing the seeds. K, seed, magnified. L, the same, cut to show the embryo. (Luerssen.)

phous pale yellow substance possessing weak basic properties. From 0.02 to 0.8 per cent. has been found, but a good sample of the drug should yield not less than 0.5 per cent. The seeds also contain a resin, colchicoresin, and about 6 per cent. of fixed oil. They yield about 3 per cent. of ash.

Colchicine, $C_{22}H_{25}NO_6$, although not crystallisable, yields a crystalline compound, $C_{22}H_{25}NO_6 \cdot 2CHCl_3$, with chloroform. The alkaloid is very soluble in cold water, alcohol, and chloroform, but only slightly in ether. Chloroform removes it from an acid as well as from an alkaline aqueous solution; boiled with dilute mineral acids it yields colchicine and methyl alcohol.

Assay.—To 10 gm. of the seeds in fine powder add 120 c.c. of a mixture of ether 77 vols., chloroform 25 vols., absolute alcohol 8 vols., and solution of ammonia 3 vols. Shake frequently during 12 hours. Filter 60 c.c. through wool into a small flask and distil off the solvent. Dissolve the residue in 10 c.c. of ether, add 5 c.c. of water and 1 gm. of hard paraffin. Distil off the ether, heat the residue on a water-bath, shake well and heat until the paraffin has separated. Cool. Pour off the aqueous solution and filter into a separator, washing the cake of wax once with hot water. Shake out first with 15 c.c. and afterwards with 10 c.c. of chloroform until exhausted. Distil the chloroformic solution to dryness, dissolve the residue in water, boil gently, dry and weigh. The weight is that of the total alkaloid in 5 gm. of the seeds.

Uses.—Colchicum is chiefly used to relieve the pain and inflammation and shorten the duration of acute gout and certain gouty affections. Its action depends upon the alkaloid colchicine. Colchicine has a marked action upon plain muscle, especially that of the intestine, producing diarrhoea and vomiting. In large doses it produces death from failure of the respiration.

Adulteration.—Colchicum seeds are said to be liable to adulteration by the fraudulent addition of glucose.

CEVADILLA SEEDS

(Sabadilla Seeds, Semina Cevadillæ)

Source &c.—Cevadilla seeds are the ripe seeds of *Schæno-caulon officinale*, Asa Gray (N.O. *Liliaceæ*), a tall herbaceous plant growing on the lower mountain slopes near the eastern coast of Mexico, in Guatemala, and in Venezuela. At the time

of the Spanish conquest the drug was known to the American Indians as a caustic application to wounds; it came into use in Europe much later as a parasiticide. The seeds are now chiefly used as the source of the official veratrine.

The plant produces a tall raceme of yellowish flowers, succeeded by small three-celled capsular fruits; as the fruit ripens it separates septicidally into three follicles, which dehisce by their ventral sutures. Each follicle contains from one to six seeds. Formerly the dried fruits were imported, but now chiefly the seeds freed from the thin, brown, papery pericarps.

Description. — Cevadilla seeds are long narrow seeds of a glossy dark brown or nearly black colour and averaging about 6 mm. in length. Towards one extremity they taper gradually to an acute point; at the opposite extremity they are more obtuse, and there both hilum and micropyle are situated, though they are not easily seen. From mutual pressure in the fruits there is usually on one side a longitudinal depression with acute edges; for a similar reason the seeds are slightly curved. The surface of the seed is seen under a lens to be finely wrinkled. The minute embryo can be detected by cutting a transverse section near the obtuse end of the seed; it is embedded in a comparatively large dark oily endosperm.

The seeds are inodorous, but have an unpleasant bitter and acrid taste; the powder produces violent sneezing.

The student should observe

- (a) The *dark colour*,
- (b) The *long narrow shape* with *acute angles*,
- (c) The *acrid taste*.



FIG. 110. — Cevadilla seed. *a*, flower, magnified. *b*, stamen, magnified. *c*, fruit, magnified. *d*, *e*, fruit after dehiscence, natural size. *f*, *g*, *h*, *i*, seeds, natural size; *k*, *l*, *m*, enlarged; *n*, cut longitudinally. (Luerssen.)

Constituents.—The seeds contain several alkaloids of which cevadine, $C_{32}H_{49}NO_9$ (also called crystalline veratrine), is the most important and the most toxic; it is easily hydrolysed by alkalies yielding cevine and methylecrotonic acid. Veratridine (also called veratrine) accompanies cevadine in the seeds; it is amorphous and yields veratric acid and verine when hydrolysed. Both cevadine and veratridine are toxic and sternutatory. Other alkaloids of less importance are sabadilline (cevadilline), sabadine, sabadinine, and sabatrine, the latter being said to be only a mixture.

The official veratrine is a mixture of these alkaloids and consists chiefly of cevadine and veratridine; the former may readily be obtained from it by dissolving in alcohol, adding water until the solution becomes faintly opalescent and setting aside to crystallise.

Keller (1895) found 4.25 per cent. of alkaloid in the seeds.

Uses.—Cevadilla seeds (and veratrine) act both internally and externally as a powerful irritant. This primary effect is followed by depression, and, when used externally, loss of sensibility; hence ointment of veratrine is used to relieve neuralgic pains &c. Veratrine is employed also as a parasiticide, but is seldom administered internally.

ARECA NUTS

(Semina Arecæ)

Source &c.—Areca nuts, as they are commonly termed, are the seeds of *Areca Catechu*, Linné (N.O. *Palmæ*), a handsome palm with a tall slender stem crowned by a number of large elegant leaves. The tree is widely cultivated throughout India and the whole of the islands of the Eastern Archipelago for its seeds, which are universally employed by the natives as a masticatory.

The fruits, which are orange yellow in colour when ripe, and of the size and shape of an egg, are borne in large numbers on a branching axis. The pericarp is fibrous and surrounds a single seed, from which it is easily separated. The seeds are usually boiled in water with the addition of a little lime and dried.

Description.—The areca nut has the shape of a short bluntly rounded cone about 2.5 cm. long and about the same in diameter, although frequently it is either a little longer or shorter than it is broad. It has a brownish colour, and the surface is marked with a network of paler depressed lines. Frequently portions of a hard, brittle, grey, silvery coat are attached more or less firmly to the seed; these are portions of

the inner layer of the pericarp, and do not belong to the seed proper. The latter is hard, but can be cut with a knife, and then exhibits a marbled interior (*ruminate endosperm*), dark brown lines alternating with opal-white portions. Examination with the lens shows these lines to be slightly fissured. They are folds of the seed-coats, corresponding in position to the fibrovascular bundles that pass into them from the funiculus; they follow the branching of the bundles and produce the reticulate markings on the seed. The outer cells of the seed-coat fill with tannin, to which the brown colour is due, and contain alkaloid (Osenbrug, 1894).

The seed has little odour, but an astringent, slightly bitter taste.

The student should observe

- (a) The *shape* of the seed,
- (b) The *ruminate endosperm*.

Constituents.—Areca nuts contain several alkaloids together with tannin (15 per cent.) and fat (14 per cent.). The

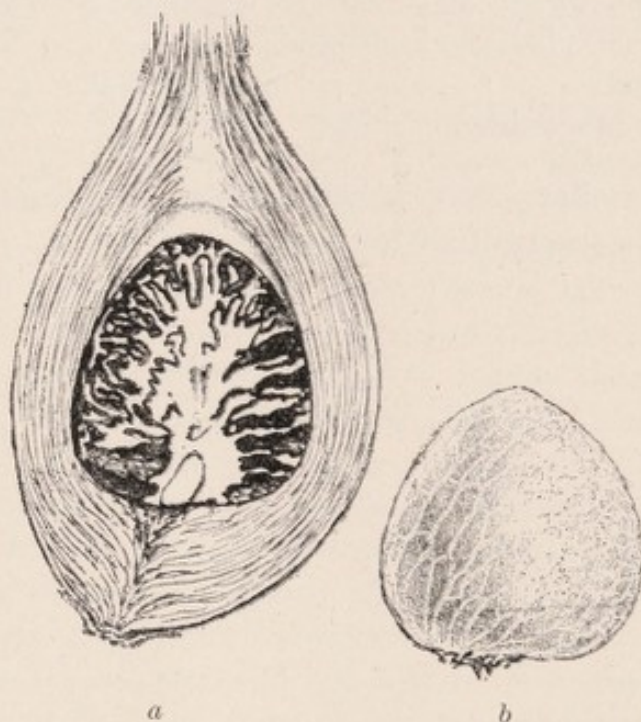


FIG. 111.—Areca nut. *a*, vertical section of the fruit and seed, showing fibrous pericarp of the former and ruminant albumen of the latter. *b*, entire seed, natural size. (Bentley and Trimen.)

most important of the alkaloids, and the one to which the sialogogue and vermifuge properties of the seed are due, is arecoline (methylarecaidine). Other alkaloids are arecaidine, arecaine, guvacine, and choline.

Arecoline, $C_8H_{13}NO_2$ (boiling-point $220^{\circ}C.$), is a colourless oily liquid yielding crystallisable salts. Boiling with hydrochloric acid converts it into methyl chloride and crystalline arecaidine, from which arecoline can be regenerated. Arecaidine, $C_7H_{11}NO_2$, is methyltetrahydronicotinic acid and can be synthesised from trigonelline. Arecaine is methylguvacine and can be prepared by methylating guvacine.

Use.—The powdered seeds are chiefly used in this country as a vermifuge for dogs.

SECTION V

HERBS AND ENTIRE PLANTS

The drugs that have been grouped together under this term comprise some consisting of the entire plant (chiretta, carrageen, ergot), others of the plant from which a small portion only has been removed (aconite, lobelia, horehound), and others again that represent only a small part of the plant (Indian hemp, savin).

Several drugs such as belladonna, henbane, and stramonium that are by common consent classed with the leaves belong more properly to this section, inasmuch as the flowers, young fruits, and stems form part of them.

The characters utilised in the identification of the herbs are to a great extent the same as those that would be employed by botanists in the identification of the plant, and these characters can usually be observed if the drug be previously boiled for a few minutes in water. The details of the flowers and leaves, and the arrangement of the latter on the stem, are thus of primary importance. Difficulties are not likely to occur, except in the distinction of the drug from other nearly allied species.

Flowering herbs are commonly gathered when in flower, and dried in the shade. They should then be completely dried, and kept in airtight containers to obviate changes that are likely to ensue as the result of the action of enzyme ferments. Such changes in some cases show themselves by changes in colour, &c., but in others they may affect and modify the active constituents without producing any visible alteration.

ACONITE HERB

(Herba Aconiti)

Source &c.—The aconite, monkshood, or wolfsbane, *Aconitum Napellus*, Linné (N.O. *Ranunculaceæ*), is a perennial herb

growing abundantly on the lower mountain slopes of Central Europe. It is cultivated in England as a garden plant as well as for medicinal use, and is found apparently wild in some localities, having probably escaped from cultivation. The drug has only recently been introduced into medicine, but the poisonous properties of aconite have long been known. Both the fresh leaves and flowering tops as well as the dried roots have been used, the latter alone being now official.

The plant should be cut when the flowers are beginning to expand, and the leaves and flowering tops separated from the



FIG. 112.—Aconite herb. *a*, leaf; *b*, flower; *c*, *d*, petals. Three-fourths natural size. (Holmes.)

larger stalks; they are used for the preparation of the juice and green extract of aconite.

Description.—The stem, which attains a height of about 1 metre or more, is upright, smooth, and usually simple, terminating in a leafy raceme of bluish flowers.

The lower leaves are petiolate, radiately veined and deeply palmatisect, the three primary divisions extending very nearly to the petiole; towards the upper part of the plant the petioles become shorter and the lamina less divided. They are of a dark green colour on the upper surface, paler beneath and glabrous, or nearly so.

The flower is zygomorphous; the calyx consists of five blue petaloid sepals (fig. 112, *b*), of which the upper (posterior) is shallow helmet-shaped; of the five petals, two only are easily found as hammer-shaped nectaries (fig. 112, *c*) concealed within the helmet-shaped upper sepal; the other three are small and inconspicuous (fig. 112, *d*); the stamens are numerous. The fruit consists of from three to five divergent follicles.

The plant has little odour, but produces slowly, when chewed, an unpleasant, acrid, burning taste.

The student should observe

- (a) The characteristic *shape of the leaf*,
- (b) The *shallow, helmet-shaped sepal*,
- (c) The characteristic *taste*.

Constituents.—Aconite herb contains certain alkaloidal constituents, but of the exact nature of these and the proportion in which they exist there is no very definite information. The dried leaves have been stated to contain from 0.12 to 0.96 per cent. of total alkaloid, of which a part at least is undoubtedly the highly toxic crystalline alkaloid aconitine, but to what extent other alkaloids are associated with it, and what their nature may be, is not at present known. Probably the non-toxic alkaloids picroaconitine and aconine, which have been isolated from the root, are also present in the herb (compare 'Aconite Root').

The herb also contains aconitic acid and tannin.

Aconitic acid, $C_3H_3(COOH)_3$, is a crystalline acid obtained by heating citric acid to $175^\circ C$. or by heating it with water and sulphuric acid; it is widely distributed throughout the vegetable kingdom.

Uses.—Aconite administered internally produces a steady fall in the body temperature, and is therefore given to alleviate certain febrile conditions; it also relieves the pain of neuralgia, and may be used internally or externally. The tincture prepared from the dry root is much more generally used than the green extract or juice made from the fresh herb. (Compare also 'Aconite Root'.)

The very poisonous nature of the herb renders care necessary in tasting it.

BROOM TOPS

(Cacumina Scoparii)

Source &c.—The broom, *Cytisus Scoparius*, Link (N.O. *Leguminosæ*), is a woody shrub, attaining a height of 2 metres, indigenous to England, and distributed over temperate Europe. It is essentially a medicine of Western origin, as it was



FIG. 113.—Broom, flowering branch.
(Maisch.)

employed by the Anglo-Saxons and by the Welsh. The younger herbaceous tops are collected, and are official in the fresh state for the preparation of the juice, and dried for making the infusion.

Description.—The stem of the broom produces numerous long, slender, wand-like branches which are arranged alternately and directed upwards. They are glabrous, tough, and flexible. The upper part of each branch is dark green in colour, and bears five distinct wings, which, however, are thrown off as the stems increase in size. The leaves are small, alternate, and hairy whilst young; the lower are trifoliate and stalked, but

those near the ends of the twigs are reduced to single sessile leaflets. They easily fall off from the stems when dried, and the dry drug therefore frequently contains but few.

The bright yellow, fragrant, papilionaceous flowers are borne on solitary, axillary peduncles, and succeeded by oblong, flattened legumes with hairy margins.

When fresh, the flowering plant has an agreeable odour which, however, disappears on drying. The taste is bitter and unpleasant.

Constituents.—Broom contains a liquid volatile alkaloid, sparteine, $C_{15}H_{26}N_2$, which has been obtained in the form of a colourless viscid oil boiling at $325^{\circ} C.$; it forms crystallisable

salts, of which the sulphate has been used medicinally. The quantity of sparteine present in the drug varies from about 0.4 to 0.5 per cent. and is greatest in March and April, rapidly diminishing towards the summer. The drug contains also an indifferent yellow crystalline substance, scoparin, $C_{20}H_{20}O_{10}$, belonging to the quercetin group.

Uses.—Broom is largely used as a diuretic in dropsy, an action which is due to the scoparin it contains. Sparteine exhibits physiologically a close resemblance to coniine, weakening the heart and depressing nerve cells.

HEMLOCK HERB

(Herba Conii, Folia Conii)

Source &c.—The common or spotted hemlock, *Conium maculatum*, Linné (N.O. *Umbelliferae*), is a biennial plant widely spread throughout temperate Europe, and generally distributed over Great Britain. It was in all probability the plant employed by the Greeks in the preparation of poisonous draughts, and was much used in Anglo-Saxon medicine, but latterly has lost much of its reputation owing to the uncertain action of preparations made from it. The herb is cultivated for medicinal use, but wild plants are also collected.

Description.—The plant produces, usually in its second year, an erect, cylindrical, glabrous, hollow stem, reaching a height of 1.5 to 2 metres, the lower part of which is marked with purplish spots which, however, usually disappear on drying.

The leaves are dark green on the upper, paler on the under surface, quite glabrous, and attached to the stem by amplexicaul petioles. The lower are large and decompound, attaining 50 cm. in length, the upper being less divided; the ultimate segments are ovate or lanceolate, and acute, terminating in smooth, colourless, horny points (fig. 114, *a*).

The umbels are about twelve-rayed, and provided with both general and partial involucre, the latter consisting of three short, lanceolate bracts directed outwards. The fruits are broadly ovate and characterised by the irregular, crenate ridges and grooved endosperm. (Compare 'Hemlock Fruits.')

The plant has a bitterish taste and unpleasant odour, especially when crushed; the addition of solution of potash produces a strong disagreeable odour of mice.

The student should observe

- (a) The *glabrous, spotted hollow stem*,
- (b) The *much divided leaves*, which are paler on the under surface, *quite glabrous*, the *ultimate divisions terminating in smooth colourless points*,
- (c) The *general and partial involucre*,
- (d) The *crenate ridges and grooved endosperm* of the fruit.

Constituents.—Hemlock herb contains coniine and conhydrine. These alkaloids are present in both stem and leaves



FIG. 114.—Portion of the leaf of a, *Conium maculatum*; b, *Anthriscus sylvestris*; c, *Aethusa Cynapium*. Magnified 2 diam. (Vogl.)

in largest quantity when the plant is in full flower, the stem then containing 0.064 per cent., the leaves 0.187 per cent., and the flowers and flower-stalks 0.236 per cent. (Farr and Wright). The herb should therefore be collected as officially directed, when the fruit begins to form, which will be when the plant is in full flower (compare p. 135).

Uses.—Fresh hemlock herb is used for the preparation of the green extract and juice. These preparations are administered as sedatives in various spasmodic diseases, in asthma, whooping cough, and spasmodic affections of the larynx.

Adulterations.—Several indigenous Umbelliferous plants have been mistaken for hemlock, but the characters detailed

above are sufficient to ensure the identification of the latter. The following may be particularly alluded to :

Anthriscus sylvestris, Hoffmann, Wild Chervil. — One of the commonest Umbelliferous plants ; it has, in common with the other less frequent species of the genus, hairy leaves by which it is easily distinguished from hemlock (fig. 114, *b*). The involucels are not directed outwards, and the fruit is elongated.

Æthusa Cynapium, Linné, Fool's Parsley. — The ultimate divisions of the leaves terminate in short brownish points. The under surface is dark green and glossy, and exhibit a more or less distinct network of veinlets (fig. 114, *c*). The umbel has no general involucre, and the bracts of the partial involucre are long and narrow. A transverse section of the leaf-stalk examined under the microscope shows on the upper surface a large central cell developed into a trichome.

COLTSFOOT

(Herba Farfaræ)

Source &c. — The coltsfoot, *Tussilago Farfara*, Linné (N.O. *Compositæ*), is a small herb with perennial creeping rhizome, abundant in Great Britain. The leaves appear much later than the flowering stems, and these two parts of the plant are therefore collected separately and usually sold separately. They have been long used as a domestic remedy for coughs.

Description. — The flowering stems, which appear in the early spring, are about 15 cm. high, and bear numerous small, narrow, alternate, reddish bracts ; they are simple and hairy, many of the hairs terminating in dark reddish brown glands. The flowerheads are terminal and solitary and surrounded by reddish involucreal bracts ; they possess numerous ray-florets with short, very narrow, bright yellow ligulate corollas, the disc-florets being less numerous and tubular. The receptacle is flat and naked, the fruits cylindrical, tapering towards the base and provided with an abundant pappus of white simple hairs.

The leaves appear much later than the flowers, and arise from separate shoots. They are radical and provided with long

stalks; the lamina is cordate in outline, measuring usually about 10 or 15 cm. in breadth, but occasionally much larger. The margin is sinuate-dentate, each tooth terminating in a hard brown point. The upper surface is dull greyish green and minutely wrinkled. Both surfaces are covered when young with loose, white, felted, woolly hairs, but those on the upper surface fall off as the leaf expands.

After the leaves have died down the shoot rests, and produces in the following spring a flowering stem, whilst other shoots develop leaves.



FIG. 115.—Coltsfoot leaf. About two-thirds natural size.

Neither leaves nor flowers have, when dried, any characteristic odour or taste.

The student should observe

- (a) The *short, very narrow, ligulate corolla*,
- (b) The *cylindrical fruit with pappus of white, simple bristles*,
- (c) The *shape and margin of leaves and their hairy under surface*,
- (d) The *characteristic glandular hairs on the peduncle*.

Constituents.—No active constituent is known. The drug contains a little tannin, and Bondurant (1887) found indications of a bitter glucoside which was not isolated.

Use.—Coltsfoot is used solely as a domestic remedy for coughs.

GRINDELIA

(Herba Grindeliæ)

Source &c.—Grindelia is described in the United States Pharmacopœia as the dried leaves and flowering tops of *Grindelia robusta*, Nuttall, or *G. squarrosa* (Pursh), Dunal. It has recently been shown that the bulk of the commercial drug is obtained from *G. camporum*, Greene, a plant which was formerly regarded as a variety of *G. robusta*, but it is now considered to be a distinct species. It is the common 'gum plant' of California and is collected in quantity near San Francisco. It is distinguished by the flattened fruits which are bi-auriculate or uni-dentate at the summit.

Part of the drug is said to be derived from *G. cuneifolia* and its variety *paludosa*; the leaves of this plant are cuneate and less coriaceous than those of *G. camporum*.

Before the flowerheads expand they secrete a white, sticky resin; in May and June the whole plant is resinous, and then the leaves and flowering tops are collected and dried.

Description.—The commercial drug consists largely of the slender upper part of the flowering stem, together with the flowerheads and a few leaves.

The stems, which are frequently as much as 50 cm. in length, are rounded, yellow in colour, and smooth. They bear alternate, pale green leaves which, however, are easily broken off, and therefore frequently lie loose in the package.

The leaves are oblong or spatulate in shape, 3 to 5 cm. long, with a serrate margin; they are rigid, brittle, smooth, sessile, and sometimes amplexicaul, and have a glabrous, minutely dotted surface.

The flowerheads are sub-conical in shape, yellowish in colour, hard and resinous, and are surrounded by several rows of lanceolate-acuminate, imbricated, recurved bracts. They contain numerous compressed fruits, each of which is crowned by a pappus consisting of two stiff, thick bristles, and when

mature is bi-auriculate or more rarely uni-dentate at the summit.

The drug has a slight odour and a somewhat balsamic taste. The student should observe

- (a) The *stalky appearance of the drug*,
- (b) The *resinous character, especially of the flowerheads*,
- (c) The *pale green, rigid, brittle leaves*.

Constituents.—The chief constituents of grindelia are amorphous resins, of which it may contain as much as 21 per cent. These include a soft greenish resin soluble in petroleum spirit and two dark coloured resins, one of which is soluble in ether. To these resins the activity of the drug appears to be due (Power and Tutin, 1905). The drug also contains a considerable quantity of lævoglucose, tannin (1·5 per cent.), and a trace of volatile oil. It leaves about 8 per cent. of ash.

Two glucosides resembling the glucosides of quillaja bark and senega root, an alkaloid and a crystallisable acid, robustic acid, are also said to be contained in the drug, but later researches have not confirmed these statements.

Uses.—The action of grindelia resembles that of atropine. The drug has the reputation of being almost a specific for certain forms of asthma, and has been recommended in cystitis and catarrh of the bladder. It is not much used in this country.

LOBELIA

(Herba Lobeliæ)

Source &c.—Lobelia or Indian tobacco, *Lobelia inflata*, Linné (N.O. *Campanulaceæ*), an erect annual herb with acrid milky juice (latex), is distributed over the eastern States of North America, and cultivated for medicinal use in the States of New York and Massachusetts. The drug was a domestic medicine of the North American Indians, and was introduced into European practice about 1830. The plant is cut as soon as the lower capsules turn brown, and dried; it is sent into commerce either in bales or in oblong compressed packets.

Description.—The stem of the plant, which varies in colour from green to yellowish or often purplish, is hairy and winged in the upper part, but quadrangular, channelled, and nearly

glabrous below. The leaves are alternate, broadly oval to ovate-lanceolate in outline, and vary in length from about 3 to 8 cm. They are sessile or shortly petiolate, and bear, especially on the



FIG. 116.—*Lobelia inflata*. 1, upper part of a plant; 2, flower; 3, corolla; 4, flower, cut vertically; 5, ovary, cut transversely; 6, ripe fruit; 7, the same, cut transversely; 8, seed; 9, the same cut longitudinally; 1, slightly reduced; 2-7, enlarged 8, 9, highly magnified. (Bentley and Trimen.)

veins of the under surface, scattered bristly hairs; the margin is irregularly crenate-dentate.

The flowers, which are arranged in a long leafy raceme, have a pale blue bilabiate corolla, a tubular calyx with five long spreading teeth, and an inferior two-celled ovary. The latter develops into an ovoid, inflated, ten-ribbed fruit, about 7 or 8 mm. long, crowned with the remains of the calyx, and containing numerous minute, brown, oval-oblong seeds, which, under the lens, exhibit a beautifully reticulated surface.

In the commercial drug the green hairy and winged or purplish and channelled stems with alternate leaf-scars are

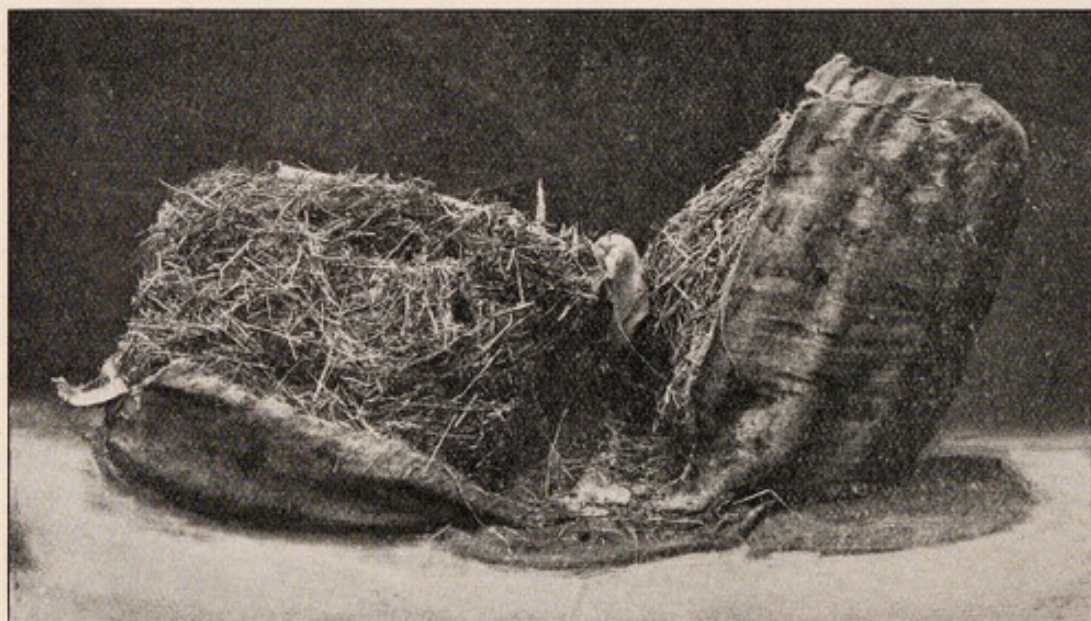


FIG. 117.—Bale of lobelia, cut open.

easily found. The leaves are mostly in a fragmentary condition, but recognisable by their hairy under surface. The flowers are seldom to be found, but the characteristic inflated fruits containing the very minute seeds are always present.

The stems and leaves contain laticiferous vessels in the bast, a character that can be ascertained by microscopical examination only, but one that may afford valuable aid in identifying doubtful specimens.

The drug has a somewhat irritant odour, and, when chewed, an unpleasant acrid burning taste.

It is said that the plants are sometimes allowed to mature their seeds and are then thrashed, the seeds being sold separately,

whilst the herb is pressed into packets. This would account for the frequent absence of the flowers from the drug, and for the presence of numerous capsules but comparatively few ripe seeds.

The student should observe

- (a) The *hairy winged stem*,
- (b) The *inflated fruits*,
- (c) The *minute oblong reticulated seeds*.

Constituents.—That lobelia contains a toxic principle is beyond question, but of the nature of that principle there is some doubt. J. U. and C. J. Lloyd (1887) isolated a white odourless, amorphous alkaloid, lobeline, which gave easily crystallisable salts with acids, and possessed powerful emetic properties. They also found a neutral crystalline inactive substance, inflatin. Other investigators, notably Siebert (1890), have obtained lobeline in the form of a pale-yellowish or colourless (Dreser, 1890) syrupy liquid with strongly alkaline reaction, yielding a crystalline hydrochloride and a crystalline platino-chloride. The formula indicated was $C_{18}H_{23}NO_2$.

The uncrystallisable lobelacrin of Enders (1871) appears to be lobeline lobelate (Lewis). The drug yields about 10 per cent. of ash.

Uses.—Lobeline has an action closely allied to that of nicotine; it first excites the nerve-cells and then paralyses them. The drug relaxes the bronchial muscles, and thus dilates the bronchioles; it is given in spasmodic asthma and in the dyspnoea of chronic bronchitis. Large doses produce vomiting, and may cause collapse through medullary paralysis.

INDIAN PINK

(Herba Spigeliæ)

Source &c.—*Spigelia marilandica*, Linné (N.O. *Loganiaceæ*), is an erect herb attaining a height of about 60 cm., and widely distributed over the United States, especially in the southern and south-western States. It possesses anthelmintic properties that were well known to the Indians, and was introduced into European medicine about 1754. The entire plant is collected in the autumn, tied into bundles, and dried. The

rhizome and roots, separated from the aerial parts of the plant, are also found in commerce.

Description.—The stem is smooth and simple, quadrangular in the upper, rounded in the lower part. The leaves are few in number, opposite and sessile; they are ovate-lanceolate in outline, about 8 cm. long, acuminate at the apex, and tapering towards the base. The midrib, and the lateral veins, of which there are usually four, are prominent; the latter branch from

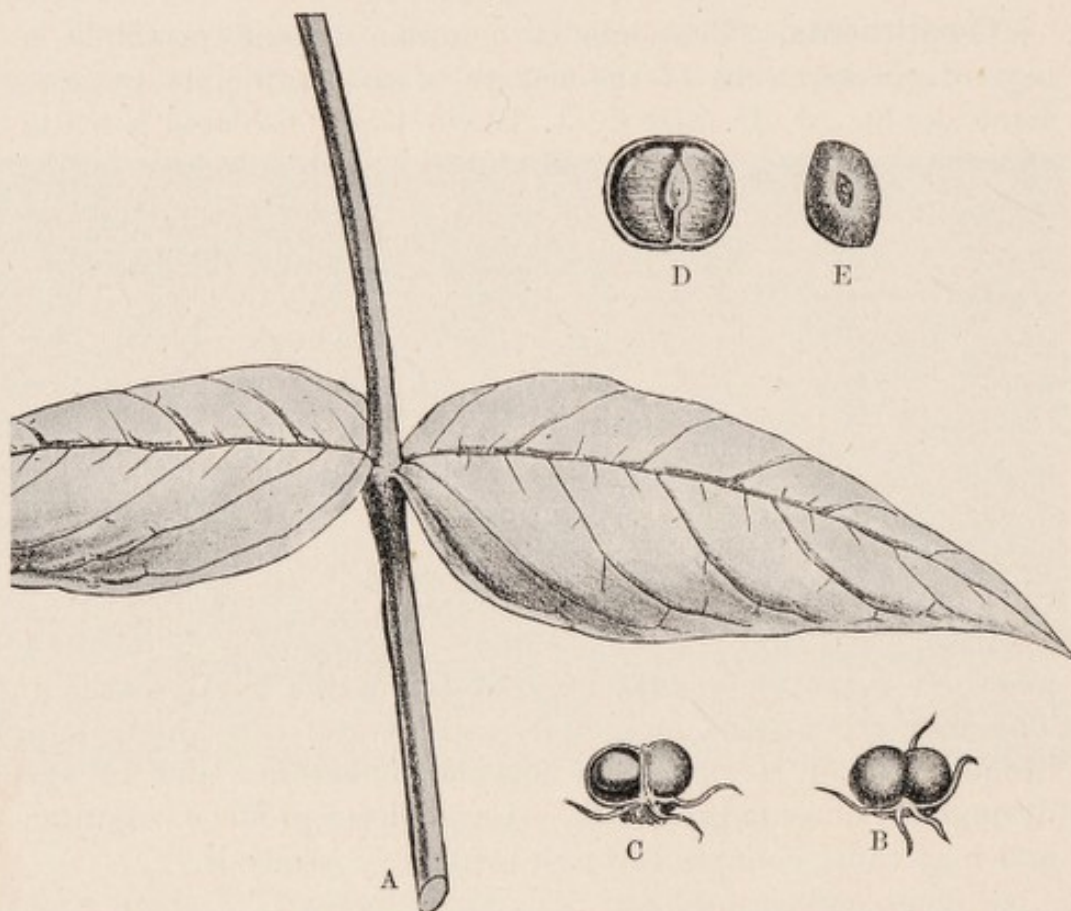


FIG. 118.—Indian Pink. A, portion of stem; B, fruit with persistent calyx; C, the same with one cell opened; D, vertical section of the same; E, seed. A, B, C, natural size; D, E, enlarged. (Bentley and Trimen.)

the midrib near the base at an acute angle, curving round towards the apex. The stem sometimes terminates in a unilateral spike of flowers which, in the fresh state, are of a brilliant red colour; these are not often found in the drug, but the small two-lobed fruits, each lobe about the size of a pea, and containing several seeds, are occasionally to be found.

The rhizome is small in size, dark brown, tortuous, and knotty. It is furnished with numerous slender wiry roots, and

bears on the upper side short branches marked with the cup-shaped scars of previous stems.

The drug is odourless, but has a rather acrid taste.

The student should observe

- (a) The *opposite sessile leaves with prominent lateral veins*,
- (b) The *small tortuous rhizome with cup-shaped scars*,
- (c) The *smooth cylindrical stem*.

Constituents.—The drug contains an acrid, bitter principle, soluble in water, and a liquid volatile alkaloid, spigeline (Dudley, 1881); the latter statement requires confirmation.

Uses.—Indian pink is often used as a vermifuge. It possesses poisonous properties allied to those of gelsemium, depressing the action of the heart and respiration, and causing loss of muscular power when given in large doses.

CHIRETTA

(Chirata, *Herba Chirettæ*)

Source &c.—Chiretta, *Swertia Chirata*, Hamilton (N.O. *Gentianæ*), is an erect annual herb growing to a height of about a metre, and indigenous to the mountainous districts of Northern India. It has long been used by the Hindoos, but was not introduced into European medicine till about 1830. The entire plant is collected when the flowering is well advanced and many fruits formed, and made into bundles about a metre long, weighing nearly a kilogramme each, which are often compressed for exportation.

Description.—The stem, which attains about 6 mm. in thickness, is of a yellowish brown or purplish brown colour, glabrous, and slightly winged. The lower part is rounded, and exhibits, when cut longitudinally, a narrow wood enclosing a large, continuous, easily separable pith; the upper part of the stem branches freely in a decussate manner, producing in the axils of opposite leaves slender, elongated branches which ramify further and bear numerous fruits and flowers.

The leaves, not many of which are usually found in the drug, are opposite and sessile, ovate or lanceolate in outline, acuminate, entire, and glabrous. The fruits are superior, ovoid

and pointed; they are formed from two carpels, but are one-celled and contain numerous minute reticulated seeds. There are not many flowers present in the drug.

The tapering root, from which the stem springs, attains about 10 cm. in length and 12 mm. in thickness at the crown, and is frequently oblique.

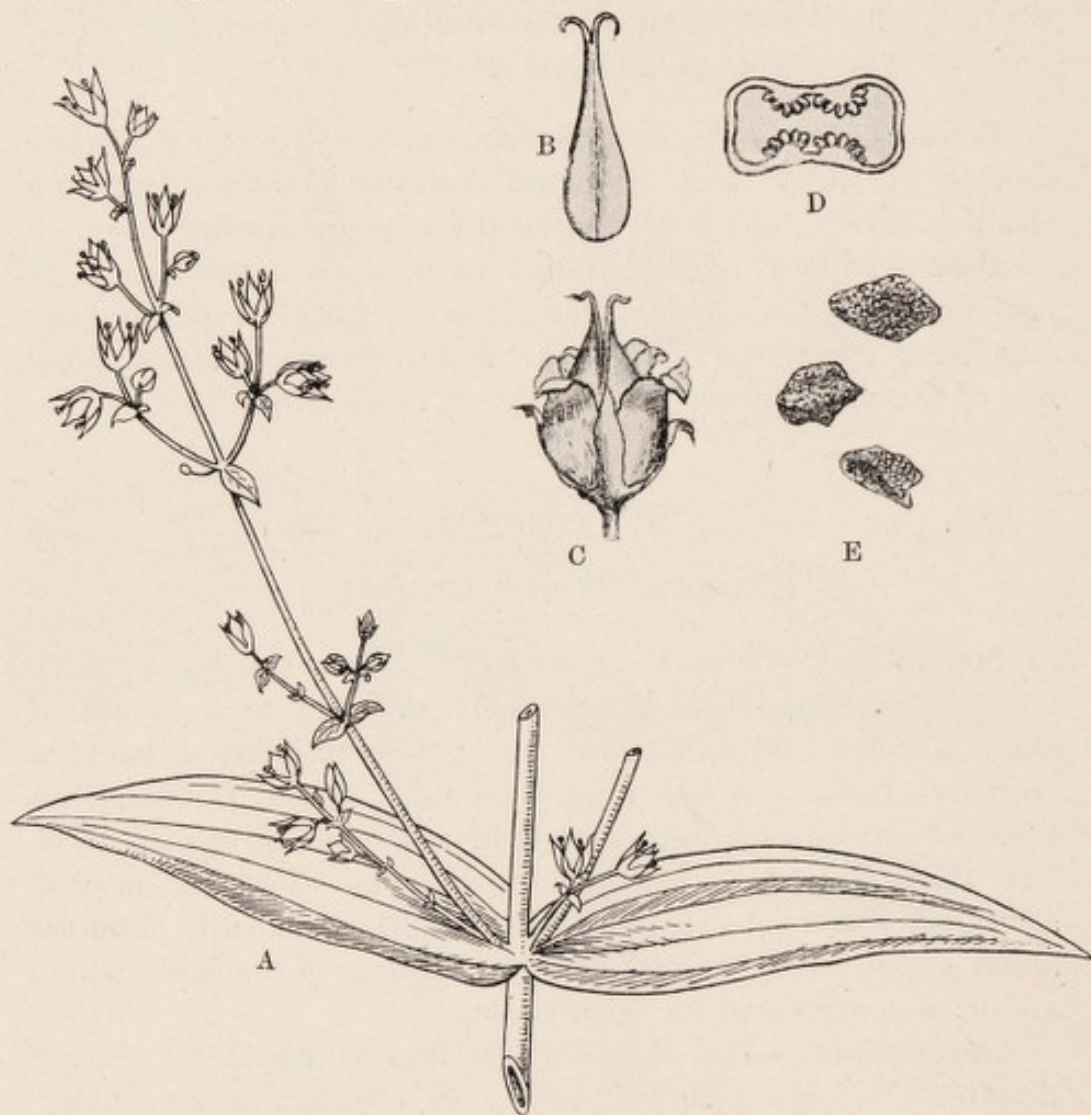


FIG. 119.—Chiretta. A, portion of flowering panicle; B, pistil; C, fruit with persistent calyx; D, transverse section of fruit; E, seeds. A, natural size. B, C, D, enlarged; E, highly magnified. (Bentley and Trimen.)

The drug has no marked odour, but all parts have an extremely bitter taste.

The student should observe

- (a) The purplish brown colour of the stem,
- (b) The large continuous pith,

- (c) The *intensely bitter taste*,
- (d) The *opposite leaves*,
- (e) The *bicarpellary, unilocular fruits*.

The first three characters will suffice to distinguish the genuine drug from other species of *Swertia*, which sometimes are mixed with it or substituted for it, as well as from other substitutions that have been occasionally noticed. The last two are characteristic of the natural order Gentianeæ and are also useful in identifying the drug.

Constituents.—Chiretta contains two intensely bitter principles, ophelic acid and chiratin, both amorphous or indistinctly crystalline yellow substances.

Ophelic acid exists in the larger proportion; it has been obtained as a viscid yellow substance with a persistent bitter taste, soluble in water, alcohol, and ether. Chiratin is a yellow powder soluble in warm water, alcohol, and ether. Boiled with hydrochloric acid it yields ophelic acid and chiratogenin but no sugar, and is therefore not a glucoside.

Uses.—This drug, which has bitter and tonic properties, is highly esteemed in India, and much used as a tonic. In this country it is now but seldom prescribed, probably on account of the very disagreeable nature of its bitterness.

Adulterations.—The name chiretta being applied in India to a number of bitter plants, it is not surprising that other more or less similar bitter drugs are occasionally mixed with or substituted for the official chiretta. Sometimes, too, plants that resemble true chiretta in appearance but are much less bitter make their appearance under the name of chiretta. Amongst the substitutions and adulterations may be mentioned *Swertia angustifolia*, Buch-Hamilton; *S. alata*, Royle; *S. trichotoma*, Wallich, &c.; *Andrographis paniculata*, Nees; the root of *Rubia cordifolia*, Linné, &c. The large continuous pith, dark colour, and intensely bitter taste are sufficient to distinguish *S. Chirata* from other species of the same genus; the opposite leaves and bicarpellary, unilocular fruits, from plants belonging to natural orders not possessing these characters.

BITTER-SWEET

(Stipites Dulcamaræ)

Source &c.—The bitter-sweet or woody nightshade, *Solanum Dulcamara*, Linné (N.O. *Solanaceæ*), is a perennial shrubby plant with long climbing or straggling stems, common in England in hedges and thickets. It produces small purplish blue flowers and red berries. During the middle ages it was much used as a medicine; now it is seldom employed.

The young stems are green and hairy, but as they grow older the hairs fall off, and they become quite smooth. The stems are gathered when about two or three years old, cut into short pieces, and dried.

Description.—Bitter-sweet stems occur in commerce in short pieces about 6 mm. in diameter, of a light greenish or brownish yellow colour, bearing occasional alternate scars. They are nearly cylindrical, quite glabrous, and more or less longitudinally furrowed and wrinkled. The yellow, glossy, corky layer can easily be scraped off, and the green primary cortex disclosed. The wood is yellowish, and exhibits, in older pieces, distinct annual rings. The stems are usually hollow in the centre, the remains of the pith being attached to the inner surface of the ring of wood.

The drug has no marked odour; the taste is at first bitter, but afterwards sweetish.

The student should observe

- (a) The *alternate scars*,
- (b) The *glabrous, glossy surface*, and *hollow centre*,
- (c) The *bitter-sweet taste*.

Constituents.—The chief constituent of dulcamara is the amorphous glucoside dulcamarin, to which the bitter-sweet taste is due; it yields on hydrolysis dulcamaretin and sugar. The drug also contains the glucosidal alkaloid solanine, which yields solanidine and rhamnose.

Solanine, $C_{42}H_{75}NO_{15}$, crystallises in colourless, bitter needles melting at $245^{\circ}C$.; it has been obtained from the berries of the black solanum (*S. nigrum*, Linné), from the berries and young shoots of the potato (*S. tuberosum*, Linné), and other members of the same natural order.

Uses.—Bitter-sweet was formerly given in rheumatic and cutaneous affections, but is now seldom prescribed.

WHITE HOREHOUND

(Herba Marrubii)

Source &c.—White horehound, *Marrubium vulgare*, Linné (N.O. *Labiatae*), is an erect herbaceous plant with perennial root, widely distributed over Europe, but not very common in England. It is, however, cultivated as well as collected wild in various parts of the country for medicinal use, and is also imported from the south of France. The Romans esteemed horehound as one of the most valuable drugs, but at present it is used only as a domestic remedy, and that not to any great extent. The plant is cut when in flower, and dried.

Description.—White horehound grows to a height of about 50 cm., and possesses a quadrangular, branching stem densely clothed with white woolly hairs. The leaves are from 3 to 5 cm. long, opposite, and petiolate; the lower rounded-ovate, the upper ovate-acuminate, with dentate or dentate-crenate margin. They are much wrinkled, and both the upper and under surfaces, but especially the latter, are covered with white felted hairs.

The flowers are arranged in dense verticillasters in the axils of the upper leaves. The hairy calyx is provided with ten recurved, hooked teeth; the whitish bilabiate corolla is characterised by its small, erect, cleft upper lip.

The drug has an agreeable though not powerful odour, and a somewhat aromatic but very bitter taste.

The student should observe

- (a) The *dense felted hairs* on the stem and leaves,
- (b) The *ten hooked teeth of the calyx*.

Constituents.—White horehound contains a bitter principle, marrubiin, crystallising in colourless plates melting at 160° C.; it is almost insoluble in water, but soluble in alcohol and ether; a little volatile oil and tannin are also present.

Uses.—Horehound has tonic, stimulant, and expectorant properties; it is used as a domestic remedy for coughs and pulmonary complaints generally.

Substitutes.—Other species of *Marrubium* have occasionally been substituted for *M. vulgare*, but the latter may be distinguished by the dense, woolly hairs and ten hooked teeth. *M. peregrinum*, Linné, has ten straight calyx teeth. *M. candidissimum* has five nearly straight calyx teeth and is less aromatic and less bitter. Black horehound, *Ballota nigra*, Linné, has dark green leaves with rough, not woolly hairs, five broadly ovate, pointed calyx teeth, and a disagreeable odour.

INDIAN HEMP

(*Cannabis Indica*)

Source &c.—The drug known as Indian hemp, or *Cannabis indica*, is derived from *Cannābis sativa*, Linné (N.O. *Urticaceæ*), cultivated in tropical districts of India.

The plant is an annual dioecious herb, indigenous to Central and Western Asia, but largely cultivated in temperate countries for its strong fibres (hemp) and its oily seed (hempseed), and in tropical countries also for the resinous secretion which it there produces. This secretion possesses very valuable and powerful medicinal properties, but it is not produced by the plant when grown in temperate climates; on the other hand, the fibre of the plant under the latter condition is stronger than that of the tropical plant.

The hemp plant grown in India differs, however, in certain particulars from that grown in Europe, and the plant was formerly considered a distinct species and named *Cannabis indica*, but this opinion is now abandoned.

The cultivation of hemp for its seed and fibre dates from very remote periods. It was used as an intoxicant by the Persians and Arabians in the eleventh and twelfth centuries, and probably much earlier, but was not introduced into European medicine till comparatively recently (1838). It is largely grown in the districts to the north of Calcutta, and westward thence through Central India to Gujerat. Very good qualities of the drug are produced in Madras.

The pistillate plants, by which alone the resin is secreted in any quantity, are pruned in order to produce flowering branches. The tops of these flowering branches are collected, allowed to wilt, and then pressed, by treading them under the

feet, into more or less compact flattened masses. This forms the drug known on the London market as 'guaza.' It is exported from Bombay, formerly in rounded canvas bales called 'robbins,' but now more frequently in wooden cases.

In the Calcutta districts a somewhat different procedure is adopted. The tops that are collected are short, and, after being allowed to wilt, they are rolled under the feet of men, who support their weight by grasping a horizontal bamboo pole. In this way rounded, instead of flattened, masses are produced. This variety is known as 'round' or Bengal ganjah (or guaza); it is more active than the flat Bombay drug, but is not seen in commerce in England, such quantities as are imported being immediately re-exported to the West Indies for the use of the coolies.

The larger leaves and young twigs collected without care and dried form the drug known as 'bhang'; it is chiefly consumed in India, made up into an electuary.

In addition to these drugs the resin secreted by the plant is also roughly collected by beating the plants on cloths to which the resin adheres; in this way a greenish brown soft mass is obtained, which may be freed from vegetable *débris* by warming and pressing through cloths. This resin is known as 'charas' or 'churrus,' and, like ganjah, is usually smoked. The Pharmacopœia guards against the use of the plants thus exhausted by limiting the drug to that 'from which the resin has not been removed.'

All these varieties of the drug are largely used in India for producing an agreeable form of intoxication.

Description.—In English commerce the drug usually occurs in flattened, compressed, rough masses of dull dusky green colour, harsh and resinous to the touch. Sometimes the tops are only 5 to 10 cm. in length, but more frequently they are 15 to 30 cm., the former being preferred. They consist of a straight stem with ascending branches, longitudinally furrowed, and bearing numerous, small, curved, appressed hairs and occasional glands. The hairs are characterised not only by their shape, but by being enlarged at the base and containing cystoliths.

The leaves on the drug (that is, the upper leaves of the plant) are alternate; the lower are digitate, and consist of three or five linear-lanceolate leaflets with distantly serrated margins;

the upper are simple. The upper part of the stem and branches bear numerous flowers or fruits.

The pistillate flowers are small and consist of a single ovary, surrounded by a perianth and supported by an ovate bract, beyond which two long brown stigmas, easily visible under a lens, protrude. The fruit is ovoid, slightly reticulated, and contains a single oily seed.

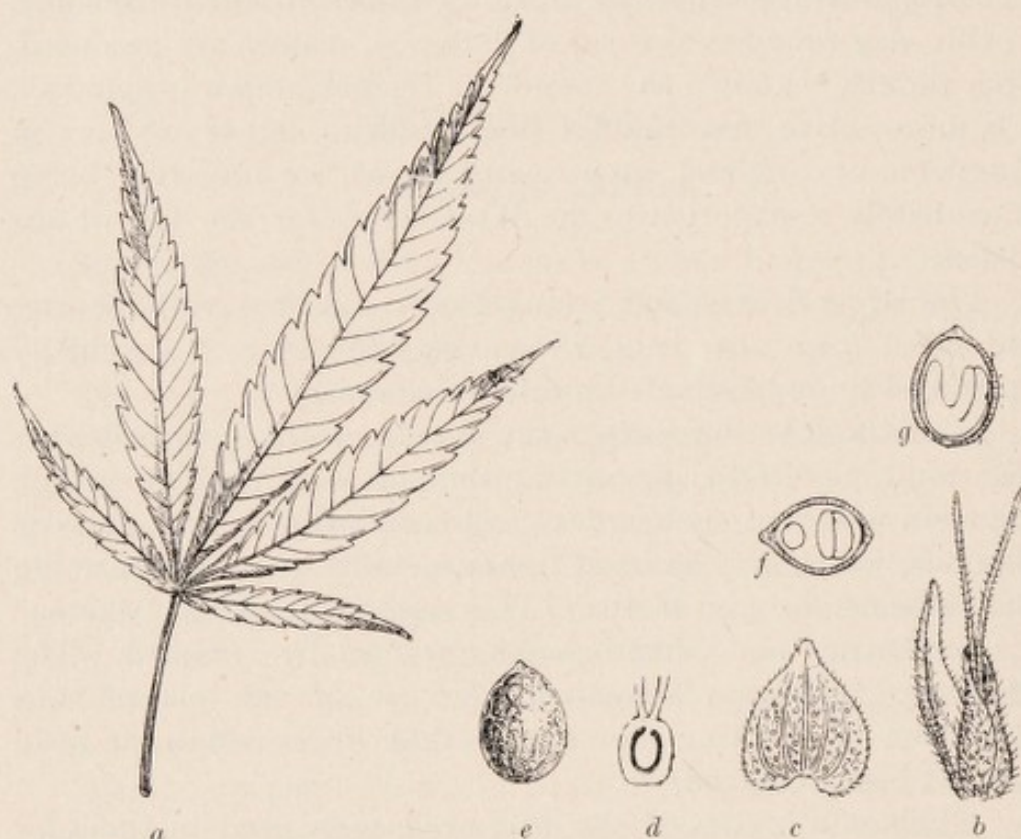


FIG. 120 —Indian Hemp. *a*, young leaf. *b*, pistillate flower enclosed by a bract and supported by a stipule. *c*, bract, showing glands. *d*, ovary, cut longitudinally. *e*, fruit (hemp-seed). *f* and *g*, fruit in transverse and longitudinal section (figures after Holmes).

All parts of the plant, but particularly the bracts, stipules, and upper leaves, bear numerous hairs and large stalked glands, the latter secreting a quantity of viscid adhesive resin.

The drug has a powerful odour, but is almost devoid of taste.

The student should observe

- (*a*) The *rough dusky green masses* in which the drug occurs,
- (*b*) The *curved appressed hairs*,
- (*c*) The *linear-lanceolate leaflets*.

It is advisable to free the drug from resin by macerating it in spirit, and then to soak it in water, when the leaves can easily be separated and the flowers dissected.

Constituents.—The resin secreted by the glands is undoubtedly the part of the plant that produces the narcotic effect of Indian hemp. This has been separated as a soft brown substance, cannabinone, from which, by distillation in vacuo, a viscous resin, cannabinal, which melts to an oily liquid when warmed, has been separated (Wood, Spivey, and Easterfield, 1896). Cannabinal produces a powerful narcotic action and is believed to be the active constituent of the drug. On exposure to the air it resinifies rapidly and becomes less active. A similar change, due possibly to the presence of oxydase enzymes, takes place in the cannabinal in the drug, the latter becoming less active. This rapid deterioration is well recognised in India, and persons addicted to the use of the drug refuse that which is more than a year old.

In addition to cannabinal and resin, the drug contains the alkaloid choline and traces of volatile oil; it yields from 10 to 18 per cent. of alcoholic extract and about 15 per cent. of ash. The activity is not, however, accurately indicated by the amount of alcoholic extract it yields, and the drug cannot be assayed by chemical means.

To avoid deterioration by oxidation of the cannabinal the drug should be completely dried and kept in hermetically sealed containers.

Uses.—Indian hemp acts upon the nervous system, producing first excitement accompanied by hallucinations and afterwards lethargy and sleep. It is used as a sedative in mania and hysteria, as well as for spasmodic cough, asthma, neuralgia, &c.

Varieties.—In addition to the guaza above described, the plant cultivated in Eastern Africa (Zanzibar) and also in France has been imported. Both varieties may be distinguished by their less resinous and matted appearance and by their brighter colour; they are much less active than the Indian drug.

EUPHORBIA PILULIFERA

(Herba Euphorbiæ)

Source &c.—*Euphorbia pilulifera*, Linné (N.O. *Euphorbiaceæ*), is an annual herb indigenous to the hotter parts of India and occurring in all tropical countries. It has been used



FIG. 121.—*Euphorbia pilulifera*. A, flowering top; B, inflorescence; C, fruit; D and E, end and side views of seed. C, D, E enlarged. (*Pharmaceutical Journal*.)

in India as a domestic remedy for ringworm, coughs, and other complaints.

The whole of the aerial part of the plant is collected whilst

flowering and fruiting, and dried. It is exported chiefly from India.

Description.—The stem is slender, erect or ascending, 30 to 60 cm. high, cylindrical, and hispidly hairy. The leaves are from 2 to 4 cm. long, opposite, oblong-lanceolate, shortly petiolate and dentate or serrulate. They are dark green in colour, frequently blotched with red, and both upper and lower surfaces are hairy. The flowers are very minute, and crowded in dense axillary or terminal cymes about 1 cm. in diameter. The fruit is a minute, yellow, three-celled capsule, about 1 mm. in diameter, each of the three carpels being distinctly keeled, and containing a single, tetragonal, wrinkled seed.

The most conspicuous part of the drug is frequently the slender rounded stems; the leaves are often much broken, but the fruits, which are very characteristic, can usually be found by examining the inflorescence with a lens. The drug is odourless, but has a bitter taste.

The student should observe

- (a) The *slender cylindrical hairy stems*,
- (b) The *minute three-celled fruits*, each carpel distinctly keeled;

and should compare the drug with

- (i) *Indian pink*, which has larger leaves with prominent lateral veins and entire margins,
- (ii) *Grindelia*, which has stouter yellowish stems bearing alternate leaf-scars,
- (iii) *Chiretta* (smaller pieces), which branches freely, and bears much larger ovoid fruits with numerous seeds.

Constituents.—It appears doubtful whether the drug really possesses the efficacy with which it has been credited. Investigations have failed to isolate any particular constituent, although it is believed to contain a poisonous glucoside.

Uses.—It has been recommended for asthma, bronchitis, hay fever, whooping cough, and other affections of the respiratory organs, but has never come into general use.

SAVIN TOPS

(Cacumina Sabinæ)

Source &c.—The savin, *Juniperus Sabina*, Linné (N.O. *Coniferae*), is a small evergreen shrub indigenous to the mountains of southern Europe, especially the southern Austrian and Swiss Alps, and frequently cultivated in Britain. It was probably introduced by the Romans, to whom the drug was well known.

The young shoots are collected in the spring from plants grown in this country; they are used fresh for the preparation of the ointment and for the distillation of the volatile oil, or dried for making the tincture. They are, however, no longer official.

Description.—The young twigs of the savin are densely covered with minute, thick, imbricated, opposite leaves, which are appressed and frequently adnate to the stem for a considerable portion of their length; they are sessile, rhomboidal in shape, and bluntly pointed. On the dorsal surface of each leaf a large oval depression is visible, corresponding to a large gland in the mesophyll of the leaf. Occasionally the small drooping baccate fruits may be found.



FIG. 122.—Savin. A, natural size; B, magnified. (Moeller.)

The lower leaves (and sometimes all) are more distant, linear, subulate, and more or less spreading.

The drug has a strong, characteristic odour and a bitter, acrid, unpleasant taste.

The student should observe

- (a) The *rhomboidal, appressed, bluntly pointed leaves*,
- (b) The *oil-glands on their dorsal surfaces*,
- (c) The *very characteristic odour*.

Constituents.—The principal constituent of savin is the volatile oil, of which it yields from 2 to 4 per cent. Tannin and resin are constituents of secondary importance.

The volatile oil (sp. gr. 0.910 to 0.930; O.R. + 40° to + 60°) consists chiefly of the alcohol sabinol and its acetic ester; it also contains cadinene, pinene, and probably other terpenes.

Uses.—Oil of savin is a powerful irritant, and is used externally to promote discharge from blisters; internally it acts as an emmenagogue, and is often used to procure abortion, frequently with fatal effect.

Substitutes.—The tops of *J. phænicea*, Linné, have, frequently been substituted in France for those of *J. Sabina*. They may be distinguished by the spiral arrangement of the leaves which also contain large sclerenchymatous cells not found in *J. Sabina*. The volatile oil which has a lower optical rotation (+ 4°) and contains less sabinol has been found in English commerce.

CARRAGEEN

(*Chondrus*; Irish Moss)

Source &c.—Irish moss, *Chondrus crispus*, Stackhouse. (Class, Algæ; Subclass, Rhodophyceæ; Order, *Gigartinaceæ*), is not a moss, but a seaweed widely distributed on the northern shores of the Atlantic Ocean. It is collected for medicinal use on the north-western coast of Ireland, the coast of Brittany, and of Massachusetts in the United States. The plant, which is exceedingly variable in colour, in the amount of furcation, and in the width of the segments, grows just below low-water mark and is collected by raking. When fresh it varies in colour from green to dark purplish brown, but is bleached by exposing it to the sun and watering it, the colouring matter, which is soluble in water, being partly washed out and partly destroyed by the treatment. The bleaching is said to be completed by chemical means.

Description.—The drug, which consists of the entire plant, is usually yellowish white in colour, translucent, and cartilaginous or horny. The thallus is rounded near its attachment to the stones upon which it has grown, but becomes flattened in its upper part, repeatedly branching dichotomously, the branches being sometimes narrow, sometimes broadly wedge-shaped, and then assuming a fanlike appearance. It has a slight odour of seaweed and a mucilaginous saline taste. A decoction

made with 20 times its weight of water solidifies to a jelly on cooling.

Constituents.—Stanford (1884) obtained from Irish moss 63 per cent. of a gelatinous substance which he termed carrageenin. This appears to be a complex mixture of carbohydrates ;



FIG. 123.—Irish Moss (*Chondrus crispus*). Three different forms of the plant, a, b, c; a, with reproductive organs, natural size. (Luerssen.)

it yields by hydrolysis galactose, dextrose, and lævulose (Sebor, 1900), and also hydroxymethylfurfuraldehyde (Müther and Tollens, 1904), and probably consists of galactan with glucosan

and lævulosan. The drug yields from 8 to 18 per cent. of ash, in which a little iodine can be detected, and about 7 per cent. of proteids.

Uses.—Irish moss possesses demulcent properties. It has been given in pulmonary complaints and for chronic diarrhoea, and has been used for the preparation of a nutritious jelly. It is also employed for various technical purposes, such as calico dressing, &c., as a cheap substitute for gum arabic, as well as for making emulsions.

Varieties &c.—*Gigartina mamillata*, J. G. Agardh, which is occasionally found mixed with Irish moss, may be distinguished by its stalked sporocarps, as may also *Gigartina pistillata*, Lamouroux, but the latter is a rare British seaweed and its presence would indicate that the drug had probably been collected in France; the sporocarps of *Chondrus crispus* are immersed in the thallus, the surface of which is slightly raised over them.



FIG. 124.—*Gigartina mamillata*. a, plant with reproductive organs, natural size. (Luerssen.)

BLADDERWRACK

(Fucus vesiculosus)

Source &c.—Bladderwrack, *Fucus vesiculosus*, Linné (Class, Algæ; Subclass, Phæophyceæ; Order, *Fucaceæ*), is a seaweed

widely distributed on the shores of the Atlantic Ocean, and one of the commonest seaweeds on the coast of Great Britain, growing on the rocks and stones exposed at low-tide. For medicinal use, the entire living plant should be collected and dried. That which is thrown up by the sea on the shore should be rejected, as by contact with the sea water it is liable to lose some of its constituents, which easily diffuse out from those cells the protoplasm of which has lost its vitality.

Description.—Bladderwrack, when fresh, is of a dark olive brown colour, changing, as the weed dries, to nearly black. The thallus of the plant is thin and flattened, about 2 cm. in width, attaining upwards of a metre in length, though it is usually rather shorter. It has an entire margin, and branches dichotomously, bearing at intervals bladder-like swellings (air-vesicles) arranged mostly in pairs; some of the branches terminate in club-like



FIG. 125.—Bladderwrack. Branch with reproductive organs. Natural size. (Maisch.)

enlargements, in which the organs of reproduction are situated. When slightly moist it is cartilaginous, but when quite dry, hard and brittle. It has a peculiar seaweedy odour and a disagreeable, mawkish, mucilaginous, and saline taste.

The student should observe

- (a) The *entire margin*,
- (b) The *vesicles usually in pairs*.

Constituents.—Bladderwrack yields to alkaline solutions a gummy or gelatine-like substance that has been found in other



FIG. 126.—*Fucus serratus*. (Planchon and Collin.)

seaweeds, and termed algin. The plant yields by hydrolysis mannitol, fucose, and arabinose.

It also contains mannite and a small proportion of iodine. The latter appears to exist in the form of an organic compound (Eschle, 1897), similar in its nature to the iodine compound found in thyroid glands. This is probably the most important constituent of the drug.

The dry plant yields about 0.0113 per cent. of iodine (v. Itallie, 1889), and 1.6 to 3.0 per cent. of ash, in which chlorides and bromides are present in addition to iodides.

Use.—Preparations of bladderwrack have been used medicinally to reduce obesity.

Varieties &c.—*Fucus serratus*, Linné (fig. 126), also a common seaweed occurring with *F. vesiculosus* on the rocky shores of Great Britain, has a serrated margin and no air-vesicles, whilst *F. nodosus*, Linné, has the vesicles usually single, not in pairs. The constituents of these seaweeds are probably similar to those of *F. vesiculosus*.

CETRARIA

(Iceland Moss)

Source &c.—Iceland moss, *Cetraria islandica*, Acharius (Class, Fungi; Subclass, Ascomycetes; Order, *Discomycetes*), is a foliaceous lichen indigenous to Great Britain and widely distributed over the northern hemisphere. It is collected chiefly in Sweden and Central Europe, growing usually amidst moss and grass on the lower mountain slopes.

Description.—The lichen consists of a very thin, erect, leafy thallus, branching fanlike into curled or flattened papery lobes about 6 mm. broad, fringed with minute projections. It is remarkably harsh and springy to the touch, tough when slightly moist, but brittle when quite dry. The upper surface is usually of a brownish or greenish brown colour; the under surface greyish and marked with numerous small, white, depressed spots. The apothecia are circular, of a dark reddish brown colour, and about 5 mm. in diameter; they are not often to be found on the plant. The drug is almost odourless, and has, when chewed, a mucilaginous, bitter taste. A decoction (1 to 20) gelatinises on cooling.

The student should remember that this drug, although commonly called a moss, is not a moss but a lichen. He should also be careful not to confuse *Iceland* moss with *Irish* moss (see before).

Constituents.—The principal constituent of Iceland moss is the carbohydrate lichenin, $C_6H_{10}O_5$, which is accompanied by isolichenin. Isolichenin is soluble in cold water, and behaves as a soluble modification of starch. Lichenin dissolves in boiling water, but the solution gelatinises on cooling.



FIG. 127.—Iceland Moss (*Cetraria islandica*). Natural size. (Luerssen.)

Both lichenin and isolichenin are converted by hydrolysis with dilute mineral acids into dextrose.

Iceland moss also contains cetraric acid, $C_{20}H_{18}O_9$, a crystalline bitter substance, almost insoluble in water, but forming soluble acid salts with monovalent alkalies; hence the bitterness of the drug can be removed by soaking in dilute solution of sodium bicarbonate. Other constituents of the drug are bitter protocetraric acid and tasteless lichenostearic acid.

Uses.—The properties of Iceland moss are those of a bitter tonic and nutritive, but it is now seldom employed.

ERGOT

Source.—Ergot is the sclerotium of *Claviceps purpurea*, Tulasne, originating in the ovary of the rye, *Secale cereale*, Linné (N.O. Gramineæ).

In the spring or early summer the spores of *Claviceps purpurea* are carried by the wind on to the flowers of various Gramineaceous plants, in the case under consideration on to those of the rye. Here they germinate and produce colourless hyphæ, which envelop, with the exception of the apex, the very young ovary, and penetrate the outer part of the pericarp, covering it with a soft white felted mass, which gradually takes the place of the ovary, and is known as the *sphacelia*. During this period a saccharine secretion, 'honeydew,' is produced by the hyphæ, and at the same time numbers of conidia are formed, thus contributing to the further dissemination of the fungus by means of the insects attracted to the honeydew, a small weevil which feeds on the saccharine secretion being especially active. After the felted mass has reached its full development, the sclerotium is gradually produced at its base by the hyphæ forming a dense compact mass instead of a loose felt. The sclerotium grows and finally projects from the ear of rye, which has by this time ripened, bearing on its apex the remains of the felt.

In this compact form the fungus is able to resist the damp and cold of the autumn and winter. In the spring it produces



FIG. 128. — Ear of Rye bearing two fully developed ergots. Natural size. (Luerssen.)

small stalk-like projections (stromata, fig. 129, B) each of which is terminated by a globular head in which numberless spores (ascospores) are developed, and these, carried by the wind on to the flowers of the rye, complete the cycle.

Ergot is collected chiefly in Spain, Russia, Germany, and Austria. It is sometimes picked grain by grain by hand, or more usually separated from the rye after it has been threshed by a machine specially designed for that purpose. Its exclusion from the grain is, in countries in which rye-bread forms the staple food of the people (as in Russia), a matter of the utmost importance, as the continued consumption of bread containing ergot has led to widespread disease (ergotism). The chief centres in Russia are Tomsk, Omsk, and Viatka.

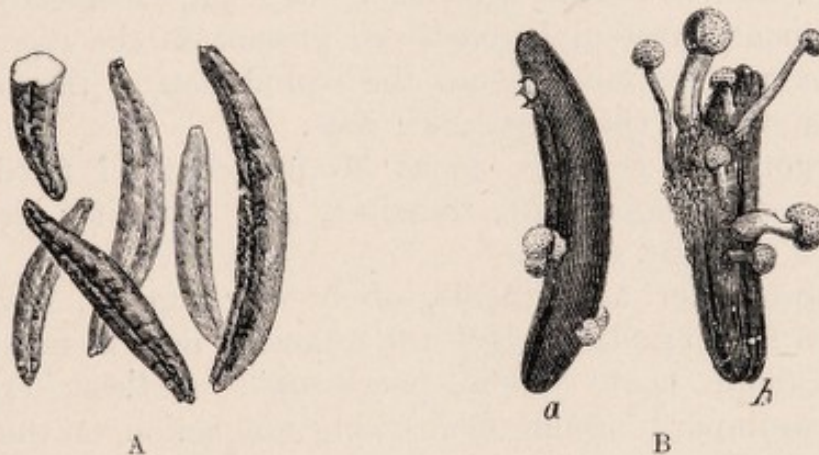


FIG. 129.—A, Ergot of Rye. (Planchon and Collin.)
B, Ergot of Rye germinating. (Luerissen.)

Description.—The grains of ergot are usually about 1.5 to 3.5 cm. in length, and of a very dark violet or nearly black colour. They are slender and curved, tapering towards both ends and rounded or obscurely triangular in section; to one extremity a small whitish appendage (remains of the sphacelia) is often attached. They are longitudinally furrowed, especially on the concave side, and often bear as well numerous small transverse fissures. Ergot breaks easily with a very short fracture, and is whitish or pinkish white within, but does not exhibit any definite structure when examined with a lens. It has a characteristic disagreeable odour and an unpleasant mawkish taste.

It should be thoroughly dried and kept in air-tight vessels to protect it from deterioration by damp and by the attack of insect pests.

Constituents.—The most important constituent of ergot is the alkaloid ergotoxine (hydro-ergotinine), $C_{35}H_{41}N_5O_6$, an amorphous alkaloid forming crystalline salts. It is converted into ergotinine by treatment with acetic anhydride, ergotoxine being re-formed when ergotinine is boiled with dilute phosphoric acid. To ergotoxine the entire action of ergot on the uterus appears to be due.

Ergotinine, $C_{35}H_{39}N_5O_5$ (0.25 per cent.), may be regarded as the anhydride of ergotoxine. In addition to its production from ergotoxine it is contained preformed in the ergot. It appears to be devoid of marked physiological action, any observed action on the uterus being probably due to traces of ergotoxine contained in it.

In addition to the ergotoxine other physiologically active constituents must undoubtedly be present in the ergot, since ergotoxine does not produce the stimulation of the heart or the convulsions that ergot itself does.

Ergot also contains about 30 per cent. of fixed oil, a phytosterin (ergosterin), trehalose, and mannite; it yields about 3 per cent. of ash.

Many other constituents, often very impure, have been isolated from ergot, of which the following may be mentioned:

Secalonic acid (yellow microscopic needles); ergotinic acid (an impure organic acid owing any action on the uterus to ergotoxine associated with it); sphacelinic acid (also impure); sphacelotoxin (a resinous substance, said to be very active); secalin (inactive, crystalline); secalintoxin (an active compound of sphacelotoxin and secalin); chrysotoxin (an active compound of sphacelotoxin with inactive ergochrysin); clavin (inactive); scleroxanthin and sclerocrystallin (yellow crystalline substances); fuscosclerotic acid and scleroiodin (amorphous brown substances); sclerotinic (sclerotic) acid (probably chiefly ergotinic acid); picrosclerotine (impure ergotinine); cornutine (impure ergotoxine).

Varieties.—The two chief commercial varieties are Spanish and Russian, the former being distinguished by its larger size.

Ergot is also collected in Germany, Austria, in the Canary Islands (occasionally), and in this country (rarely).

Assay.—As there is no known method of determining ergotoxine there is no chemical assay at present available. It is, however, possible to obtain an insight into the relative activity of preparations

of ergot by injecting them into fowls and observing the extent of gangrene produced in the combs and wattles. The determination of the inactive ergotinine which is frequently carried out is, of course, valueless.

Action and Uses.—The chief action of ergot is the stimulation of plain muscle, especially of the uterus and of the arterioles in peripheral parts of the body; it is employed to excite or increase uterine contraction and to control uterine hæmorrhage.

SECTION VI

WOODS

Under this heading are grouped together a number of drugs consisting of the wood of the trunk, branch, or root of trees. Medicinal woods are derived from dicotyledonous plants, and the following structural details which may be of assistance in identifying woods apply to those of dicotyledonous origin.

1. *Medullary Rays*.—These are best examined on a smooth transverse and tangential section. On a transverse section they appear as fine continuous lines radiating from the centre to the periphery. They vary in width in different woods and also frequently in the same wood; the wide ones are usually visible to the naked eye, but they are best examined under the lens. The distance between the rays also varies with the different woods, a variation which may be indicated by stating the number of rays that occur in 5 mm. of the wood.

The size and distribution of the vessels also afford valuable information. The vessels in the spring wood are usually larger and more numerous than those in the autumn wood, and hence more or less well-defined concentric lines are produced; in some woods, however, the distribution is irregularly radial. They are often large enough to be visible to the naked eye (over 0.1 mm.), frequently, however, scarcely perceptible even under the lens (under 0.02 mm.); they may occur singly or be arranged in radial or tangential groups of two or more.

The parenchymatous tissue of the wood may also exhibit a characteristic distribution usually assuming the form of more or less distinct concentric circles (false annual rings).

The woods dealt with in the succeeding section are easily distinguished from one another by their colour, odour, or taste, but the student should examine them carefully with the lens, as above described, in order to distinguish them from other similar woods that might be substituted for them.

GUAIAACUM WOOD

(Lignum Guaiaci, Lignum Vitæ)

Source &c.—The lignum vitæ or guaiacum wood of commerce is derived from *Guaiacum officinale*, Linné, and *G. sanctum*, Linné (N.O. *Zygophyllæ*), both evergreen trees, the former a native of the West Indian Islands and the north coast of South America, the latter indigenous to southern Florida and the Bahamas. Both occur in Cuba and Hayti, whence the wood is largely exported. The Spaniards became acquainted with the drug when they conquered San Domingo; it was soon brought to Europe, where it acquired an immense reputation in the sixteenth century as a cure for syphilis and certain other diseases, the resin extracted from the trunk being introduced subsequently.

The trees are felled, the bark stripped off, and the wood exported in logs varying commonly from 1 to 2 metres in length and from 10 to 50 cm. in thickness.

Description.—The logs are exceedingly hard, heavy, and compact, and consist of a dark greenish brown heartwood surrounded by a yellowish sapwood. The exterior is yellowish brown in colour and either smooth or furrowed, the furrows being oblique and varying in direction (corresponding to the arrangement of the wood fibres in the wood).

The medullary rays, which can be seen under a lens, are narrow, straight, and closely approximated; the vessels are distinct, usually single, and arranged in concentric zones.

The wood splits very irregularly, owing to the oblique and varying course taken by the wood fibres. Both these and the vessels—in fact, all the elements of the heartwood—are filled with a dark resin, which is sometimes also found in cavities in the trunk. This resin assumes under the influence of oxidising agents a deep blue colour, a reaction which can be utilised in identifying the wood, for a tincture prepared from it will acquire a deep blue colour on the addition of a dilute solution of ferric chloride.

The wood exhales, when warmed, a faint aromatic odour, recalling benzoin, and has, when chewed, an acrid taste. Its toughness and hardness render it valuable for many technical purposes, it being used in making blocks, pulleys, &c. The

chips or turnings, in which state it is usually employed in pharmacy, should consist of the dark-coloured heartwood alone, but they are frequently mixed with the lighter, pale yellow sapwood from which they may be separated by a 30 per cent. solution of sodium chloride in which the splinters of heartwood sink, a property that is sometimes useful in distinguishing them from other woods (*e.g.* boxwood). The sapwood contains but very little (about 3 per cent.) of resin, which is not identical with the resin of the heartwood.

The student should observe

- (a) The *pale colour of the sapwood*,
- (b) The *dark greenish brown heartwood*,
- (c) The *distribution of the vessels*.

Microscopical Characters.—The vessels are large and isolated, often extending from one medullary ray to the next. The medullary rays are one cell wide and three to six cells high. The wood-fibres are abundant and have very thick walls. The wood parenchyma occurs in narrow bands and some of the cells contain prismatic crystals of calcium oxalate.

Constituents.—The heartwood of guaiacum contains between 20 and 25 per cent. of resin, which has been found to consist of guaiaretic acid, guaiaconic acid, and guaiacic acid. Guaiaconic acid is the constituent that is coloured blue by oxidising agents. (Compare 'Guaiacum Resin.')

Guaiacum wood also contains guaiacsaponic acid and guaiacsaponin, two non-toxic bodies belonging to the class of saponins; they are present in larger quantity in the sapwood than in the heartwood. Guaiaguttin, which resembles gutta-percha, is also present.

Guaiaconic acid, though a characteristic constituent of the wood, has been found in other woods (*e.g.* species of *Bulnesia* and *Porlieria*), and its presence therefore is not an infallible diagnostic character of guaiacum wood.

Uses.—Guaiacum has a local stimulant action which is sometimes useful in sore throat. The resin is used in chronic gout and rheumatism, whilst the wood is an ingredient in the compound concentrated solution of sarsaparilla, which is used as an alterative in syphilis.

Substitutes, &c.—Commercial guaiacum wood turnings frequently contain the sapwood as well as chips of other woods.

These may be detected by their floating in brine and by the amount of alcoholic extract which should not be less than 22 per cent.

QUASSIA WOOD

(*Lignum Quassiae*)

Source &c.—The official quassia wood is derived from *Picræna excelsa*, Lindley (N.O. *Simarubææ*), a tree reaching a height of 15 to 20 metres, and common on the plains and lower mountains of Jamaica.

Quassia wood was introduced into medicine about the middle of the eighteenth century, but was then obtained from *Quassia amara*, Linné, a smaller tree than *Picræna excelsa*, and indigenous to the north of South America, whence its usual, distinctive name of Surinam quassia. The wood of *P. excelsa* was found to possess the same properties, and has been substituted for it in England, but Surinam quassia remains official on the Continent.

The trunks and larger branches with the bark attached are exported in logs and billets about $1\frac{1}{2}$ to 2 metres in length and 20 to 30 cm. in diameter.

Description.—The logs of Jamaica quassia wood are commonly covered with a thin, dark grey or nearly black bark. The wood is pale yellow in colour, light, rather dense, and easily split. When the smoothed transverse section is moistened and examined with a lens numerous narrow medullary rays can be seen traversing somewhat irregular concentric rings. The latter are not annual rings, but are produced by the distribution, in more or less concentric zones, of bands of parenchyma (false annual rings). The vessels are usually in groups of two or three, and frequently extend from one medullary ray to the next.

Not unfrequently dark grey patches are visible in the wood; they are caused by a fungus, the dark hyphæ of which penetrate the wood through the cells of the medullary rays and wood parenchyma.

The wood has no odour, but the taste is purely and intensely bitter. For use in pharmacy it is usually cut across the grain by large knives like chisels and the chips kiln-dried to prevent them becoming mouldy, as the wood often contains much moisture.

The student should observe

- (a) The *pale colour* and *intensely bitter taste* of the drug,
- (b) The *distribution of the vessels*.

Constituents.—According to Massute (1890), Jamaica quassia wood contains two closely allied crystalline bitter principles, *a-picrasmin*, $C_{35}H_{46}O_{10}$ (m.pt. 204° C.), and *β -picrasmin*, $C_{36}H_{48}O_{10}$ (m.pt. 209° – 212° C.), which are to be regarded as the active constituents; it contains, further, a very small amount of a crystalline bitter principle melting at 234° C., as well as a minute quantity of a yellow crystalline substance which exhibits in acidified alcohol a magnificent blue fluorescence. It contains no tannin.

Use.—Quassia is used as a pure bitter tonic.

Substitutes.—*Surinam quassia* is usually in smaller billets than Jamaica quassia; it is best distinguished by its microscopical characters, most of the medullary rays being one cell wide, whereas in Jamaica quassia they are two, or three cells wide; the wood parenchyma is free from crystals of calcium oxalate, which are conspicuous in Jamaica quassia. The width of the medullary rays and the presence of calcium oxalate are therefore specified in the Pharmacopœia in order to exclude Surinam quassia; for although the physiological action is presumably the same, it is desirable for the sake of uniformity to use one variety of the wood only. The bitter principles contained in Surinam quassia are distinct from those of Jamaica quassia, and have been called 'quassiins' (Massute, 1890).

LOGWOOD

(*Lignum Hæmatoxyli*)

Source &c.—The logwood tree, *Hæmatoxylon campechianum*, Linné (N.O. *Leguminosæ*), is a tree of moderate size, indigenous to Central America, but naturalised in the West Indian Islands. The use of the wood as a dye was probably known to the Mexicans, for its introduction into Europe followed closely on the conquest of Mexico by Cortes; in 1746 it was introduced into the London Pharmacopœia as a mild astringent but is now not much used medicinally.

The wood is exported in the form of billets and logs from which both bark and sapwood have been separated ; the heartwood alone contains the colouring and astringent principles.

Description.—The logwood of commerce consists simply of the heartwood of the tree, and is imported in logs and billets from 6 to 15 cm. in diameter and 1 to 2 or more metres in length. Externally these are of a dull dark orange or purplish red colour, internally they are reddish brown ; they are hard and heavy, but easily split. The transverse section exhibits under the lens very narrow and closely approximated medullary rays and narrow concentric dark zones alternating with paler ones, a difference due to the colouring matter secreted in the former.

The odour of the chips is faint but pleasant, recalling that of violets ; the taste is sweetish and astringent. When chewed the wood tinges the saliva violet. It imparts a similar colour to dilute aqueous solutions of caustic alkalies.

Logwood is cut by suitable machinery into chips or turnings of a reddish brown colour, and these are usually subjected to a process of fermentation. They are well moistened, heaped together, and exposed to the air for a period of from four to six weeks, the heaps being frequently turned over ; they are then dried. By this process the chips darken in colour and exhibit patches of a dark beetle-green lustre. The unfermented chips are alone official.

The student should observe

- (a) The *reddish brown colour* of the chips,
- (b) The *violet colour they produce in contact with alkaline solutions.*

Constituents.—The principal constituents of unfermented logwood is hæmatoxylin, $C_{16}H_{14}O_6 \cdot 3H_2O$, of which it contains about 10 per cent. This, when pure, forms colourless crystals which acquire a reddish colour on exposure to the air. It is sparingly soluble in water but dissolves readily with purple coloration in solutions of the caustic or carbonated alkalies and ammonia. The latter solution absorbs oxygen from the air, forming hæmatein-ammonia, from which acids separate hæmatein, $C_{10}H_{12}O_6$, a dark violet crystalline body with green metallic lustre. It is this change that takes place during the fermentation of logwood, the hæmatoxylin being partially converted into hæmatein.

Logwood contains, further, tannin, resin, quercetin, and a trace of volatile oil. The sweetish taste is produced by the hæmatoxylin, the astringency by the tannin.

Varieties.—Several commercial varieties of the wood are recognised, that from Yucatan (Campeachy) being considered the best, while British Honduras and San Domingo also furnish wood of good quality; Jamaica logwood is less esteemed as it is inferior in colouring power. Bastard logwood is the name given to a variety of the wood of paler colour and much less colouring power than the genuine; it appears to be derived from a variety of *H. campechianum*.

Uses.—Logwood is largely used as a dye and in the manufacture of inks. Much of it is converted for these purposes into an aqueous extract containing about 50 per cent. of hæmatoxylin and from 10 to 30 per cent. of hæmatein. Medicinally, it is employed occasionally as a mild astringent.

RED SANDERS WOOD

(Red Sandal Wood, Lignum Pterocarpi)

Source &c.—Red sanders wood is the heartwood of *Pterocarpus santalinus*, Linné filius (N.O. *Leguminosæ*), a small tree indigenous to Southern India and the Philippine Islands. During the middle ages it was classed as a spice and used for culinary purposes, and at one time it was supposed to possess medicinal properties; it is now employed solely as a colouring agent.

The tree is regularly cultivated in districts situated to the west and north-west of Madras. The felling of the trees is controlled by the inspectors of forests, and the revenue thus obtained is considerable. The dark red heartwood alone is exported.

Description.—Red sanders wood is imported in irregular often branching billets, commonly 7 to 15 cm. thick and about a metre long, deprived of both the rugged bark and the pale sapwood. It is of a deep blood-red colour both internally and externally, the transverse section exhibiting alternating darker and lighter zones. The medullary rays are just visible under the lens; the vessels are large, mostly isolated, and connected by fine, bright red lines (wood parenchyma). The wood is very hard, but can be easily split. It is inodorous, has but

a very slight astringent taste, and when chewed does not colour the saliva red.

The red resinous colouring matter is produced in the form of droplets in all the elements of the heartwood (wood fibres, wood parenchyma, and vessels). It is readily soluble in alcohol, but only very sparingly in water, and in this respect it differs essentially from logwood, which freely yields its colouring matter to water.

In pharmacy the wood is usually employed in the form of small, hard, splintery raspings of a dull purplish red colour.

The student should observe

- (a) The *dull purplish red colour*,
- (b) The *hardness*,
- (c) The *slight solubility of the colouring matter in water*.

Constituents.—The chief constituent of red sanders wood is santalin (santalic acid), $C_{15}H_{14}O_5$, which has been obtained in blood-red microscopic needles melting at $104^{\circ} C$. It is insoluble in water, but yields a blood-red solution with alcohol, yellow with ether, and violet with caustic alkalies. Santal (Weidel, 1869), pterocarpin, and homopterocarpin (Cazeneuve and Hugouneng, 1887, 1890) are colourless crystalline substances also contained in red sanders wood.

Use.—Red sanders wood is used solely as a colouring agent, and even in this respect it has only a limited application, as the colouring matter requires alcohol to dissolve it, and is precipitated when the alcoholic solution is diluted with water.

SANDAL WOOD

(Yellow Sandal Wood, *Lignum Santali*)

Source &c.—The yellow sandal wood tree, *Santalum album*, Linné (N.O. *Santalaceae*), is a small tree distributed over India and the Malay Archipelago. It is found especially in Southern India, from Mysore to Madras, and is regularly cultivated there for the sake of its wood, which has long been used in India in religious ceremonies. It was known in Europe in the eleventh century, and has been used medicinally since the middle of the fifteenth century.

The yellow sandal wood tree is a Government monopoly in Mysore, whence nearly all the sandal wood of commerce is obtained. The tree is plentiful, but must be grown slowly in arid situations upon poor and stony soil to yield the largest proportion of oil. The tree is uprooted and roughly deprived of its bark and part of the sapwood. It is then taken to certain depôts (of which there are nine in Mysore), where the trunks are sawn into lengths of about a metre and trimmed, and the roots are freed from bark. The logs are sent either direct to London or by native craft to Bombay or other ports on the west coast of India, whence they are exported to London. Periodical auctions of the wood are held in Mysore, where also a certain amount of oil is distilled.

Description.—Sandal wood logs are about a metre in length and up to 15 or 20 cm. in diameter, consisting of the heartwood only of the tree. This is yellowish or pale reddish in colour, hard, heavy, and dense, but easily split. The transverse section shows alternating lighter and darker zones; the medullary rays, which are very fine and close together, are visible under a lens; the vessels are mostly solitary, being only occasionally arranged in small radial groups.

The wood has a slightly bitter taste, but strong, very fragrant odour.

In the yellow sandal wood the formation of heartwood is due to the production of a volatile oil, not, as in the case of guaiacum or red sandal wood, of a resin, or, as in the case of log-wood, of a mixture of resin, tannin, and colouring matter. The volatile oil is found in all the elements of the wood; it is not secreted by or contained in any particular cells or glands.

The student should observe

- (a) The *pale colour*,
- (b) The *characteristic odour and taste*,
- (c) The *vessels usually single*.

Constituents.—The only important constituent of the wood is the volatile oil (sp. gr. 0.975 to 0.980; O.R. — 16° to — 20°), of which it yields from 2 to 5 per cent. The chief constituent of the oil is the alcohol santalol, $C_{15}H_{26}O$, of which it contains over 90 per cent.

Uses.—The wood is used as a source of the volatile oil, and technically for the manufacture of various articles. Sandal wood

oil is a stimulant and disinfectant of the whole genito-urinary tract.

Varieties.—The wood of other trees is occasionally imported under the name of sandal wood. The chief of these are West Australian sandal wood (from *Fusanus spicatus*, Robert Brown, N.O. *Santalaceæ*) and Venezuelan or West Indian sandal wood (*Amyris balsamifera*, Linné, N.O. *Burseraceæ*). They may both be distinguished by the vessels being arranged in *radially elongated groups* (Petersen, 1886).

The volatile oil of West Australian sandal wood has a sp. gr. of 0.953 to 0.965 and an optical rotation $+ 5^{\circ} 20'$; that of West Indian sandal wood has a sp. gr. 0.960 to 0.967 and an optical rotation $+ 24^{\circ}$ to $+ 29^{\circ}$. Both are therefore readily distinguished from Indian sandal wood oil.

SECTION VII

BARKS

The term bark is commonly employed by pharmacognosists to denote all the tissues of the stem and root of trees and shrubs exterior to the cambium. It comprises, therefore, botanically, such tegumentary tissue as may have been formed, primary and secondary cortex, together with primary and secondary bast.

In examining a bark attention should first be directed to the shape of the pieces in which it occurs.

Barks are said to be in *flat* pieces when they are quite flat ; in *curved* pieces when they present a curved but not deeply concave transverse section ; in *recurved* pieces when the concave surface is the outer portion of the bark ; in *channelled* pieces when the transverse section is deeply concave. Should it be so deeply concave that the edges nearly or quite overlap, a *quill* is produced, and should both edges be inrolled a *double quill* is formed. Single or double quills packed inside one another form *compound* quills.

Next the physical characters should be noted, such as colour, odour, taste, nature of the outer and inner surface, &c.

The appearance of the edges when a piece is broken ('fracture' of a bark) often affords useful information ; the fracture may be short, granular, splintery, or fibrous, terms which sufficiently explain themselves.

As the bark of any particular tree may be, and frequently is, collected from axes varying in size from a twig to a large trunk, the drug thus produced will exhibit not only corresponding variations in size, but also considerable variation in external appearance caused by the changes in the tegumentary tissue due to the growth of the axis. The internal structure, however, retains its important characteristics unchanged, and the student should therefore carefully examine a smooth transverse section which he will find an excellent and often indis-

pensable guide to the identification of a bark. Before passing to this part of the work he should study the anatomy of the bark in his text-book of botany; the following brief notes may, however, be useful.

Tegumentary Tissue.—Few barks are so young when collected as to retain their epidermis; this tissue has usually been replaced by a cork of varying thickness. Sometimes the development of successive layers of phellogen deeper and deeper in the cortex, and possibly in the secondary bast, has resulted in the formation of corresponding layers of cork, the tissues thus cut off losing their vitality. To the mass of protective tissue (the 'bark' of botanists) thus formed the name of 'outer bark' is commonly assigned by pharmacognosists.

The characters of the cork, influenced in some cases by the nature of the cell contents (cascarilla, alder buckthorn), often afford a valuable means of identifying a bark.

Phelloderm is seldom formed in quantity sufficient to be diagnostically important. Canella bark alone contains a sclerenchymatous phelloderm easily visible under a lens.

Cortex.—This tissue, often termed 'primary,' or 'middle' bark by pharmacognosists, is the tissue extending from the epidermis, cork, or phelloderm, as the case may be, up to and including the endodermis. Beyond the presence or absence of groups of sclerenchymatous cells, of oil-cells, oil-glands, or calcium oxalate, it seldom affords any well-marked characters.

Bast.—The primary bast being seldom distinguishable even under a microscope, this tissue is practically composed of secondary bast. It comprises the tissue extending from the endodermis to the cambium, and corresponds to the inner bark of many pharmacognosists. Its structure should be carefully examined, as it is frequently of great diagnostic importance.

It occasionally happens that the cells of the pericycle thicken and lignify, and thus form a band of sclerenchymatous tissue, readily visible under a lens, in the mature bark (sassy bark, nux vomica bark); otherwise the extent of the secondary bast is not readily fixed; it continues at least as far as the medullary rays extend.

The chief features of importance in the bast, and visible under a lens, are the presence or absence of: (i) sclerenchymatous cells; (ii) bast fibres; (iii) oil-cells or oil-glands; (iv) calcium oxalate; (v) mucilage.

Sclerenchymatous cells commonly occur in rounded, less often in tangentially elongated, groups exhibiting a uniform semi-translucent appearance. They impart to the bark hardness and render the fracture short and granular (sassy bark).

Bast fibres may occur scattered or in groups, which are then often tangentially elongated and arranged in tangential lines. They impart to the bark a tough and fibrous character; from the fractured surface of such a bark the fibres usually project (oak, elm, &c.).

If the bast fibres approach sclerenchymatous cells in nature the fracture becomes splintery (quillaia).

Oil-glands or oil-cells usually appear as minute yellowish, reddish, or brownish translucent points; their presence is often very characteristic (canella bark).

Calcium oxalate is generally visible as colourless points or lines (cusparia bark); if present in large quantity the tissue itself may appear white (canella).

In addition to these characters the odour, taste, colour, &c. of the bark must be noted.

BARBERRY BARK

(Cortex Berberidis)

Source &c.—The common barberry, *Berberis vulgaris*, Linné (N.O. *Berberidæ*), is a shrub commonly about 2 metres high, with three-lobed thorns at the bases of the tufts of leaves. It occurs scattered over Great Britain, and is distributed over the greater part of Europe and temperate Asia. The yellow flowers, which are arranged in elegant drooping racemes, are succeeded by oblong scarlet fruits.

The stem bark is collected by shaving, and dried.

Description.—Barberry bark occurs in small, thin, nearly flat pieces not often exceeding 5 cm. in length or 1 cm. in breadth, dark in colour, with a decided yellow or yellowish grey tinge.

The outer layer (cork) is dark yellowish grey in colour, and is marked with shallow, longitudinal furrows or deeper fissures, becoming ultimately scaly; it frequently bears the minute black apothecia of small inconspicuous lichens. The inner surface is dark yellowish-brown, longitudinally striated

and fibrous, and occasionally has fragments of yellow wood adhering to it.

The bark breaks with a fracture that is short in the outer portion (cork and cortex), but fibrous and strongly laminated in the inner (bast).

The transverse section exhibits under the lens a narrow cork and a dark brown bast traversed by paler, yellow medullary rays. The bast rays contain narrow, tangentially elongated bundles of bast fibres, which easily separate from the bast parenchyma in strands and produce the laminated appearance and fracture.

The bark has a bitter taste, and colours the saliva yellow when chewed.

The student should observe

- (a) The *yellow colour* both of the bark and the wood that is sometimes attached to it,
- (b) The *minute lichens* (the presence of which proves it to be stem bark),
- (c) The *strongly laminated bast*.

Constituents.—Barberry bark contains several alkaloids, of which berberine is the most important. Berberine, which can be obtained in yellow crystals, is found in a number of plants belonging not only to this but to other natural orders, as, for example, in *Hydrastis canadensis* (Ranunculaceæ).

Oxyacanthine and berbamine are colourless alkaloids that have been obtained from the bark of barberry root, and doubtless exist also in that of the stem.

Berberine, $C_{20}H_{17}NO_4$, crystallises in brilliant yellow needles with four or six molecules of water, and melts when anhydrous at $145^{\circ}C.$; it forms well crystallised compounds with acetone and chloroform, and is coloured in aqueous solution blood-red by chlorine water. Berberine is one of the few alkaloids that occur in plants belonging to several different natural orders (Berberideæ, Ranunculaceæ, Rutaceæ, Leguminosæ).

Uses.—Barberry bark is sometimes employed as a remedy for fevers, and as a tonic.

CANELLA BARK

(Wild Cinnamon Bark, Cortex Canellæ)

Source &c.—Canella bark is obtained from *Canella alba*, Murray (N.O. *Canellaceæ*), a small tree distributed over the West Indian Islands and found also in Florida. With this tree the Spaniards became acquainted when they discovered America, and thinking, from its aromatic bark, that it was a kind of cinnamon, which was known to them as a valuable Asiatic spice, they brought it to Europe, where it received the name of white cinnamon or 'canella alba.' It is now used by the negroes as a condiment.



FIG. 130.—Canella bark.
Natural size.

The bark of the tree is covered with a thick layer of ash-grey cork; by gentle beating, this layer of cork is detached, and the remainder of the bark, which has been at the same time loosened, can then be stripped off and dried. It is exported chiefly from the Bahamas.

Description.—Canella bark occurs in commerce in channelled pieces and single quills of very varying size, evidently obtained from small trunks and from large and small branches. The quills vary in diameter from 5 to 25 mm. or more; channelled pieces may be as much as 50 mm. broad and 5 mm. thick. Much of the bark shows evidence, in the shape of irregular longitudinal fractures, of the beating to which it has been subjected. The outer surface is of a bright pale reddish or yellowish buff colour, very hard and granular, and usually marked at somewhat distant intervals with circular crateriform scars or with whitish spots, as well as with numerous shallow transverse or longitudinal depressions. The inner surface is paler, and finely striated longitudinally.

The bark breaks with a very short granular fracture. The smoothed transverse section exhibits under the lens a narrow, irregular, translucent, brown outer layer (phelloderm of sclerenchymatous cells), a paler cortex in which numerous

brown oil-cells can be seen, and, in the bast, white wavy medullary rays.

The odour is agreeably spicy, recalling cinnamon; the taste pungent and bitter.

The student should observe

- (a) The *hard buff outer surface* with its characteristic *scars or spots*,
- (b) The *oil-cells* and *medullary rays*,
- (c) The characteristic *odour and taste*.

Constituents.—Canella bark contains about 1 per cent. of volatile oil which has a pungent aromatic taste and contains eugenol, cineol, and terpenes. The bitter principle has not yet been isolated, and it is doubtful whether the pungency is due entirely to the volatile oil. The bark contains no tannin, a negative character by which it may be distinguished from that of *Cinnamodendron corticosum*, Miers.

Uses.—Canella has aromatic stimulant and tonic properties.

WINTER'S BARK

(True Winter's Bark, Cortex Winteranus)

Source &c.—True Winter's bark is derived from *Drīmys Wintēri*, Forster (N.O. *Magnoliaceæ*), a tree distributed throughout the whole of South America. It was first brought to Europe in 1579 by Captain Winter from the Straits of Magellan. It is now imported from Colombia.

Description.—True Winter's bark occurs in channelled pieces or strongly inrolled quills from 3 to 8 mm. in thickness, the quills being often small in diameter in comparison with their great thickness. Both surfaces are usually of a rusty-brown colour, the outer being occasionally whitish or silvery, the thinner pieces frequently bearing lichens. The inner surface is well characterised by deep and close striations, the projecting ridges being the inner margins of the bast rays, which are strongly lignified, and therefore do not contract on drying. A transverse section shows radiating lines of white bast, the intervening parenchyma as well as that of the cortex being dark brown. The bark has a terebinthinate odour and an extremely pungent taste, which, however, disappears on keeping.

Constituents.—Winter's bark contains 0·6 per cent. of a volatile oil consisting chiefly of the terpene, winterene. It also contains resin, tannin, and mucilage. A cold aqueous infusion is coloured dark violet by solution of potassium hydroxide, a reaction that is sometimes useful in identifying the bark.

Uses.—Winter's bark has stimulant, tonic, and antiscorbutic properties. It is much used in Brazil as an astringent and stimulant.

Substitutes.—*Cinnamodendron Bark*: the bark of *C. corticosum*, Miers (N.O. *Canellaceæ*) was for many years substituted for true Winter's bark. It closely resembles canella bark, but is usually of a dingy brown (occasionally pale yellow) colour; the freshly cut surface even of very old specimens has a distinct odour of coriander, by which the bark can be readily identified.

Malambo Bark: the bark of *Croton Malambo*, Karsten (N.O. *Euphorbiaceæ*), which occurs in hard curved or channelled pieces with silvery white cork and reddish brown inner surface. It breaks with a short fracture and has a slightly aromatic, very bitter taste.

CUSPARIA BARK

(Angostura Bark, Cortex Cuspariæ)

Source &c.—Cusparia bark is obtained from *Galipœa officinalis*, Hancock (N.O. *Rutaceæ*), a tree indigenous to the



FIG. 131.—Cusparia bark, showing buff spongy cork and obliquely cut edges. Natural size.

mountains of Venezuela, and there abundant. It was introduced into European medicine about the end of the eighteenth century, being brought from Angostura (on the Orinoco) to Trinidad, whence its name 'Angostura' bark. It was long considered to be derived from *Cusparia febrifuga*, De Candolle, a

tree closely allied to *G. officinalis* botanically, but characterised by the presence of calcium oxalate in rosettes, while in *Galipea* this takes the form of acicular crystals.

Description.—Cusparia bark occurs in somewhat thin curved or channelled pieces or single quills, usually about 8 or 10 cm. long and 1.5 to 3 mm. thick, but sometimes much longer, one of the longitudinal margins being frequently obliquely cut. The outer layer (cork) is sometimes buff-coloured, friable, and easily removed by the finger-nail, sometimes dark grey, thin and firmly adherent, a difference due to the alternate production of layers of thin and thick-walled cork cells.

Below the cork is a hard, dark brown middle layer (cortex), whilst the inner surface of the bark (bast) is of a cinnamon or chocolate brown colour and finely striated. This portion frequently exhibits a laminated structure and bears numerous minute short white lines, longitudinally arranged, which are usually easily visible under a lens, especially after the inner surface has been smoothed with a knife. They are caused by axially elongated cells filled with acicular crystals of calcium oxalate. Similar white masses of calcium oxalate may be seen on the smoothed radial and transverse sections.

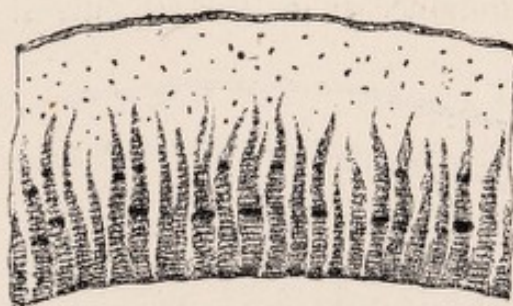


FIG. 132.—Cusparia bark. Transverse section, showing oil-cells and groups of bast-fibres. Magnified. (Planchon and Collin.)

The bark breaks with a short resinous fracture, the transverse section exhibiting a whitish cork, a yellowish brown cortex, and, in the bast, yellowish oblique or wavy medullary rays alternating with darker bast-rays. Throughout both cortex and bast numerous cells filled with white crystals of calcium oxalate, as well as minute dark ones filled with oil, may be distinguished under the lens.

Microscopical Characters.—A transverse section examined under the microscope shows a cork varying in thickness and in the nature of the cells, layers with thin-walled cells alternating with thick-walled. The primary cortex usually contains but few sclerenchymatous cells; when present they are generally near the cork and probably belong to the phelloderm. The secondary bast contains

occasional tangentially elongated groups of bast fibres and slender axially elongated prisms of calcium oxalate. All the tissues except the cork contain small oil-cells with droplets of yellowish oil, and tangentially elongated cells filled with acicular raphides.

The bark has an unpleasant musty odour and a bitter taste. The student should observe

- (a) The cork, which is often spongy,
- (b) The laminated inner portion,
- (c) The calcium oxalate,
- (d) The characteristic odour.

Constituents.—The bitterness of cusparia bark is due chiefly to angosturin, $C_9H_{12}O_5$, a substance that has been obtained in colourless pulverulent crystals melting at $58^\circ C.$,

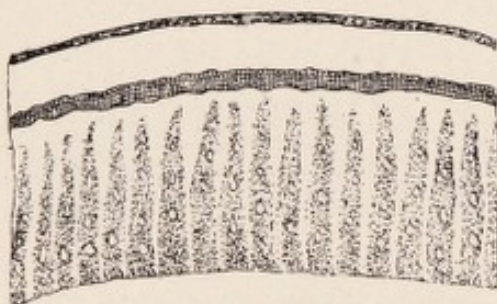


FIG. 133.—Nux Vomica bark. Transverse section, showing band of sclerenchymatous cells. Magnified. (Planchon and Collin.)

easily soluble in water, alcohol, and ether. The bark also contains a number of alkaloids (2.4 per cent.), five of which — viz. galipine, cusparine, galipidine, cusparidine, and cuspareine — have been crystallised. Amorphous alkaloids are also present, as well as a glucoside yielding by hydrolysis a fluorescent substance.

By distillation the drug yields about 1.5 per cent. of an aromatic volatile oil, the most important constituent of which is the aromatic sesquiterpene alcohol, galipol.

Cusparine, $C_{20}H_{19}NO_3$, forms colourless needles or compact crystalline masses, readily soluble in alcohol, ether, and chloroform; its salts are sparingly soluble in water.

Galipine, $C_{20}H_{21}NO_3$, crystallises in colourless needles, but yields deep yellow salts.

Cusparidine, $C_{19}H_{17}NO_3$, *galipidine*, $C_{19}H_{19}NO_3$, and *cuspareine*, $C_{34}H_{36}N_2O_5$, are present in small amount only.

Uses.—Cusparia belongs to the group of aromatic bitters. It formerly had a high reputation as a febrifuge and tonic, being preferred to cinchona bark on account of its freedom from astringency.

Substitutes.—The accidental substitution in Hamburg in 1804 of the bark of *Strychnos nux-vomica*, Linné, for cusparia bark led to several cases of poisoning. Such a substitution or admixture is not likely to occur again, and would moreover be easily detected, as the barks do not bear much resemblance to one another. *Nux vomica* bark is harder and thicker; it occurs in small, often recurved, pieces, with dark greyish, yellowish, or rusty-red cork, usually bearing numerous greyish warts. The dark transverse section exhibits under the lens a distinct paler line of sclerenchymatous cells separating the cortex from the bast; this line of sclerenchymatous cells is never found in cusparia bark.

SIMARUBA BARK

(Cortex Simarubæ)

Source &c.—Simaruba bark is obtained from two species of *Simaruba*, viz. *Simaruba amara*, Aublet, and *S. glauca*, De Candolle (N.O. *Simarubæ*), both of them tall trees with long horizontal roots, the former a native of Guiana and Northern Brazil, the latter of the West Indian Islands and Florida. It was brought from Guiana to Paris in 1713 as the bark of a tree called by the natives *simaruba* and used by them with great success in dysentery. In Europe it soon gained renown, and was imported in considerable quantity.

The bark at present in commerce is that of *S. amara* and is imported from British Guiana and Venezuela. It is stripped from the root, probably after a preliminary beating to loosen it, freed from the outer layer (cork), and dried.

Description.—*Simaruba* bark is imported in long fibrous strips, sometimes as much as a metre in length, a decimetre wide, and between 3 and 6 mm. thick. These pieces are more or less fissured and rent longitudinally, probably the result of beating. Externally they are of a buff or yellowish brown colour, and rough as though they had been deprived of the outer cork layer by rasping. They are frequently marked with

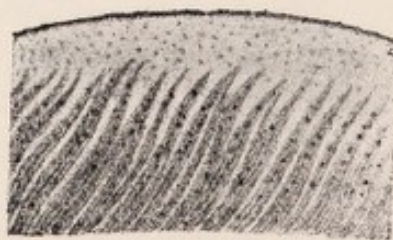


FIG. 134.—*Simaruba* bark. Transverse section, magnified. (Berg.)

brownish raised corky warts or the depressions left after their removal.

The inner surface is yellowish, longitudinally striated, and fibrous. In fact the whole bark is characterised by its extremely fibrous nature, as it may be bent double without completely breaking.

The transverse section exhibits numerous, narrow medullary rays traversing the bark from the inner almost or quite to the outer margin, and showing therefore that the drug consists almost entirely of bast tissue, the cork and part or all of the cortex having been removed.

The drug has no odour, but a very bitter taste.

The student should observe

- (a) The *extremely fibrous* nature of the bark,
- (b) Its *yellowish colour* and *bitter* taste,
- (c) The characters of the *transverse section*.

Constituents.—Simaruba bark contains 0.05 to 0.1 per cent. of a colourless, crystalline bitter principle possessing neither alkaloidal nor glucosidal properties and quite distinct from other crystalline bitter principles occurring in plants of the same natural order (*e.g.* samaderin, quassiin). It also contains a tasteless crystalline substance, fixed oil, a yellow resin, and traces of a fluorescent substance (Gilling, 1908).

Use.—Simaruba bark was formally used for dysentery; it is now seldom employed in European medicine.

EUONYMUS BARK

(Cortex Euonymi)

Source &c.—Euonymus bark is the dried root-bark of the wahoo tree, *Euonymus atropurpureus*, Jacquin (N.O. *Celastrinæ*), a tall erect shrub with small dark purple flowers succeeded by crimson fruits; it is common in the eastern United States, extending westward to Wisconsin and southward to Florida. The root-bark is alone official, but the stem-bark also is collected.

Description.—Euonymus root-bark occurs in small, more or less irregular quilled or curved pieces, not usually exceeding 8 cm. in length or 12 mm. in width. The outer layer is a soft,

spongy, finely fissured cork, easily removed with the finger-nail; it is of a light ash-grey colour marked with darker lines or patches (due to adhering particles of earth) and occasional small transverse scars. The inner surface is of a pale tawny yellow or buff colour and nearly smooth; occasionally a thin shaving of pale yellow, dense wood adheres to it, indicating that the bark is separated with difficulty from the root.

It breaks with a very short fracture, and if the two pieces be separated very gently from one another delicate silky threads will be seen connecting them; these threads consist of a substance



FIG. 135.—*Euonymus* root-bark.
Natural size.



FIG. 136.—*Euonymus* root-bark.
Transverse section, magnified.
(Planchon and Collin.)

resembling caoutchouc or gutta-percha which is secreted in laticiferous cells in the bast, and is found in all species of *Euonymus*.

The section, which is of a greyish white colour, exhibits, when moistened, a narrow whitish cork, a pale cortex, and darker bast.

The bark has a faint but characteristic odour recalling that of liquorice root, and a disagreeable and persistent, bitter, acrid taste.

Microscopical Characters.—The transverse section exhibits a thick layer of narrow cork cells, a cortex containing abundant cluster crystals of calcium oxalate and a wide layer of secondary bast in which small cells filled with a granular substance are scattered. The bark contains no bast fibres or sclerenchymatous cells. The medullary rays are one cell wide.

The student should observe

- (a) The *spongy grey cork*,
- (b) The characteristic *silky threads from the fractured surface*,
- (c) The *bitter taste*.

Constituents.—Very little that is definite is known of the chemical constituents of euonymus bark. A nearly colourless, amorphous, intensely bitter principle, euonymin, has been isolated (Wenzell, 1862), as well as a crystalline glucoside (Meyer, 1883, Romm, 1885), resembling digitalis in its action, to which the same name has been given; the latter constituent is said not to be contained in commercial euonymin. Both of these substances must be carefully distinguished from commercial euonymin, which is a powdered extract, and from the crude mixture of substances precipitated by water from a concentrated alcoholic tincture, which is also known as euonymin.

The bark also contains considerable quantities of dulcite, $C_6H_8(OH)_6$, a hexatomic alcohol readily crystallising in large plates melting at $188.5^\circ C.$; it has a sweetish taste and has been found in a considerable number of plants.

Uses.—Euonymin (the powdered extract) is an hepatic stimulant, direct cholagogue, and mild cathartic. It is used in constipation and in hepatic derangements.

Substitute.—The stem-bark, which, although not official, is a commercial article, occurs in long thin narrow strips; it has a dark greenish grey cork, green cortex, and fibrous bast; it is therefore easily distinguished from the root-bark.

ALDER BUCKTHORN BARK

(Cortex Rhamni Frangulæ)

Source &c.—The alder buckthorn, *Rhamnus Frangula*, Linné (N.O. *Rhamnææ*), is a shrub indigenous to and not uncommon in England, and distributed generally over Europe. It is distinguished from the common buckthorn (*R. cathartica*, Linné), the only other indigenous species, by the entire leaves, hermaphrodite flowers with five stamens, absence of thorns, and tree-like habit.

The medicinal value of the bark appears to have been known in the middle ages, but forgotten until recent years, when its use was again advocated. Even now it appears to meet with little favour.

The bark is stripped from the stem and branches, the wood of which was formerly valued for making charcoal for gunpowder. When fresh it has an unpleasant odour and taste, and acts as an emetic, properties which are lost when the



FIG. 137.—Alder Buckthorn bark. A, young, B, older bark. Natural size.

bark is dried and kept : alder buckthorn bark should not therefore be employed medicinally until it has been kept for at least a year.

Description.—The dried bark as found in commerce varies very much in size according to the size of the stem or branch from which it has been collected. It occurs in single or double quills which may be as much as 4 cm. in diameter or as little as 6 mm.; commonly they are 15 cm. or more in length. Young bark is usually extremely thin and has a smooth, glossy, dark purplish exterior marked with small circular or transversely elongated, whitish lenticels. The cork frequently

exfoliates, or at least easily separates, disclosing a yellowish brown cortex, but the inner part of the cork is of a dark crimson colour easily seen by gently scraping off the outer cork cells. The inner surface is dark cinnamon-brown in colour and nearly smooth, exhibiting under the lens fine longitudinal striations. The fracture is short in the outer, but rather fibrous in the inner part, groups of bast fibres projecting a short distance beyond the fractured surface.

The transverse section shows under the lens a narrow dark purple cork and yellowish brown cortex and bast.

Older bark is commonly much rougher. It has usually a dull dark purple colour, and is marked with transversely elongated lenticels and shallow longitudinal fissures, the cork exhibiting less disposition to exfoliate. The transverse section shows a similar purple cork; the bast is thicker and allows of very thin medullary rays being distinguished. The absence of sclerenchymatous cells is a character occasionally of value in excluding substitutes.

The bark has no odour and a taste that is scarcely bitter. As previously observed, it should not be used medicinally until at least a year after its collection.

The student should observe

- (a) The *dark purple cork*, showing, when scraped, a *deep crimson colour*,
- (b) The *light-coloured lenticels*,
- (c) The *shortly fibrous fracture* of the bast.

Microscopical Characters.—A transverse section exhibits a cork consisting of narrow cells many of which contain a bright purplish crimson colouring matter. The cortex contains small starch grains, cluster-crystals of calcium oxalate and elongated mucilage cells but no sclerenchymatous cells. The secondary bast contains numerous tangentially elongated groups of thick-walled bast fibres; the medullary rays are mostly two cells wide. The cells of the medullary rays and bast parenchyma contain a yellowish amorphous substance dissolving in solution of potassium hydroxide with production of a bright purple colour.

Constituents.—The active constituents of alder buckthorn bark are but imperfectly known. It contains a glucoside, frangulin, $C_{21}H_{20}O_9$, which crystallises in lemon-yellow needles melting at 228° C. to 230° C. It is slowly volatile at ordinary temperature and stains the paper in which the drug

is kept; it is soluble in caustic alkalies with purple coloration. Boiled with alcoholic hydrochloric acid it is converted into rhamnose and frangula-emodin. Rhamnose (isodulcitol) is a pentatomic alcohol (pentose, pentagluconic), and is produced by the hydrolysis of quercitrin and a number of other glucosides, which are therefore termed rhamnosides. Frangula-emodin, $C_{15}H_{10}O_5$, occurs in reddish yellow crystals melting at $254^{\circ}C$. It is a derivative of anthraquinone, viz. trioxymethylantraquinone, $C_{14}H_4(CH_3)(OH)_3O_2$, and appears to be identical with rheum-emodin, but different from aloë-emodin and senna-emodin.

Frangula-emodin has been known under various names viz. frangulin (Casselmann, 1857), frangulinic acid (Faust, 1869, Keussler, 1873), avornic acid (Kubly, 1866), rhamnoxanthin (Binswanger, 1850).



FIG. 138.—Alder Buckthorn bark. Transverse section, magnified. (Berg.)

Frangulin is said not to be present in the fresh bark, but to be produced from some unknown constituent during the maturing of the bark, the change in the physiological action of the bark occurring simultaneously. It has been stated (Aweng, 1897) that this change can be effected by heating the bark for some time to $100^{\circ}C$. by which an enzyme ferment, the cause of the emetic action, is destroyed, but this statement is of very doubtful accuracy.

The total quantity of frangula- (or other) emodin present in the bark either free or in the form of a rhamnoside has been estimated at 1 per cent. in old bark, 2 per cent. in bark of medium age, and 3.8 per cent. in very young bark. This proportion is insufficient to account for the laxative action of the drug, and the assumption is that either other at present unknown purgative bodies are present or that the frangulin exists in an unknown more active form.

The presence of frangula- (or other) emodin in the bark is readily demonstrated by moistening 0.1 gm. of the powdered

bark with 10 drops of alcohol and boiling for a few moments with 10 c.c. of water. The cooled decoction is shaken with 10 c.c. of ether, the yellowish ethereal solution separated and shaken with ammonia, which will acquire a reddish colour.

Use.—Alder buckthorn bark has been used as an agreeable laxative, preferable to cascara sagrada on account of its less disagreeable taste.

Substitutes.—Other barks are occasionally offered for sale resembling alder buckthorn bark but differing from it in structure; this is, therefore, of importance in identifying it.

CASCARA SAGRADA

(Cortex Rhamni Purshiani, Sacred Bark,
Chittam Bark)

Source &c.—Cascara sagrada, as this drug is commonly called, is the bark of *Rhamnus Purshianus*, De Candolle (N.O. *Rhamnaceæ*), a shrub or small tree abundant in North California and very abundant in the States of Washington and Oregon, the bark being collected in these States and exported from San Francisco. The bark of *R. californicus*, Eschscholz, was known to the Spanish settlers in California as cascara sagrada, a name which has since been applied to the bark of the closely allied *R. Purshianus*. The latter has been much used as a laxative since 1883.

The bark is collected in the spring and early summer, as soon after the rains as possible, at which season it is easily peeled from the wood and dried in the shade. If left till later in the year it adheres so firmly to the wood that it has to be cut off, and then brings shavings of wood with it.

Description.—Cascara sagrada occurs in straight, stiff, single quills or in channelled pieces. The quills vary from 5 to 25 mm. or more in diameter, whilst the channelled or sometimes flattish pieces may be as much as 10 cm. wide; commonly the drug is seen in pieces about 10 to 20 cm. long, 2 cm. wide, and from 1.5 to 4 mm. thick, the thinnest being most esteemed.

The outer layer is a smooth, dark purplish brown cork marked with transversely elongated whitish lenticels. The bark, however, is usually more or less completely covered with

silvery grey patches of lichens which conceal the purple cork and the lenticels and give to the drug its pervading greyish white colour, but they can easily be removed by scraping, disclosing the purplish cork. The inner surface is of a dark, or even very dark, reddish brown colour and longitudinally striated, with faint transverse corrugations.

The fracture is short; that of the bast being shortly fibrous. The smoothed transverse section exhibits under the lens a narrow purplish cork, a yellowish grey cortex in which darker translucent points (groups of sclerenchymatous cells) can be distinguished, and a brownish yellow bast in which wavy, somewhat distant medullary rays may sometimes be discerned.

The bark has a characteristic though not strong odour, and a persistent, nauseously bitter taste.

Like alder buckthorn bark, this drug should be kept for at least a year before it is used medicinally; the action is then milder and less emetic. It also shares with alder buckthorn bark the property of imparting a yellow colour to the paper in which it is kept.

Microscopical Characters.—The structure of cascara sagrada closely resembles that of alder buckthorn bark, the chief differences being in the contents of the cork cells which are reddish brown, and the presence of groups of sclerenchymatous cells in the cortex and secondary bast.

The student should observe

- (a) The *purplish cork* and the *grey lichens* covering it,
- (b) The *groups of sclerenchymatous cells* in the cortex,
- (c) The *characteristic odour and taste*;

and should compare the bark with

Alder Buckthorn bark, which has deep crimson inner cork layers and no sclerenchymatous cells.



FIG. 139.—Cascara Sagrada bark. Natural size.

Constituents.—Our knowledge of the constituents of cascara bark is very deficient. The presence of emodin and an allied substance, possibly frangula-emodin, has been definitely proved, but the latest research (Jowett, 1904) failed to afford any evidence of chrysophanic acid, chrysarobin, or any glucoside yielding by hydrolysis emodin, chrysophanic acid, or rhamnetin; the evidence as to the presence of such glucosides is therefore conflicting. The total amount of emodin and frangula-emodin (1.4 to 2.0 per cent.) present in the bark either normally or after boiling with dilute sulphuric acid is quite insufficient to account for the purgative action of the drug, and the real laxative principle remains therefore still unknown.

The bitter taste of the bark appears to be due to a lactone which is converted into less bitter salts by treatment with alkalies or alkaline earths, but this change is accompanied by simultaneous loss of activity.

The bark also contains fat (about 2 per cent.), glucose, and a hydrolytic enzyme which, however, was devoid of any griping action when taken internally. No difference could be detected in the chemical constituents of the fresh (one year old) bark and the matured (three years old) bark. Purshianin (Dohme) and cascarin (Leprince) appear to be impure substances.

The presence of emodins may be demonstrated by the test given under Alder Buckthorn bark; the ammonia acquires a yellowish red colour.

Cascara bark yields about 27 per cent. of aqueous extract and 5 per cent. of ash.

Uses.—Cascara sagrada is tonic and stomachic in small doses, aperient in large doses, and cathartic if freely given. It is said to be more active and more certain than alder buckthorn.

Substitute.—The bark of *R. californicus*, Eschscholz, is said to have been substituted for that of *R. Purshianus*. The shrub occurs sparingly in North California, but abundantly in the south and east of the State, as well as in Arizona, New Mexico, and Texas. The bark is said to be distinguished by its dull grey, slightly reddish cork, its fewer lenticels and uniform coat of lichens; the inner surface is said to be paler, and the medullary rays commonly 3 to 4 cells wide, those of *R. Purshianus* being only 2 to 3 cells wide. The two plants are, however, so closely allied that some botanists refer them to the same species.

SASSY BARK

(Red Water Bark, Cortex Erythrophlei)

Source &c.—Sassy bark is derived from *Erythrophleum guineense*, G. Don (N.O. *Leguminosæ*), a large tree indigenous to and widely distributed on the west coast of Africa (Upper Guinea and Senegambia). Possibly other species than



FIG. 140.—Sassy bark. A, portion of bark of medium thickness, showing fissured surface; B, portion of very thick bark showing rugged surface, with depressions produced by exfoliation of the outer portion.

E. guineense yield the sassy bark of commerce, as certain differences have been observed in the alkaloid obtained from the bark imported at different times.

It has poisonous, emetic, and purgative properties, and is used by the West African negroes as an ordeal poison. An alkaloid prepared from it was recommended in 1875–77 as a substitute for digitalis.

The bark is collected from the trunk as well as from the larger and smaller branches.

Description.—Sassy bark varies exceedingly in size and thickness according to the age of the stem or branch from which it has been collected. Most common are hard heavy curved or flat pieces about 8 or 10 cm. long, 4 to 8 cm. wide, and about 5 to 10 cm. thick; but small quills, not 1.5 cm. in diameter, may sometimes be found.

In pieces of medium thickness the outer layer (cork) is usually of a dull grey colour, but sometimes it is so dark as to be nearly black; it is interrupted by reddish warts or circular spots that eventually fuse together into longitudinal bands.



FIG. 141.—Sassy bark. Transverse section, magnified, showing the distribution of sclerenchymatous tissue. (Planchon and Collin.)

Older and therefore thicker barks are rugged, and have a more uniform reddish brown colour. They often exhibit conchoidal depressions of considerable size (1 to 2 cm. long), the whole surface, elevations as well as depressions, being ruggedly ridged. In these barks most of the primary cortex has been exfoliated by the formation of cork. Very young bark is comparatively smooth and dark in colour; it bears occasional small reddish warts and exhibits longitudinal reddish bands.

The inner surface exhibits shallow longitudinal striations or elevations, and is of a dark reddish brown or, more commonly, dull black colour.

The bark is extremely hard, and breaks with a very short granular fracture. The transverse section examined under the lens is most characteristic. The cork appears as a narrow brownish line; the cortex is narrow and darker in colour, and separated from the bast by a pale complete or interrupted line of sclerenchymatous cells. The bast, which constitutes the major part of the large and thicker pieces, exhibits numerous large closely approximated groups of sclerenchymatous cells embedded in reddish brown (parenchymatous) tissue. The structure of this portion of the bark is discernible with the naked eye, and is identical in both young and old bark. The bark has no odour, and only a slightly bitter and astringent taste.

The student should observe

- (a) The *reddish brown warts (or outer surface)* and the *nearly black inner surface*,
- (b) The *hard granular fracture*,
- (c) The *sclerenchymatous cells* in the bast.

Constituents.—Sassy bark contains an alkaloid, erythrophlœine, possessing an action similar to that of foxglove. It has not yet been obtained in a crystalline form, nor has it been sufficiently investigated.

Uses.—Erythrophlœine has been found useful in certain forms of heart disease. The hydrochloride has local anæsthetic properties and has been used in dental operations.

WILD CHERRY BARK

(Virginian Prune Bark, Cortex Pruni Virginianæ)

Source &c.—The bark that is commonly known as 'wild cherry bark,' and officially in the British Pharmacopœia as Virginian prune bark, is obtained from *Prunus serōtina*, Ehrhart (N.O. *Rosaceæ*), the black cherry, a tree widely distributed over North America, especially throughout the northern and central States. The wood is highly valued for cabinet work, whilst the bark is employed medicinally, having come into extensive use in America during the latter part of the eighteenth century.

The bark of the trunk is of a blackish brown colour and rough; that of the twigs and smaller branches is smooth or even glossy, dark reddish brown in colour, and bears numerous whitish lenticels. For medicinal use, bark from the smaller branches is collected in the autumn, at which time experiments have proved it to be most active; that from the trunk has been shown to be inferior to that from the branches (Stevens, 1896).

Description.—Wild cherry bark varies considerably in appearance. It occurs usually in flattened, curved, or recurved pieces, attaining 12 cm. in length and 5 cm. in width, but generally smaller and about 2 mm. in thickness. Young bark is frequently covered with a thin, smooth, often glossy, reddish brown cork, much interrupted by whitish lenticels which are strongly tangentially elongated. It can easily be peeled off in

thin, membranous tangential strips, disclosing a smooth greenish brown cortex. Much of the commercial drug has been deprived of its cork, and then the smooth greenish brown cortex, bearing scars corresponding to the lenticels, constitutes the outer



FIG. 142.—Virginian Prune bark, showing transverse lenticels and papery cork peeling off. Natural size.

layer. Sometimes even this has been removed, and the exposed part is then the outer layer of bast, which has a rough or rasped appearance and is of a uniform dark cinnamon-brown colour; examined under the lens such bark exhibits pale longitudinal strands (sclerenchymatous cells) alternating with darker parenchymatous tissue (medullary rays).

The inner surface of the bark is of a cinnamon-brown colour and is finely longitudinally striated or rough, with reticulately anastomosing pale strands, the interstices of which are only partially filled with the brown (parenchymatous) tissue of the medullary rays.

The fracture is short and granular; the fractured surface has a reddish grey colour, and usually exhibits numerous tortuous, pale red medullary rays alternating with

bast rays containing much sclerenchymatous tissue, the latter projecting beyond the medullary rays, owing to their contracting less on drying.

The bark has a slight odour of bitter almonds, which becomes much more apparent when it is moistened; the taste is astringent, aromatic, and bitter, resembling that of bitter almonds.

The student should observe

- (a) The reddish brown cork with numerous lenticels,
- (b) The irregularly reticulated or fissured inner surface,
- (c) The granular fracture,
- (d) The taste of bitter almonds when chewed.

Constituents.—Wild cherry bark yields, when moistened with water, hydrocyanic acid and benzaldehyde. This reaction

has been shown by Power and Moore (1909) to be due to laevo-mandelonitrile glucoside, $C_{14}H_{17}O_6N$, which is isomeric, but not identical with prulaurasin and sambunigrin (compare p. 47); it is hydrolysed by an enzyme also contained in the bark, yielding hydrocyanic acid, benzaldehyde and dextrose.

Experiments have shown that thin green bark collected in the autumn from trees of moderate size yields most hydrocyanic acid (0.12 to 0.16 per cent.); the bark of the root is said to be more active than that from the stem or branches (Stevens, 1896).

The bark contains also a brown resin, trimethylgallic acid, paracumaric acid and traces of benzoic acid and volatile oil; a green resin yielding by acid hydrolysis β -methylæsculetin is also present. The commercial drug afforded Power and Moore 0.075 per cent. of hydrocyanic acid.

Uses.—The bark has mild tonic and sedative properties; it is frequently given for coughs and chest complaints.

Substitutes.—The bark of other North American species of *Prunus* is occasionally substituted for the official. The latter is well characterised by its short granular fracture and distinctive taste, as well as by the presence of abundant sclerenchymatous cells and absence of bast fibres. Spurious barks may be fibrous or more astringent or almost devoid of taste. Old (trunk) bark is characterised by the numerous depressions on the outer surface and the absence of lenticels.

QUILLAJA BARK

(Panama Wood, Soap Bark, Cortex Quillajæ)

Source.—Quillaja bark, or, as it is often called, soap bark, is obtained from *Quillaja saponaria*, Molina (N.O. *Rosaceæ*), a large tree indigenous to Chili and Peru. The bark, which is called 'cullay' by the natives and has apparently been long used by them for washing silk and wool, was known to Europeans in the early part of the eighteenth century, but was not regularly imported until about 1857, when it was sent to France under the name of 'Bois de Panama,' the name indicating the route by which it was sent. It is evidently stripped from the trees in large pieces, freed from the outer

dark brownish portion (bark), and dried. The tree has been introduced into India, where it yields a bark identical with the commercial drug.

Description.—Soap bark comes into commerce in large flat pieces about a metre in length and 10 or 15 cm. in breadth; it is usually about 6 mm. thick, and evidently the produce of trunks of considerable size.

The outer surface is usually of a pale brownish or yellowish white colour, longitudinally striated and streaked with reddish brown where the outer portion (bark) has been imperfectly removed. Sometimes, from insufficient trimming, the bark is of a uniform dark dull red colour and bears patches of the outer

bark still adhering to it. The inner surface is smooth and white or yellowish white.

The bark breaks with a splintery fracture, and the fractured surface exhibits a disposition to separate into thin plates or laminae. Here and there, especially on the freshly fractured laminated surfaces, but also on the smooth inner surface of the bark, minute, glittering, prismatic crystals (calcium oxalate) can be seen with the naked eye, or better with a lens; sometimes these are present in considerable numbers.

The smoothed transverse section is seen under a lens to be traversed by parallel tangential and radial lines, which give it a chequered appearance; the



FIG. 143.—Quillaja bark, showing splintery fracture. Natural size.

tangential lines are tangentially arranged bands of bast parenchyma, the radial are medullary rays, the darker portions between being groups of bast fibres.

The bark is almost odourless, but small portions dislodged when it is handled or broken are extremely irritating to the nostrils and fauces and give rise to prolonged fits of sneezing; the taste is acrid and unpleasant.

The student should observe

- (a) The *splintery, laminated fracture*,
- (b) The *glittering crystals of calcium oxalate*,
- (c) The *very smooth inner surface*,
- (d) The *appearance of the transverse section* ;

and should compare this bark with

- (i) *Elm bark*, which is fibrous and has a roughish, not smooth, inner surface,
- (ii) *Slippery elm bark*, which has a decided odour of fenugreek and is very fibrous.

Constituents.—The principal constituents of quillaja bark are two colourless, amorphous, toxic glucosides, quillajic acid and quillaja-sapotoxin. Both of these substances impart to water the property of frothing, and possess other characters common to the class of substances known as 'saponins' (see below). The drug also contains cane sugar.

The saponins are nitrogen-free glucosides of acid or neutral reaction, soluble in water and in hot dilute alcohol, less soluble in strong alcohol, insoluble in ether, and capable of imparting to water the property of frothing freely like soap solution. They are widely distributed, having been found in 200 plants belonging to 50 natural orders, but are most strongly represented in the orders *Caryophyllaceæ* and *Sapindaceæ*. They are all glucosidal, and yield by hydrolysis a non-toxic sapogenin together with two or more sugars.

All saponins are toxic when introduced directly into the circulation, but the degree of toxicity varies greatly; they are protoplasmic poisons, irritating and killing protoplasm and dissolving red blood-corpuscles. Taken by the mouth some can be borne in considerable quantity. Almost all of them stupefy fish even when present in small proportion (1 : 200,000) only. With concentrated sulphuric acid they produce a characteristic red coloration; with a mixture of alcohol and sulphuric acid and ferric chloride a green colour is obtained.

The saponins have been classified in two series, viz. acid saponins (quillajic acid, polygalic acid, guaiacsaponic acid, &c.) and neutral saponins (quillaja-sapotoxin, senegin, parillin, guaiacsaponin, &c.). The composition of many of them may be expressed by the general formula $C_nH_{2n-8}O_{10}$ (Kobert); for neutral saponins of the formula $C_{17}H_{26}O_{10}$ the name of sapotoxin is reserved.

Commercial saponin is usually obtained from quillaja bark, and is a mixture of quillajic acid, quillaja-sapotoxin, and frequently also a

non-toxic modification of quillajic acid produced during the preparation; as the term saponin has become a generic one, a prefix to indicate the source would be desirable.

Quillajic acid, $C_{19}H_{30}O_{10}$, has been obtained as a colourless amorphous mass, the powder of which is strongly sternutatory. The aqueous solution is acid and has an acrid taste. Boiled with a mineral acid it yields quillaja-sapogenin, galactose, and another sugar, which is non-fermentable and dextrorotatory.

Quillaja-sapotoxin, $C_{17}H_{26}O_{10}$, is also white, amorphous, sternutatory, and acrid.

Uses.—Quillaja bark has been recommended as a stimulant and expectorant, but has not met with much favour. A tincture is largely used as a means of emulsifying tars &c.

Substitutes.—Considerable quantities are imported of a quillaja bark differing from the foregoing in being thinner and in having a more or less uniform brownish outer layer marked with white reticulations. It appears to be derived from a different species of *Quillaja*, possibly *Q. Poeppigii*, Walpers, or *Q. smegmadermos*, De Candolle.

WITCH-HAZEL BARK

(Cortex Hamamelidis)

Source &c.—The witch hazel, *Hamamelis virginiana*, Linné (N.O. *Hamamelidaceæ*), is a common shrub in the United States and Canada. It attains a height of about 3 metres and resembles the common hazel both in its leaves and its fruit, which is edible. The bark should be collected in the spring.

Description.—Witch-hazel bark occurs in thin channelled pieces of a characteristic pale reddish pink colour, occasionally as much as 15 or 20 cm. long and 2.5 cm. wide, but usually much smaller. They are sometimes covered with an ash-grey smooth cork which in older pieces becomes darker in colour, fissured, and scaly. Frequently the cork has been removed and the cortex forms the outer layer, which is then pale reddish brown in colour and nearly smooth, exhibiting under the lens slight transverse striations.

The inner surface is pale reddish pink in colour and finely striated longitudinally; small portions of white wood, which is

seen in transverse section to be dense and traversed by numerous thin medullary rays, are frequently found adhering to it.

The outer portion of the bark (cork and cortex) breaks with a short fracture, but the inner portion (bast) is coarsely fibrous and disposed to separate into laminae, due to its containing numerous tangentially elongated groups of bast fibres. The smoothed transverse section exhibits under the lens a dark narrow cortex and a pale tangential line (sclerenchymatous cells) separating this from the bast. In many of the pieces the cork and much of the cortex have been removed, and the ring of sclerenchymatous cells may then form the outer layer.

The bark has no odour, and an astringent, slightly bitter taste.

The student should observe

- (a) The *reddish pink* colour,
- (b) The *pale grey but not glossy* cork,
- (c) The *line of sclerenchymatous cells between the cortex and bast*;

and should compare this bark with

- (i) *Oak bark*, which has a glossy, silvery cork and usually a brownish colour,
- (ii) *Willow bark*, which has a dull greenish brown cork, is usually longitudinally striated on the outer surface, and does not exhibit a line of sclerenchymatous cells.

Constituents.—The bark contains about 6 per cent. of tannin, part of which, hamamelitannin, is crystalline and part amorphous; gallic acid is also present (Grüttner, 1898).

Uses.—It is astringent and hæmostatic, and is useful in hæmorrhages from the nose, lungs, rectum, or uterus.



FIG. 144.—Witch-hazel bark, showing scaly cork. Natural size.

POMEGRANATE BARK

(Cortex Granati)

Source &c.—The pomegranate tree, *Punica Granatum*, Linné (N.O. *Lythrariceæ*), is a shrub or small tree indigenous to North-western India, but cultivated generally in the warmer parts of the temperate regions, especially in the countries bordering on the Mediterranean. More than one variety is known, but that producing crimson flowers is the commonest.

The vermifuge action of the pomegranate was well known to the ancients, who employed the juice of the fruit mixed with wine, as well as the small roots and a decoction of the root-bark. The drug appears to have been subsequently forgotten, but at the beginning of the present century its use among the Hindoos attracted the attention of English physicians, and it began to be successfully employed. The bark of the root is said to be the most efficacious, especially when administered in the fresh state, but analyses have shown that the stem-bark is only slightly inferior in the proportion of alkaloid it contains (Ewers, 1899). As it is difficult to procure the root-bark alone

in commerce, the official description has been framed so as to include that of the stem.



FIG. 145.—Pomegranate root-bark. Transverse section, magnified. (Berg.)

Description.—Pomegranate bark occurs in irregular, curved or channelled pieces, varying usually from 5 to 10 cm. in length and from 1 to 3 cm. in width; it seldom forms quills.

The root-bark has a rough outer surface of an earthy yellow colour with darker patches and is marked with conchoidal depressions, due to exfoliation of the outer portion. The inner surface is smooth and yellow in colour, with irregular, darker, brown blotches.

It breaks with a very short fracture, the fractured surface being nearly white and exhibiting under the lens numerous fine tangential and still finer radial lines.

The stem-bark differs from the root-bark in being smoother. It exhibits no conchoidal depressions, the formation of cork being less abundant, but it presents occasional, shallow, longitudinal furrows and bands of pale cork. Very frequently the

minute apothecia of lichens can be detected on it; these are not to be found on the root-bark. The latter, too, is usually in more irregular, curved, flattish or even recurved fragments, whilst the stem-bark is in straighter, channelled pieces and sometimes in quills.

The bark of both stem and root is odourless, but has an astringent, slightly bitter taste.

The student should observe

- (a) The *short fracture and pale interior*,
- (b) The *yellow colour of the inner surface with brown patches*,
- (c) The *comparatively smooth surface of the stem-bark and the frequent presence of lichens*,
- (d) The *rough surface, conchoidal depressions, and absence of lichens characteristic of root-bark*.

Constituents.—The most important constituents of pomegranate bark are the alkaloids it contains. Four of these have been isolated (Tanret, 1878–1880); three, viz. pelletierine, isopelletierine, and methylpelletierine, are liquid, but pseudopelletierine is crystalline. These alkaloids exist to the extent of about 0·5 per cent. in the stem-bark, and 0·6 to 0·7 per cent. in the root-bark (Ewers, 1899). The average of commercial bark appears to be about 0·35 per cent. Carr and Reynolds (1908) found only 0·12 to 0·29 per cent.; other authorities give 0·5 to 0·7 per cent.

The freshly dried bark has been found (in Java) to yield as much as 3·0 per cent., and indications are not wanting that the percentage of alkaloid diminishes on keeping. The Swiss Pharmacopœia requires a minimum of 0·5 per cent.

Pomegranate bark contains further about 22 per cent. of gallotannic acid.

Pelletierine ($C_8H_{15}NO$) (Tanret, 1878) or punicine (Bender, 1885) is a colourless liquid boiling at $195^\circ C.$, but rapidly assuming a brown colour. Isopelletierine closely resembles it; methylpelletierine boils at $215^\circ C.$ Pseudopelletierine has also been called granatonine (Cimician and Silber, 1893) to indicate its ketonamine nature.

Uses.—Pomegranate bark has an anthelmintic and slightly irritant action, but is somewhat astringent unless taken freely.

It is used in the treatment of tapeworm, which is expelled (not actually killed) by the decoction, or by the sulphate of pelletierine.

BLACK HAW BARK

(Cortex Viburni Prunifolii)

Source &c.—Black haw bark is the root-bark of *Viburnum prunifolium*, Linné (N.O. *Caprifoliaceæ*), a shrub indigenous to the Eastern and Central United States.

Description.—The drug occurs in short, quilled, channelled or curved pieces from 1 to 4 mm. (usually about 2 or 3 mm.) in thickness, and of a dull brown or reddish brown colour. In the youngest pieces the outer surface is slightly longitudinally wrinkled, older pieces exhibit small, rounded, or oval lenticles, while in old bark the surface is irregularly wrinkled, fissured, and scaly. Inner surface longitudinally striated, rough and reddish brown. Fracture short and granular, the fractured surface exhibiting a dark brown cork and a whitish or reddish cortex and bast, in which numerous pale yellowish groups of sclerenchymatous cells are distinguishable. The odour is slight, the taste bitter and astringent. Portions of the smaller roots often occur in the drug.

The student should observe

- (a) The *dull outer surface*,
- (b) The *granular fracture*,
- (c) The *bitter taste*;

and should compare the bark with

- (i) *Wild Cherry bark*, which has a glossy outer surface,
- (ii) *Pale Cinchona bark*, which has a more fibrous fracture and (usually) rougher surface.

Constituents.—Black haw bark contains viburnin (a water-soluble bitter glucoside), tannin, and a little resin.

Uses.—The drug has been used for dysmenorrhœa and asthma; it is supposed to prevent threatened abortion and to check hæmorrhage.

CINCHONA BARK

(Cortex Cinchonæ)

Source &c.—The genus *Cinchona* embraces, according to Baillon, about twenty species, all of which are indigenous to South America and restricted in that country to the chain of the Andes extending from Western Venezuela, through New Granada, Ecuador, and Peru, to Bolivia. On the spurs of this mountain range, at an elevation of about 5,000 to 7,000 feet, where the climate is warm and moist, the cinchona trees occur usually singly, not forming forests and seldom groups. They are evergreen shrubs or trees, frequently of handsome appearance and considerable size, attaining upwards of 100 feet in height.

The natives of Peru and Bolivia appear to have been only imperfectly acquainted with the febrifuge properties of the bark of these trees; at least they seldom employed it. In 1638 the Spaniards learnt the use of the drug when the Countess Chinchon, wife of the Viceroy of Peru, was cured of fever by its means. The bark soon found its way into Spain, probably by the aid of the Jesuits, who were frequently instrumental in introducing new drugs into Europe; it was known as Countess bark, Jesuit's bark, or Peruvian bark, and early in the eighteenth century the trade in it at Loxa in Ecuador had assumed considerable proportions.

Just about this time (1736) the expedition sent by the Paris Academy of Sciences to measure a degree of the earth's surface at the equator, which was accompanied by the botanist Jussieu, found trees, hitherto unknown, that yielded valuable cinchona bark. The botany of these trees was subsequently specially investigated by Mutis (1760), Ruiz and Pavon (1778-1788), Weddell (1845-1848), and others.

The method that was adopted of collecting the bark—viz. by felling the tree and stripping the bark from it—very soon aroused fears that the trees would eventually be exterminated. Attempts were made by the Jesuits to induce the bark collectors to plant young trees to replace those that they destroyed, and suggestions and attempts to cultivate the trees were not wanting. These eventually culminated in Markham's expedition to Peru and Bolivia (1859), which was successful in introducing *Cinchona succirubra*, *C. officinalis*, and other

species into British India, the cultivations being commenced at positions in the Himalayas and Neilgherries that had already been recommended by Royle.

A few years previously the German botanist Hasskarl was commissioned by the Dutch on a similar expedition, and succeeded in bringing plants and seeds to Java.

From small beginnings the cultivation of cinchona trees in British India, Ceylon, and Java has rapidly assumed such enormous dimensions that the world is practically independent of South America for its supply of quinine. Part only of the plantations belong to either the English or Dutch Government, the bulk are conducted as private enterprises, and the cultivation of cinchona trees has been carried on in many other countries besides the two referred to, as, for instance, in Jamaica, Bolivia, tropical Africa, &c.

The chief species of cinchonas that yield commercially valuable barks are

1. *Cinchona Calisaya*, Weddell, Southern Peru and Bolivia.
2. *C. Ledgeriana*, Moens, Southern Peru and Bolivia.
3. *C. officinalis*, Linné, Ecuador and Peru.
4. *C. succirubra*, Pavon, Ecuador.

The first three of these species—viz. *C. Calisaya*, *C. Ledgeriana*, and *C. officinalis*—yield barks rich in quinine, and it is to the cultivation of these three species, especially *C. Ledgeriana*, that attention is now being directed. *C. succirubra* has been largely grown in India, but is now being replaced by other more valuable species. *C. lancifolia*, Mutis, and certain other species yield barks that are poor in quinine; they are therefore not cultivated, but nevertheless these barks are imported from South America and used to some extent as sources of the cinchona alkaloids.

Collection.—The following methods have been adopted in collecting cinchona bark:

1. *Felling*.—In South America the bark is collected, usually in the rainy season, by felling the tree, stripping the bark from it, and drying it either in the sun or over a gentle fire in huts. Large thick pieces from the trunk and large branches are pressed under weights, and often freed from the dead outer portions (bark), and occur therefore in commerce in the form of thick, flat, heavy pieces (*flat bark*); the bark from the smaller branches curls as it dries into quills (*quilled bark*).

Hence the bark from the same tree may occur in two forms differing very considerably in appearance. Cultivated trees are not allowed to attain the age or size of the South American forest trees, and yield therefore no flat bark.

2. *Mossing and Renewing*.—MacIvor found in 1863 that, if the bark were removed in longitudinal strips and the trunk were afterwards protected by covering it with moss, the cambium rapidly replaced the bark that had been removed by a fresh growth, and this fresh growth proved to be richer in alkaloid than the natural bark of the tree. This method of collecting the bark was largely adopted in India, and is practised as follows: When the trees have reached a sufficient age longitudinal incisions are made and alternate strips of bark about 4 or 5 cm. wide are removed, leaving the intervening strips untouched. The bark thus collected, which has not been subjected to any artificial treatment, is known as 'natural bark.' The trunk is then covered with moss, paper, straw, or other protecting material, and left to replace the bark that has been stripped off. After a sufficient time has elapsed the covering is removed, and the strips that were left untouched on the first occasion are now collected; these have spent part of their life under a protecting covering of moss, and are called 'mossed' bark.

The tree is now again covered, and having been deprived by the first two strippings of all its original bark, yields, when visited for the third time, bark that has been entirely developed under the covering of moss to replace that which had been removed; this is 'renewed' bark.

The process is an interesting one, and has been successfully used, but the labour and consequently the expense it involves are considerable.

3. *Shaving*.—By this modification of renewing, only a portion of the bark is removed by shaving; the remainder is left on as a protection to the tree, which therefore does not require any covering of moss.

Both these methods are being abandoned in favour of the following:

4. *Uprooting*.—The tree is allowed to grow until it has attained the age at which it yields the maximum proportion of alkaloid. It is then uprooted and the bark stripped from the root as well as from the stem. By this means the valuable root-

bark is secured, and the land can then be planted with a different variety of cinchona.

5. *Coppicing*.—The tree is cut down to form stools, from which adventitious shoots arise. These shoots yield handsome quills of bark, and the method is specially suited for the production of the quilled bark sold to the pharmacist.

The bark is usually collected in the rainy season, when it separates easily from the stem; the colour of the inner surface of the fresh bark is always pale, but by the action of the air a change in the tannin rapidly takes place, and the bark assumes a brown or red colour. The drying is usually effected in the sun, or frequently by artificial heat in a specially constructed drying machine. For exportation, the bark is usually pressed by hydraulic pressure into firm bales (as in Ceylon) or stamped into sacks (as in Java), or, in the case of fine quills for druggists' use, carefully packed in cases.

Description.—The commercial varieties of cinchona bark yielded by the following species of *Cinchona* may be briefly described.

1. *C. Calisaya*.—The bark yielded by this species is sometimes called 'yellow' bark, but as this term is also applied to all cinchona barks exhibiting a distinctly yellowish brown colour it is better to specify this variety of yellow bark as *calisaya* bark. It was formerly imported in two distinct varieties, viz. (a) *flat* and (b) *quill calisaya*, but the former is now seldom seen.

(a) *Flat calisaya* was formerly imported in thick, flattish, heavy pieces 20 cm. or more in length, from 5 to 10 cm. in width, and varying frequently from 6 to 12 mm. in thickness. The inner surface was tawny yellowish brown in colour and showed a close fibrous structure, the undulating course of the fibres often communicating a wavy appearance to the bark. The outer surface was darker and marked with broad, shallow, longitudinal depressions (digital furrows). These were caused by the formation in the bark of concave lines of cork, by which shallow curved pieces of the bark had been cut off. This outer bark was commonly removed from the drug before exportation.

(b) *Quill calisaya*.—This, which at present is the variety of *calisaya* bark commonly seen, is principally obtained from plantations of *C. Calisaya* in Bolivia, and is the produce there-

fore of cultivated trees. It occurs in quills varying usually from 12 to 25 mm. in diameter and 30 cm. or more in length, fine specimens attaining 60 cm. in length and 5 to 8 cm. in diameter. The outer surface is of a dull dark grey or dull brownish colour marked with lighter, whitish patches. The outer layer is rugged, and exhibits shallow, rather broad longitudinal fissures that are frequently of a brownish colour, and hence, even if not deep, are easily seen. Transverse cracks

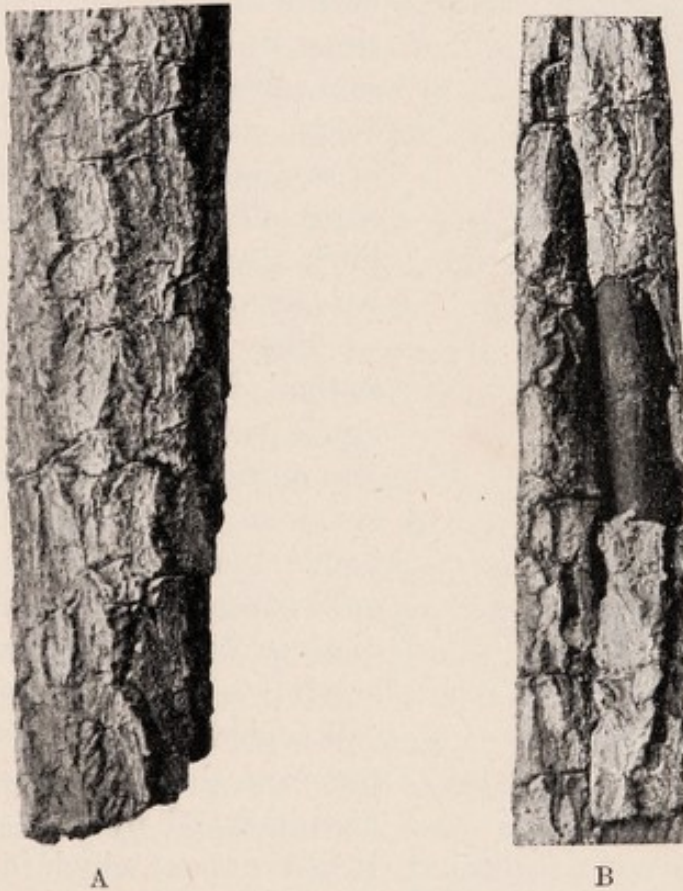


FIG. 146.—Calisaya bark. A, showing the longitudinal fissures and transverse cracks, natural size; B, showing in addition exfoliating cork, natural size.

mark the bark at distances of 6 to 12 mm. This layer shows in many pieces a decided disposition to exfoliate in flakes, the inner portion, which is of a dull yellowish brown colour, bearing impressions corresponding to the cracks of the cork.

The bark breaks with a shortly fibrous fracture, the smoothed section exhibiting a narrow dark brown outer layer (cork) and brown inner portion.

The taste is distinctly bitter and astringent, the former quality predominating.

2. *C. Ledgeriana*.—This species, which is considered by some botanists to be a variety of *C. Calisaya*, yields a bark that very closely resembles quill calisaya in general appearance and is remarkable for its richness in quinine. On this account the tree is being largely cultivated in Java in preference to other species, and most of the 'yellow' bark of commerce is Ledger bark imported from Java.



FIG. 147.—Pale bark (*C. officinalis*), showing very numerous longitudinal and transverse cracks. Large specimen, natural size.

Commercial Ledger bark occurs usually in single, sometimes in double, quills about the same size as quill calisaya. The colour internally is a dull tawny brown, often with a reddish tinge; externally the quills mostly exhibit large light grey or whitish patches of lichen.

They are marked with longitudinal furrows and transverse cracks, which, however, are usually more numerous and less conspicuous than in quill calisaya; hence the bark is rougher than quill calisaya. Some pieces bear distinct longitudinal ridges and scattered reddish warts that recall typical red bark (see below), but from this bark they are easily distinguished by their colour and by their taste, which is bitter but not markedly astringent. Sometimes the cork shows a distinct disposition to exfoliate as it does in quill calisaya, but in this feature the bark varies considerably.

As already observed, Ledger bark bears a close resemblance to quill calisaya; it is best distinguished by its more numerous and less conspicuous longitudinal fissures and transverse cracks.

3. *C. officinalis*.—The bark of this species, commercially known as *pale cinchona* or *crown bark*, is obtained chiefly from India, although some is imported from South America. It

occurs in quills only, and these are much narrower than those of quill calisaya, seldom exceeding 12 mm. in diameter, the bark itself being usually less than 1.5 mm. thick. They are frequently inrolled on both margins, so as to form double quills. The outer surface is of a dull brown colour, and often has foliaceous lichens adhering to it. Typical pieces are marked with numerous transverse cracks often less than 6 mm. apart, in addition to which there are numerous less prominent longitudinal cracks, all of which, but especially the transverse, tend to impart to the bark a roughness to the touch that is characteristic. The colour of the inner surface is usually yellowish brown, and the taste resembles that of calisaya bark in being bitter as well as astringent.

4. *C. succirubra*.—This species yields a drug that is characterised by a more or less distinct reddish colour, and is therefore usually known as 'red bark'; it occurs in two forms, viz. 'flat' and 'quill.' The former is imported from South America, but the latter is obtained from cultivated trees, and is imported principally from Java.

(a) *Flat red bark* occurs in flattish pieces, often of considerable size, and attaining 20 mm. in thickness, though usually thinner; in these respects it resembles flat calisaya, but it differs from that bark essentially in having the outer bark attached; the latter is rugged, of a dusky, ferruginous red colour, and marked with longitudinal ridges of cork as well as brighter red warts. The inner surface has also a distinctly red colour, and does not exhibit the wavy fibrous structure characteristic of flat calisaya.

The bark has a bitter and markedly astringent taste.

(b) *Quill red bark*.—The only official cinchona bark is that obtained from the stem and branches of cultivated plants of *C. succirubra*. This variety of cinchona bark is imported chiefly from Java, but India and Portuguese West Africa also send red cinchona bark to the market, which would be equally official provided that it corresponded to the description and test.

The quills of red cinchona vary in size, but are often about 25 mm. in diameter. The outer surface is of a dull brownish grey or reddish brown colour, and often bears numerous greyish lichens attached to it. It is always more or less strongly wrinkled longitudinally, and marked with warts which are sometimes small and numerous or sometimes larger and scattered; in the latter case they are usually either reddish in colour or

exhibit a reddish colour when broken. Some varieties of the bark bear small transverse cracks and reddish warts, the longitudinal wrinkles being less pronounced. In thickness the bark varies from 2 to 4 mm. The colour of the inner surface is in typical specimens reddish brown, but that of the interior of the bark is yellowish brown. This colour is due to a change in the tannin of the bark, by which a reddish phlobaphene is produced. When removed from the tree the inner surface is



FIG. 148.—Red Cinchona bark, showing longitudinal wrinkles (A), reddish warts and small transverse cracks (B). Slightly reduced.

white, but the tannin changes so rapidly that within thirty seconds a perceptible colour is developed (Tschirch). The bark has a distinctly astringent and bitter taste. The Pharmacopœia requires that it shall yield between 5 and 6 per cent. of total alkaloid, of which not less than half should consist of quinine and cinchonidine.

Branch bark may generally be distinguished from trunk bark by being thinner, by bearing more numerous wrinkles and small warts, and by being more strongly inrolled.

Renewed bark may be recognised by its more uniform brownish red colour and few but well-developed ridges and warts.

All these varieties of red bark are characterised by their taste, which is more markedly astringent than that of pale or yellow bark.

5. *C. lancifolia*.—The cinchona barks yielded by *C. lancifolia* (Columbian, Cartagena barks) occur both in single quills and in flattish pieces; they are usually more or less spongy in texture and reddish brown in colour. They are characterised and easily distinguished by the presence of smaller or larger patches of silvery cork which are to be found on almost every piece. The bark has an astringent bitterish taste.



FIG. 149.—Bark of *Cinchona lancifolia*, showing patches of silvery cork.
Natural size.

Microscopical Characters.—The transverse section of quilled red cinchona of moderate thickness exhibits an abundant cork layer, a cortex containing small starch grains, cells filled with sandy crystals of calcium oxalate, and, on its inner margin, large isolated oval laticiferous cells. The secondary bast contains large, striated bast fibres either singly or in small radially elongated groups; these bast fibres are spindle-shaped and have conspicuous more or less funnel-shaped pits. The walls of all the parenchymatous cells are dark reddish brown in colour.

The student should carefully compare the principal varieties of cinchona bark and note the following prominent characters:

1. Quilled barks:

- (a) *C. succirubra*; longitudinal wrinkles and reddish warts; a more or less spongy bark.

- (b) *C. Calisaya*; longitudinal furrows, transverse cracks, cork often exfoliating; a firm hard bark.
- (c) *C. officinalis*; very numerous small transverse and longitudinal cracks; quills usually very small and rough to the touch; a firm bark.
- (d) *C. lancifolia*; more or less uniformly smooth surface with patches of silvery-grey cork.
- (e) *C. Ledgeriana*; cracks more numerous than in *C. Calisaya*; bark rougher.

2. Flat barks:

- (a) *C. succirubra*; ferruginous red colour, reddish warts, and raised ridges; usually in thick pieces.
- (b) *C. lancifolia*; exhibits the characteristic silvery cork.
- (c) *C. Calisaya*; thick pieces with a wavy fibrous surface exhibiting depressions.

Constituents.—The chief constituents of cinchona barks are the alkaloids they contain, of which a number have been isolated. Some of these are well-defined crystalline substances, and doubtless exist preformed in the bark (possibly combined with quinic or cinchotannic acid); some, on the other hand, have been obtained only in an amorphous condition; and of others, again, it is questionable whether they are not produced from other pre-existing alkaloids during the process of isolation.

The principal alkaloids in cinchona are quinine, cinchonidine, cinchonine, and quinidine; next in importance are hydroquinine, hydrocinchonidine, quinamine, and homocinchonidine.

In addition to the alkaloids, many cinchona barks also contain a very bitter amorphous glucoside, quinovin; a crystalline organic acid, quinic or kinic acid, also found in coffee, in the whortleberry (*Vaccinium Myrtillus*, Linné), and other plants; a particular tannin, cinchotannic acid, which by oxidation rapidly yields a dark-coloured phlobaphene, cinchona red; starch, calcium oxalate, &c.

The amount of total alkaloid present in cinchona barks is subject to great variation. Quilled red bark from India

averages about 6.5 per cent.; that from Java is richer, yielding about 8.25 per cent. Calisaya quills afford about 6 or 7 per cent. and pale bark about 6 per cent. Ledger bark from Java is the richest of all, yielding from 5 to 10 or even more per cent. of total alkaloid. Root-bark is the richest, and stem-bark is better than branch-bark. The relative value of a bark is, however, determined by the proportion of quinine it contains.

Quinine was first isolated by Pelletier and Caventou in 1820, after Gomez in 1811 had produced from cinchona a crystalline combination of quinine and cinchonine. It occurs in the largest proportion in Ledger bark, the highest recorded yield being 14.5 per cent. This, however, is quite exceptional, the quinine in commercial Ledger bark averaging from 3.0 to 8.0 per cent. Bolivian cultivated calisaya contains from 3.0 to 4.0, and cultivated *C. officinalis* about 3.0 per cent. Indian red bark contains about 1.5 per cent. of quinine, but that from Java is richer, attaining as much as 5 per cent.

Cinchonine is found in small quantity in most of the cinchona barks, especially in *C. lancifolia* and some specimens of *C. succirubra*; this alkaloid is frequently found more abundantly in the root-bark than in the stem-bark.

Quinidine, discovered by Henry and Delondre in 1833, seldom exceeds 0.5 per cent. in any bark; it occurs chiefly in certain varieties of *C. Calisaya*.

Cinchonidine, isolated in 1847 by Winckler, is found more generally distributed and in much larger proportion than quinidine. The cultivated *C. succirubra* at present exported from India contains as a rule more cinchonidine than quinine, from 3 to 4 per cent. being frequently present.

All these alkaloids exist, according to de Vrij, combined with cinchotannic acid in the parenchymatous tissue of the bark.

Assay.—Cinchona bark may be assayed by the official method or by the following (essentially that of the United States Pharmacopœia), which determines the total alkaloid and the ether-soluble alkaloid (quinine, quinidine, and cinchonidine):—

Shake 15 gm. with 125 c.c. of ether and 25 c.c. of chloroform occasionally during ten minutes. Add 10 c.c. of solution of ammonia and shake frequently during five hours, then add 15 c.c. of distilled water, shake vigorously, and let stand till clear. Decant 100 c.c. into a separator and shake out first with 15 c.c. of normal sulphuric

acid, then with 10 c.c. of semi-normal acid, and finally with 5 c.c. of water. Filter the mixed acid liquids into a graduated cylinder and wash till the volume is 50 c.c.

For total anhydrous alkaloid take one-half of this, add 25 c.c. of a mixture of chloroform three volumes with ether one volume and add 5 c.c. of solution of ammonia. Shake out and repeat with 20 c.c. of chloroform-ether and with 10 c.c. of chloroform. Evaporate the chloroformic solutions in a tared, flat-bottomed flask to dryness, add 3 c.c. of ether and again evaporate. Dry at 110° C. and weigh. The weight is that of the total alkaloid in 5 gm. of the cinchona bark.

For ether-soluble alkaloid, take the other half of the 50 c.c. of acid liquid, add 20 c.c. of ether and 5 c.c., or a sufficiency, of solution of ammonia, keeping the temperature below 20° C. Shake moderately for two minutes, stand for ten minutes at 15° C., separate the aqueous liquid, transfer the ethereal solution to a tared, flat-bottomed flask rinsing the separator with ether, evaporate, dry at 110° C. for two hours; and weigh. The weight is that of the ether-soluble alkaloid in 5 gm. of the cinchona bark.

Uses.—The cinchona barks are far too bulky for use as antiperiodics and antipyretics if quinine can be obtained. They are therefore given only as bitter stomachics and tonics. The amount of tannin contained in them indicates that they may be used when an astringent effect also is desired.

CINNAMON BARK

(Cortex Cinnamomi)

Source &c.—The cinnamon tree, *Cinnamomum zeylanicum*, Breyn (N.O. *Laurineæ*), is a small evergreen tree indigenous to Ceylon and cultivated there for the sake of its aromatic bark.

Cinnamon bark appears to have been collected from wild plants and exported towards the end of the thirteenth century. After the occupation of the island by the Portuguese in 1536, the exportation became more regular. In 1770 the cultivation of the tree was successfully carried out by the Dutch, who, as in other cases, made strenuous efforts to retain the cinnamon trade in their own hands, controlling the supply and the price. Soon afterwards the English obtained possession of the island, and the trade in cinnamon was diverted from Amsterdam to London.

Cinnamon is now almost entirely obtained from cultivated plants. These are cut down to form stools, from which adventitious shoots arise. When these are from 1.5 to 2 metres long and about a year and a half or two years old, they are cut down during the rainy season. The shoots are trimmed from the leaves &c., ringed at the nodes with a brass or copper knife (to avoid the discoloration that steel would cause), and the bark removed in strips, which are allowed to remain exposed in heaps for about twenty-four hours. Each strip is then stretched upon a stick and the epidermis and cortex scraped off, great care being taken that neither too much nor too little is removed. They are then packed inside one another so as to form sticks, which are dried, cut to a definite length, sorted, and made into bundles. The trimmings are either exported as such (cinnamon chips), or are used in the island for the distillation of the volatile oil. The leaves and petioles also yield an oil, which, however, is less valuable than that from the bark.

Description.—Cinnamon occurs in long slender flexible sticks about 1 metre in length and 6 mm. in width, each consisting of numerous (about forty) channelled pieces or single quills, about 1 to 2 dm. in length, skilfully packed into one another, the largest on the outside, so as to form a long stick of compound double quills; such a stick may easily be separated into its component parts after it has been soaked in water.

Each of the pieces of bark of which the stick is composed is of papery thickness and of a dull pale brown colour. The outer surface is marked with paler, glossy, undulating, longitudinal lines (bundles of bast fibres), and shows here and there scars or holes, indicating the insertion of leaves or lateral shoots, but does not bear even a small trace of epidermis or cork. The inner surface is rather darker than the outer, and finely striated longitudinally.

The fracture is short and rather splintery; the transverse section shows an outer pale layer (sclerenchymatous cells) and an inner dark layer (bast). Having been deprived, by scraping, of the epidermis (or cork, if any has formed) and the cortex, the drug consists almost entirely of the bast, and this statement corresponds with the appearance of the bark.

Cinnamon has a fragrant odour and a warm, sweet, aromatic taste.

The student should observe

- (a) The *uniform colour and absence of cork*,
- (b) The *narrow wavy longitudinal lines*,
- (c) The *odour and taste*.

Constituents.—The principal constituent of cinnamon bark is the volatile oil, of which it yields 0.5 to 1.0 per cent.; the bark contains also tannin and mucilage. Inferior qualities are generally more mucilaginous and contain a volatile oil of inferior fragrance. The drug yields about 4 per cent. of ash.

The volatile oil (sp. gr. 1.025 to 1.038; O.R. -0.5° to -1°) contains about 75 per cent. of cinnamic aldehyde together with terpenes and small quantities of numerous other bodies. The amount of cinnamic aldehyde present is approximately determined by shaking a measured quantity in a flask having a long slender graduated neck with a hot 30 per cent. solution of sodium bisulphite; the latter forms with the cinnamic aldehyde a water-soluble compound, but the terpenes &c. float on the aqueous liquid; they can be measured and deducted, the difference being cinnamic aldehyde.

Uses.—Cinnamon is used chiefly as a flavouring agent in astringent powders and tinctures. It has aromatic and mildly astringent properties.

Substitutes.—The cinnamon tree has been cultivated in other countries, but has never yielded a bark equal in aroma to Ceylon cinnamon. This fact has been attributed to the disposition the tree exhibits to pass into numerous varieties according to the conditions of climate and cultivation. From plantations in Southern India cinnamon of good quality has been obtained, whilst that exported from Brazil, the West Indies, and Java, is distinctly inferior.

CASSIA BARK

(*Cassia Lignea*, Chinese Cassia)

Source &c.—Cassia bark is obtained from *Cinnamomum Cassia*, Blume (N.O. *Laurineæ*), a medium-sized tree, probably a native of Cochin China, but cultivated now in the south-eastern provinces of the Chinese Empire (Kwang-si and Kwang-tung). This tree yields the bark known in English commerce as cassia bark or Chinese cassia lignea. Other species of *Cinnamomum*

growing in the country between these provinces of China and north-eastern India yield barks to which the name of *Cassia vera* (or sometimes also *Cassia lignea*) is given; they are exported from Calcutta and Saigon. The *cassia vera* of the London market is a firm, rather thick bark with a very mucilaginous taste; it is said to be the bark of *C. Burmanni*, De Candolle.

The bark is collected entirely from cultivated trees. When about six years old the branches are cut and all the small twigs and leaves are stripped off; two longitudinal slits are then made, and three or four transverse incisions are cut round the circumference through the bark at intervals of about 40 cm. The bark is then removed in pieces about 40 cm. long and half the circumference of the branch. These are next laid with the concave surface downwards and a small plane passed over them, by which the cork and part of the cortex are more or less completely removed. The bark is then tied up into bundles and exported in boxes resembling tea chests, which are sometimes wrapped in bast-mats.

Description.—*Cassia* bark is imported in bundles about 30 or 40 cm. long and weighing about 500 grammes. The pieces of which the bundle is composed vary from 5 or 6 to 40 cm. in length and average from 1 to 2 cm. in width and 3 to 5 mm. in thickness. They are either channelled pieces or single (but not double) quills, of a dark earthy brown colour and smooth, but with patches of the thin greyish cork still adhering to the outer surface, indicating a want of care in trimming them.

The fracture is short, the section of the thicker pieces showing a faint white line (sclerenchymatous cells) sometimes near the centre, sometimes near the outer margin and parallel to it. In odour and taste *cassia* bark resembles cinnamon, but it is less delicate in aroma and more mucilaginous and astringent.

Cassia bark occurs in much larger and thicker pieces than cinnamon, seldom in double quills, and never packed into sticks. It is darker in colour, and frequently exhibits patches of cork on the outer surface.

The student should observe

- (a) The *thickness of the bark* and its *dark colour*,
- (b) The *patches of cork*,
- (c) The *characteristic odour* and *taste*.

Constituents.—The constituents of cassia bark are similar to those of cinnamon. It yields from 1 to 2 per cent. of *volatile oil*, resembling but not identical with that of cinnamon.

BEBEERU BARK

(Bibiru Bark, Greenheart Bark, Cortex Nectandræ)

Source.—The greenheart tree, *Nectandra Rodiæi*, Hooker (N.O. *Laurineæ*), is a large forest tree growing abundantly on the hills in *British Guiana*. Its tall straight stem yields a hard

and resistant wood that is highly valued for shipbuilding; the bark was recommended early in the present century as a substitute for cinchona bark, and the alkaloid obtained from it in 1835 by Rodie as a substitute for quinine. It aroused some interest at first, but now neither the bark nor the alkaloid obtained from it is much used.



FIG. 150.—Greenheart bark, showing short fracture. Natural size.

Description.—Bebeeru bark occurs in flat heavy pieces, frequently 10 to 15 cm. long, 5 to 8 cm. wide, and 3 to 10 mm. thick. It is of a more or less uniform greyish brown colour, and frequently marked on the outer surface with broad shallow depressions left by the exfolia-

tion of the outer portions by formation of bands of cork; these exfoliating portions are occasionally but not often found adhering to the bark. The outer layer is usually a very thin greyish brown, often warty cork, which can easily be scraped off, disclosing a darker brown inner portion. The inner surface is walnut-brown in colour, bears shallow, rather broad longitudinal depressions, and is coarsely longitudinally striated by strands of sclerenchymatous tissue, which under the lens can be seen slightly projecting beyond the remaining parenchymatous tissue.

The bark is extremely hard, and breaks with a short granular fracture. The transverse section, smoothed and moistened, exhibits under the lens a very narrow pale grey cork; the remainder of the bark is completely traversed by closely approximated, yellowish, wavy medullary rays, showing that in the majority of cases the drug consists (with the exception of the cork that covers it) of bast tissue. Between the medullary rays numerous minute groups of sclerenchymatous cells can be distinguished, arranged in radial lines.

The bark has no odour, but a bitter taste.

The student should observe

- (a) The *flat heavy pieces*,
- (b) The *thin grey cork*,
- (c) The *structure of the transverse section*;

and should compare this bark with

- (i) *Sassy bark*, which is seldom flat, is often nearly black on the inner surface, and exhibits in transverse section large conspicuous groups of sclerenchymatous cells;
- (ii) *Coto bark*, which has a reddish brown colour, is usually much thicker, and has a characteristic odour and taste;
- (iii) *Elm bark*, which is much paler in colour and fibrous.

Constituents.—The chief constituents of bebeeru bark are the alkaloids beberine and siperine and probably others that have not yet been isolated.

Beberine, $C_{19}H_{21}NO_3$, crystallises in colourless prisms melting at $214^{\circ}C$. It has a bitter taste, and forms colourless crystalline salts. It is identical with pelosine (see 'Pareira brava'), but distinct from buxine, a similar alkaloid occurring in box.

Siperine has been obtained in the form of dark scales of very doubtful purity.

The commercial sulphate of beberine in dark brown scales, which was official in the British Pharmacopœia of 1885, is not a pure sulphate of the alkaloid. It contains about 30 per cent. of beberine associated with siperine and probably other alkaloids as well as with much colouring matter.

Uses.—Bebeeru bark is a bitter stomachic and tonic; the alkaloid is, to a small extent, antipyretic, but these effects being insignificant, its use in fever and ague has now been abandoned.

COTO BARK

(True Coto and Paracoto Bark)

Source &c.—Coto bark was first sent to Europe about 1873 from Bolivia under the name of coto-cinchona. Its botanical source is unknown, but it appears to be derived from a tree belonging to the natural order *Laurineæ*, and probably closely allied to the genus *Cryptocarya* (Hartwich, 1899). The bark was employed in the form of powder or alcoholic tincture for diarrhoea and for neuralgia, and rapidly gained a reputation in Europe as an astringent. Owing, however, partly to the difficulty of obtaining the genuine bark, it fell into disuse, and is now seldom prescribed.



FIG. 151.—Paracoto bark, showing a fissured cork and splintery-fibrous fracture. Natural size.

This, the true coto bark, was in commerce but a very short time. In 1876 it was replaced by a very similar bark, also imported from Bolivia. This later bark was found on examination to yield constituents resembling but not identical with those of true coto; one of these was called 'paracotoin,' and the bark that yielded it 'paracoto bark.'

Paracoto bark, as it is properly termed, is at present the current variety of coto; it is commonly sold as coto bark, and to it the following description refers.

Description.—Paracoto bark occurs in flat or curved pieces commonly up to 30 cm. long, 8 or 10 cm. wide, and 10 to 15 cm. thick. They are hard, heavy, and of a cinnamon-brown

colour ; some of the pieces bear on their outer surfaces patches of a thin whitish, others of a brownish cork ; they are frequently nearly smooth, or bear transverse wrinkles, or are irregularly chequered by longitudinal fissures and transverse cracks. The inner surface is brown and distinctly and coarsely striated, this being due to projecting strands of sclerenchymatous tissue.

The bark breaks with a fibrous, splintery fracture, coarse stiff strands of sclerenchymatous tissue projecting from the fractured surface. The inner part easily separates into coarse longitudinal strips, on the surface of which, especially after they have been exposed to the air for some time, glistening prismatic crystals can be observed even with the naked eye.

The section is very characteristic. The outer layer, a thin brownish cork, encloses a narrow brown cortex separated by a distinct paler line (of sclerenchymatous cells) from the very thick bast which in older barks constitutes nine-tenths of the drug. This bast contains an abundance of sclerenchymatous tissue arranged in rounded or tangentially elongated groups. The section resembles that of sassy bark, but the groups of sclerenchymatous cells are much smaller and the colour is reddish brown.

The drug has a very characteristic odour and a pungent taste.

The student should observe

- (a) The *brownish cork* and *brown striated inner surface*,
- (b) The *characteristic transverse section*, and
- (c) The *distinctive odour* ;

and should compare this bark with

- (i) *Sassy bark*, which has a nearly black inner surface, darker outer surface, and fewer and larger groups of sclerenchymatous cells ;
- (ii) *Bebeeru bark*, which is smoother and exhibits distinct medullary rays, but very inconspicuous masses of sclerenchyma ;
- (iii) *Flat red cinchona bark*, which is characterised by its rusty red colour, reddish warts, and bitter astringent taste.

Constituents.—Paracoto bark contains several crystalline bodies, the chief of which, paratoin, $C_{12}H_8O_4$, occurs in pale

yellow scales melting at 152° C., and giving a yellowish brown colour with nitric acid; it is dioxymethylene-phenylcumalin. Other crystalline bodies present in the bark are phenylcumalin (leucotin), hydrocotoin (dimethyl ether of benzoylphloroglucinol), methylhydrocotoin, protocotoin (dioxymethylene-phloroglucinol), and methylprotocotoin (oxyleucotin).

The bark also contains piperonylic acid, resin, tannin, and a little volatile oil.

Use.—The drug has been employed with success for diarrhoea, but is not much used now.

Varieties.—True coto bark closely resembles paracoto; it is said to be distinguished by its odour, which recalls cinnamon, that of paracoto recalling nutmeg, and by its taste, which is more pungent. The most definite distinctive characters lie in the constituents. True coto contains cotoin and phenylcumalin, the substance formerly known as dicotoin being probably a mixture of these two substances. Cotoin, $C_4H_{12}O_4$, is the monomethyl ether of benzoylphloroglucinol; it crystallises in pale yellow prisms (melting-point 130° C.) which colour nitric acid blood red.

The following simple test is the only definite means of distinguishing these two varieties of coto bark: Shake 10 grammes of the powdered bark with 100 grammes of ether frequently during an hour. Pour off the ethereal solution, add 50 grammes of water and distil off the ether. Cool, shake with 30 grammes of petroleum spirit, transfer to a separator (disregarding the resin which adheres to the sides of the flask), filter the aqueous solution into a porcelain dish, evaporate to dryness, dissolve the residue in a little glacial acetic acid, and add a drop of fuming nitric acid. True coto thus tested will afford a blood red coloration (Cæsar and Loretz).

MEZEREON BARK

(Cortex Mezerei)

Source &c.—Mezereon bark may, according to the British Pharmacopœia, be obtained from either of the following species of *Daphne* (N.O. *Thymelæaceæ*):

1. *Daphne Mezereum*, Linné, *Mezereon*, a small shrub attaining a metre in height, growing in moist woods in hilly parts

of Europe, and found also in the southern counties of England. It bears in early spring, before the leaves appear, purple, sweet-scented flowers on the preceding year's shoots. The bark is collected chiefly in Thuringia.

2. *Daphne Laurēola*, Linné, *Spurge Laurel*, a small indigenous evergreen shrub, not uncommon in woods; it bears inconspicuous green odourless flowers in the axils of the leaves, the latter being crowded towards the summit of the stem. The bark is seldom collected.

3. *Daphne Gnidium*, Linné, a small shrub with numerous straight slender branches and small white flowers; it is a native of the south of France and the north coast of Africa, and is

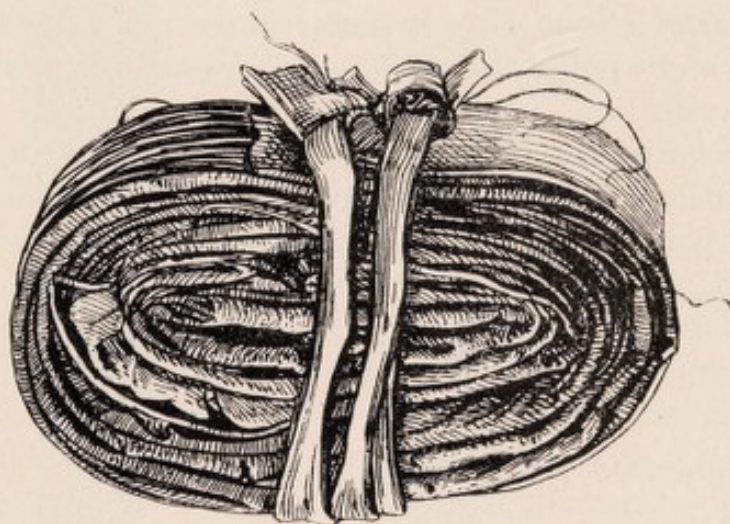


FIG. 152.—Mezereon bark. Slightly reduced.

found generally on the shores of the Mediterranean. It is largely collected in Algeria and the south of France, and has been long known and used as an irritant.

The bark of all these plants is collected in the winter or early spring, when it separates readily from both stem and root in long flexible strips. These are dried, and either sold loose or made into small bundles or flat disc-like rolls. They all possess acrid properties, and the description in the British Pharmacopœia is framed so as to admit both stem-bark and root-bark of all three species of *Daphne*.

Description.—The bark of *Daphne Mezereum* sometimes occurs in quills of varying length, but more usually in long, thin, more or less flattened fibrous strips that are remarkable for

their extreme toughness and flexibility ; they can easily be torn lengthwise, but it is almost impossible to break them.

The outer surface (cork) is of a yellowish or olive brown colour, very thin, and transversely wrinkled, that of the stem-bark being marked with scattered rounded scars of leaves and buds, and often bearing the minute black apothecia of small lichens. It easily separates in papery fragments from the cortex, which is either green (stem-bark) or yellowish (root-bark) in colour. The inner portion of the bark (bast) has a pale yellowish or nearly white and silky inner surface ; it is extremely tough and fibrous from the presence of numerous strands of tough bast fibres.

The dry bark has little or no odour, but a persistent burning acrid taste. So marked is the acrid nature of the bark that, moistened and applied to the skin, it produces inflammation and even vesication.

Spurge laurel bark is very similar to the foregoing ; it may be distinguished by the purplish grey colour of the cork and by elongated, pointed oval leaf- and bud-scars which are crowded at intervals.

The bark of *D. Gnidium* has a dark purplish brown cork ; the leaf-scars resemble those of *D. Mezereum*.

The student should observe

- (a) The *thin, easily separable cork*,
- (b) The *silky inner surface*,
- (c) The *extreme toughness and flexibility*.

Constituents.—Mezereon bark contains a greenish brown amorphous resin, mezerein, possessing extremely acrid and sternutatory properties. It easily changes into an acid bitter resin, mezereic acid, which is present in the ethereal and alcoholic extracts of the bark. A crystalline bitter glucoside, daphnin, has also been isolated, as well as a fixed oil and a substance resembling euphorbone, neither of which is acrid.

Uses.—Mezereon is a powerful local irritant capable of producing vesication. Internally it is stimulant, and in large doses an irritant poison ; it is, however, seldom administered internally, and although frequently employed in the south of France as an irritant, finds but little use in this country.

CASCARILLA BARK

(Cascarilla, Cortex Cascarillæ)

Source &c.—Cascarilla bark is obtained from *Croton Eleutēria*, J. J. Bennett (N.O. *Euphorbiaceæ*), a shrub or small tree indigenous to the Bahama Islands, the name cascarilla having its origin probably in the resemblance this bark bears to small quilled cinchona bark, which was formerly called cascarilla (the diminutive of the Spanish *cáscara*, bark). It is evidently the bark of twigs, branches, and possibly small stems.

Description. — Cascarilla bark is usually imported in single quills or

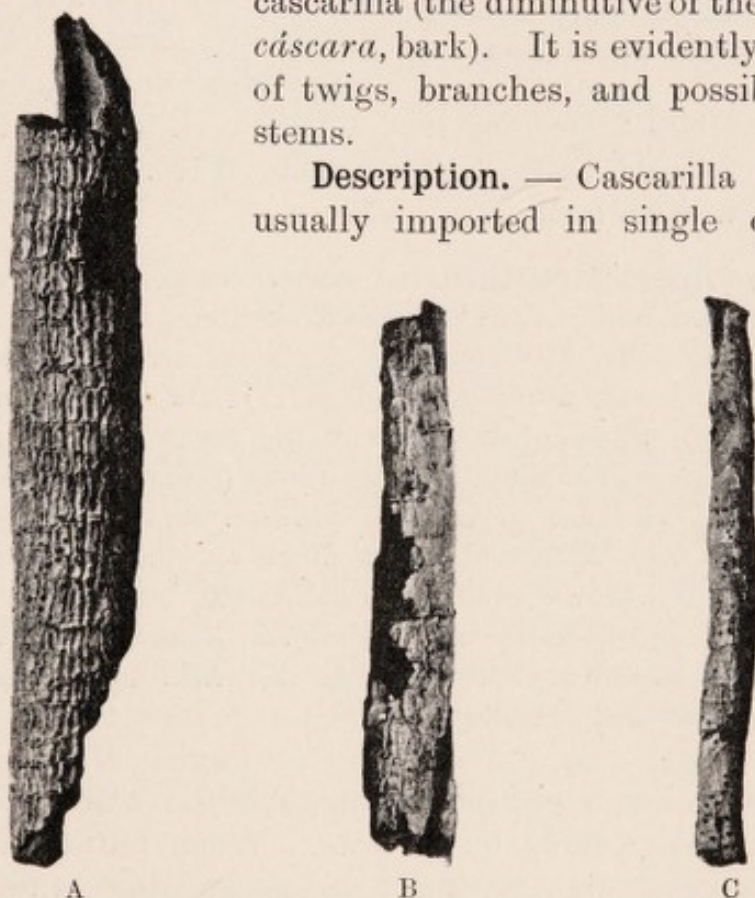


FIG. 153.—Cascarilla bark. A, large; B, medium; C, small.
All natural size.

channelled pieces, commonly varying from 5 to 10 cm. in length and from 4 to 6 mm. in width, rarely exceeding the latter limit. The outer layer of the bark is a white or greyish white cork which owes its characteristic chalky appearance to the presence in the cells of numerous crystals of calcium oxalate. It is longitudinally wrinkled, and often, at more distant intervals, both longitudinally and transversely furrowed, thus assuming a chequered appearance. It frequently

bears the minute black apothecia of a small lichen, and easily exfoliates, disclosing a brown or dark grey inner layer (cortex) marked with furrows corresponding to those in the cork. On some portions of the bark the white cork is so thin that



FIG. 154.—Cascarilla bark. Transverse section, magnified. (Berg.)

the brown cortex shows through and imparts to the outer surface a brown or dark grey colour.

The inner surface of the bark is dark in colour and longitudinally striated. The fracture is short and resinous. The

section exhibits under the lens a pale cork layer and a dark brown cortex and bast, the latter being traversed by numerous very thin whitish medullary rays.

Microscopical Structure.—A transverse section of cascarilla bark, examined under the microscope, exhibits a cork of varying thickness, the cells of which have thickened outer but thin inner walls; in the latter, numerous minute crystals of calcium oxalate are embedded. Some of the cells of the cortex contain prismatic or cluster-crystals of calcium oxalate, others (secretion cells) droplets of oleo-resin. The bast contains in addition small scattered groups of small (not over $26\ \mu$ wide) bast fibres together with numerous cells filled with a brown amorphous substance, but neither bast nor cortex contains any cells with thickened lignified walls. These characters are useful in distinguishing cascarilla bark from various barks that have been substituted for it.

The bark has a pleasant aromatic odour and an aromatic but rather disagreeably bitter taste. When burned it exhales an agreeable odour, whence its use as an addition to fumigating mixtures, tobacco, &c. It yields about 8 per cent. of ash, but siftings may yield much more, probably because they contain many cork fragments rich in calcium oxalate.

The student should observe

- (a) The *chalky cork*,
- (b) The *longitudinal wrinkles* and *longitudinal and transverse fissures*,
- (c) The *short resinous fracture* and the appearance of the *section under the lens*,
- (d) The *aromatic odour* and *bitter taste*.

Constituents.—Cascarilla contains about 1 per cent. of volatile oil, a crystalline bitter principle, cascarillin, which is neither alkaloidal nor glucosidal, and at least two alkaloids, viz. betaine and cascarilline, the latter crystallising in prismatic plates.

Use.—Cascarilla is used as an aromatic, bitter stomachic.

Substitutes.—*Copalchi bark*, from *Croton nivëus*, Jacquin (West Indies, Venezuela), occurs in long quills, much larger than those of cascarilla; it has a thin, greyish cork, below which is the cortex marked with minute transverse furrows.

The bark of *Croton lucidus*, Linné (?): the cork is greyish and firmly adherent; the inner surface is striated and pinkish brown, and the transverse section shows numerous groups of sclerenchymatous cells.

ELM BARK

(Cortex Ulmi)

Source &c.—The common elm, *Ulmus campestris*, Linné (N.O. *Urticaceæ*), is a large handsome tree attaining a height of 100 metres or more, and found in England, especially in the southern counties, although doubtfully a native. It extends also over Central and Southern Europe. The Greeks and Romans were well acquainted with the properties of elm bark, and it continued to be used during the early and middle ages. It has now fallen into disuse, its place having been taken by other drugs possessing similar astringent qualities in a higher degree.

The bark should be stripped from the trunk and branches in the spring, when it can easily be separated, and freed from its dark rough outer portion (bark); the remaining whitish inner part (secondary bast) forms, when dried, the elm bark of commerce.

Description.—The elm bark of commerce consists, as observed, of the dried secondary bast of the tree. It occurs usually in rather thick flattened pieces about 10 or 12 cm. long, 3 to 5 cm. wide, and about 5 mm. thick. The outer surface is yellowish or pale rusty brown in colour, often discoloured and frequently marked with dark brown patches of the outer portion (bark) that have been left adhering to it; it

bears evidence of the instrument that has been used in scraping it. The inner surface is longitudinally striated or nearly smooth. It is tough, but breaks with a rather short, not very fibrous fracture. The smoothed transverse section exhibits under the lens numerous dark, usually oblique medullary rays that completely traverse the bark, thus proving it to be bast. Crossing the medullary rays at right angles are numerous rows

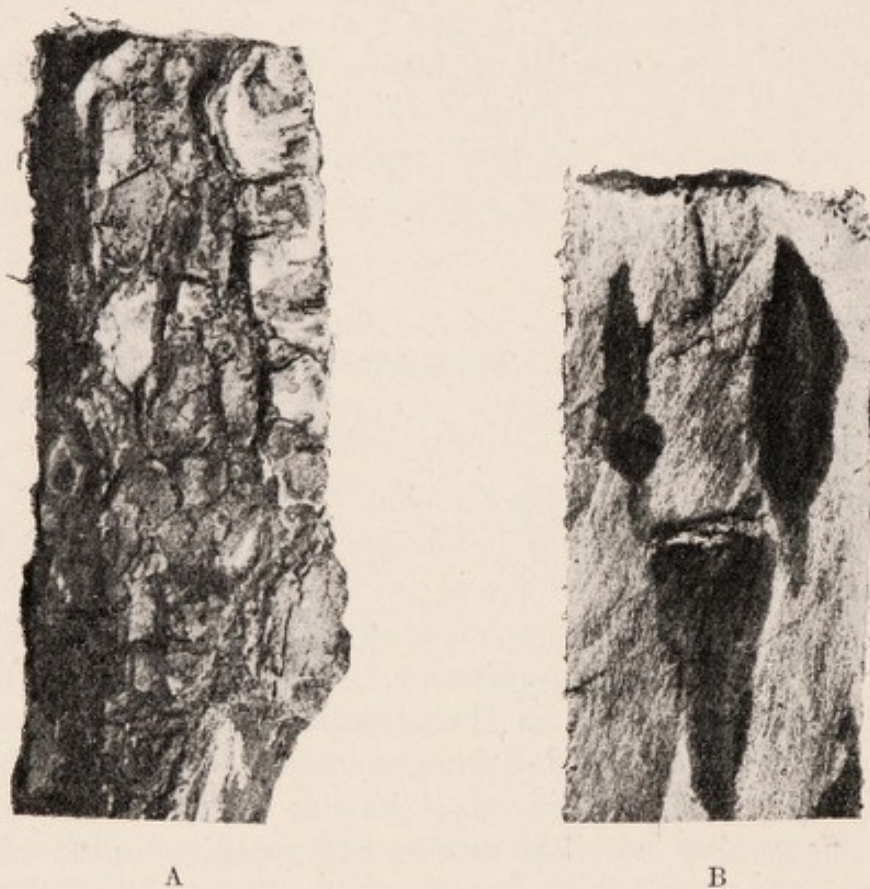


FIG. 155.—Elm bark. A, with outer layers attached; B, commercial bark.
Natural size.

of tangentially elongated whitish masses (groups of bast fibres).

The bark is inodorous, but has a slightly astringent, mucilaginous taste.

The student should observe

- (a) The *flattened pieces*,
- (b) The rather *fibrous, but not splintery fracture*,
- (c) The (usually) *striated, not perfectly smooth, inner surface*;

and should compare the bark with

- (i) *Quillaja bark*, which has a perfectly smooth inner surface, splintery, laminated fracture, and acrid taste ;
- (ii) *Slippery elm bark*, which is thinner, very fibrous, and has an odour resembling fenugreek.

Constituents.—Elm bark contains as principal constituent a little tannin ; mucilage and starch are also present.

Use.—It was formerly employed as an astringent, but is now seldom used.

SLIPPERY ELM BARK

(Cortex Ulmi Fulvæ)

Source &c.—The slippery elm, *Ulmus fulva*, Michaux (N.O. *Urticaceæ*), is a small tree indigenous to the central and northern of the United States. The bark is collected in the spring from the trunk and large branches, deprived of its outer dead portions, and dried ; the tree is thereby destroyed, and as the wood has no commercial value no effort is made to replace it. Large quantities of the bark are collected in the lower peninsula of Michigan.

Description.—Like the preceding drug the slippery elm bark of commerce consists entirely of the secondary bast of the tree. It is commonly imported in large flat strips half to one metre long, but only 3 mm. or less in thickness. The outer surface is reddish yellow in colour, with patches of the reddish brown outer portion (bark), and is distinctly striated longitudinally ; the inner surface is tawny yellow and also longitudinally striated.

It is extremely tough and fibrous ; narrow pieces can be bent double without completely breaking. The section, examined under the lens, is seen to be completely traversed by medullary rays (showing it to be bast), between which small tangential bands (bast fibres and bast parenchyma) are arranged, giving the section a chequered appearance. If the transverse section is moistened and allowed to remain for a minute or two and again examined, numerous cells full of transparent swollen mucilage can be detected. No trace of the cortex can be

found, but portions of the dark outer layer (bark) are frequently present.

The bark has a strong odour resembling fenugreek, and a very mucilaginous taste.

The student should observe

- (a) The *striated inner and outer surface*,
- (b) The *fibrous fracture*,
- (c) The *odour of fenugreek and the mucilaginous taste* ;

and should compare the bark with

- (i) *Elm bark*, which is thicker, less fibrous, and odourless ;
- (ii) *Quillaja bark*, which has a splintery fracture, a smooth inner surface, and is odourless.

Constituents.—The principal constituent is mucilage, which appears to swell but not dissolve in water ; it is contained in large mucilage cells in the bast, and is present in such proportion that 1 gm. of the powdered bark will convert 50 c.c. of water into a thick jelly.

Uses.—The bark has demulcent and emollient properties. It is chiefly used as an external application in the form of a poultice.

OAK BARK

(Cortex Quercus)

Source &c.—The British oak, *Quercus robur*, Linné (N.O. *Cupuliferae*), is widely diffused over Europe and largely cultivated for its wood and especially for its bark, which, from the large proportion of tannin it contains, is valued highly for tanning. Although the astringent properties of the bark have long been known, and although it has been used from time immemorial in preparing leather, it never appears to have been much used in medicine.

In the collection of oak bark the trees are usually felled when they have reached an age of twelve to thirty-five years, and in the early spring when the buds are opening. Longitudinal incisions are made through the bark, which can then be removed in strips, and after drying is ready for the market.

Young bark is preferable to old, because as the trees increase in age the outer portions are cut off by the production of layers of cork in the bast (formation of outer bark), and the tannin in the portions thus cut off undergoes certain changes. Bark from older stems is also collected and freed from its dead outer portions, but such bark is not so valuable for tanning or fit for medicinal use.

From the stools that are formed when the trees are felled adventitious shoots arise, and these, when they have attained a sufficient age, are cut and peeled.



FIG. 156.—Oak bark. A, outer surface, showing the smooth, glossy cork and transverse lenticels. B, inner surface. Natural size.

While the bark is young (up to about twenty years old) it possesses a smooth, glossy, silvery cork; such bark is to be preferred and should alone be used medicinally.

Description.—Oak bark usually occurs in channelled pieces 10 to 20 cm. in length and 2 to 3 cm. in breadth. The outer layer is a thin, smooth, shining, silvery-grey, firmly adherent cork, which in young barks is marked with darker transverse lenticels and in older barks is frequently longitudinally fissured

and bears darker spots and patches; beneath the cork is a reddish brown cortex. The inner surface is strongly striated longitudinally and fibrous, and varies in colour from yellowish to reddish brown.

The bark breaks with a short fracture in the outer part (cork and cortex), but is coarsely fibrous in the inner part (bast). Under a lens the section exhibits a thin cork, a narrow yellowish cortex, occupying about one-fourth of the total width, separated by a pale line (sclerenchymatous cells) from the reddish brown bast, which is chequered by tangentially arranged groups of bast fibres. Touched with dilute solution of ferric chloride the section assumes a black colour.

The bark has a scarcely perceptible odour, but a strongly astringent taste.

The student should observe

- (a) The *glossy silvery cork*,
- (b) The *line of sclerenchymatous cells*,
- (c) The *striated fibrous inner surface*;

and should compare the bark with

- (i) *Willow bark*, which usually possesses a dull greenish brown cork, paler inner surface, and no line of sclerenchymatous cells;
- (ii) *Witch-hazel bark*, which has a dull grey cork and reddish pink colour.

Constituents.—The principal constituent of oak bark is the tannin, quercitannic acid, $C_{17}H_{16}O_9$ (Etti), of which it contains from 5 to 20 per cent. according to the age of the bark. Oak bark, as described above, should contain 15 to 20 per cent.; trunk bark contains only 5 to 8 per cent., or if the dead outer bark has been removed, 8 to 10 per cent. Quercitannic acid has been obtained as an amorphous, yellowish brown or reddish white powder readily soluble in water and alcohol. When boiled with dilute sulphuric acid it is converted into oak-red, $C_{38}H_{26}O_{17}$, a reddish brown substance, which is insoluble in water, alcohol, and ether. Whether at the same time dextrose is produced is still doubtful; probably it is not, and oak-red may be regarded as the anhydride of quercitannic acid. Quercitannic acid combines with gelatin to form an insoluble

compound; in this way raw hide in contact with a solution of quercitannic acid becomes converted into leather, hence the value of oak bark for tanning.

In addition to quercitannic acid and oak-red the bark contains the following substances: gallic acid, $C_7H_6O_5$, (trihydroxybenzoic acid), a colourless, crystalline substance occurring in a number of plants, and produced when gallo-tannic acid is boiled with dilute sulphuric acid; ellagic acid, $C_{14}H_6O_8$, a pale yellow, microcrystalline substance which forms a deep yellow solution with caustic alkalies and dark blue with ferric salts; quercite, $C_6H_{12}O_5$, a sweet, crystalline body found in acorns; phloroglucinol (phloroglucin), $C_6H_3(OH)_3$, a crystalline body occurring in several plants and produced when many resins, tannins, &c., are fused with potash.

Use.—Oak bark has been used medicinally as an astringent, but is not much prescribed at present.

WILLOW BARK

(Cortex Salicis)

Source &c.—The willow bark of commerce is generally referred to the white or common willow, *Salix alba*, Linné (N.O. *Salicinæ*), a common tree on river-banks and marshy ground in England and throughout Central and Southern Europe. Its astringent properties were well known to Dioscorides, but the bark appears to have fallen into disuse until the latter end of the last century, when it was recommended as a remedy for ague. For this purpose, however, salicin, the principal active constituent of willow bark, has entirely taken the place of the bark, which is now seldom used medicinally. Salicin is usually obtained from the bark of other species of *Salix*, which contain it in greater abundance than *S. alba*. Very frequently, too, the structure of commercial willow bark shows that it is not derived from *S. alba*.

Description.—The willow bark of commerce usually occurs in channelled pieces several inches in length and 10 to 20 cm. in width; they are usually of a greenish or greyish brown colour.

The outer surface is in young bark a smooth, sometimes glossy cork; in older barks it is dull, slightly longitudinally

wrinkled, and usually of a greenish brown colour. The inner surface has a pale reddish colour, and, in the younger pieces at least, appears smooth to the naked eye, but is seen under the lens to be finely striated longitudinally. Older pieces are more coarsely striated. It is so fibrous in the inner part that it can be bent double without completely breaking, but the outer part has a short fracture.

The section examined under a lens shows numerous minute tangentially arranged groups of bast fibres. Under the micro-

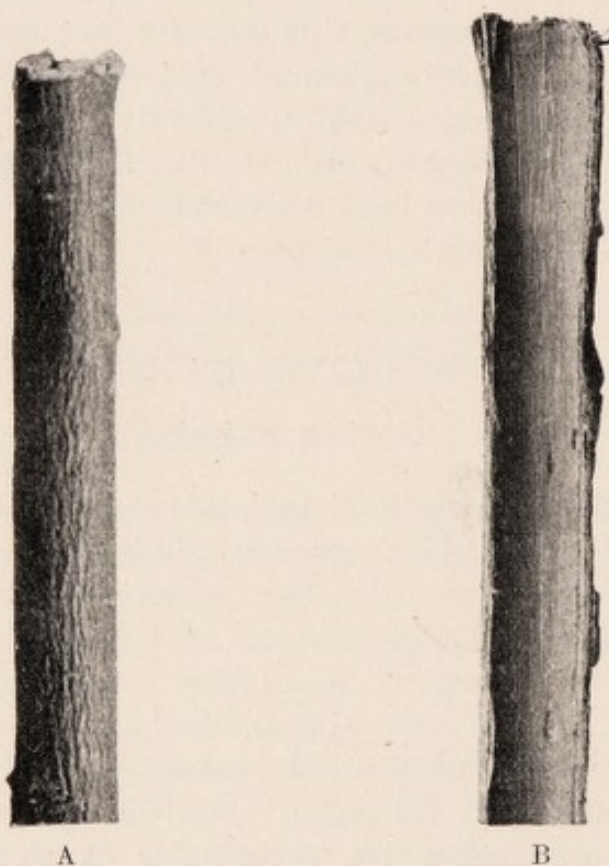


FIG. 157.—Willow bark, showing, A, outer surface ; B, inner surface.
Natural size.

scope the cork is seen to consist of but few rows of cells, the outer wall of which is strongly thickened and bulges outwards ; one such row of cork cells is formed each year. The bast contains no groups of sclerenchymatous cells. These characters sharply distinguish willow barks from poplar and other barks.

Willow bark often has a slight agreeable odour, and an astringent, slightly bitter and aromatic taste.

Constituents.—The principal constituent of commercial willow bark is tannin together with a little salicin.

Salicin, $C_{13}H_{18}O_7$, is a crystalline bitter glucoside present in the bark of various species of *Salix* and *Populus*. Emulsin hydrolyses it in aqueous solution to saligenin, $C_6H_4\begin{smallmatrix} OH \\ \diagdown \\ CH_2OH \end{smallmatrix}$ (orthohydroxybenzyl alcohol), and dextrose. Boiled with dilute sulphuric acid it yields saliretin and dextrose. Cautiously heated with dilute sulphuric acid and potassium bichromate, salicylic aldehyde with an odour of meadow sweet is evolved.

The student should observe

- (a) The *greenish* or *greyish brown* colour ;
- (b) The *smooth* or *wrinkled* outer surface ;
- (c) The *pale reddish* inner surface ;

and should compare this bark with

- (i) *Oak bark*, which has a silvery cork and dark brown inner surface ;
- (ii) *Witch-hazel bark*, which has a pale greyish cork and reddish pink inner surface.

Uses.—Willow bark is astringent and has been used in rheumatism and ague ; it has, however, been completely replaced by salicin.

Varieties.—Different species of the genus *Salix* are known as willows, osiers, and salallows. The name willow is generally applied to those species that form trees, osiers to those that form long slender shoots with few lateral branches, and salallows to those that have a shrubby growth.

The chief willows are *S. alba*, the wood of which is used for making cricket-bats, chip-boxes, &c., *S. triandra*, which is often pollarded close to the ground to give long shoots (also called osiers) for white basket work, and *S. fragilis*, Linné, the shoots from which have a reddish colour. *S. fragilis* is largely grown in Belgium, and the bark peeled from the shoots constitutes the 'rood score' (*i.e.* red bark) from which salicin is made. Rood score is largely imported into this country for that purpose, and contains about 3 per cent. of salicin.

The chief osiers are *S. viminalis*, which is used for hampers, *S. vitellina*, which is employed for binding, and *S. purpurea*, which is used for fine basket work. The bark of the last-named

species is especially rich in salicin, containing 6 or 7 per cent. of salicin. The bulk of the salicin employed medicinally appears, however, to be made from *S. fragilis*.

LARCH BARK

(Cortex Laricis)

Source &c.—The larch, *Larix europæa*, De Candolle (N.O. *Coniferae*), a lofty tree, is largely planted in *England*, but is a native of Southern and Central Europe. In the Austrian Alps, in the neighbourhood of Bozen, Trient, and Meran, forests of larch of considerable extent exist. In this district the turpentine secreted by the trunk (true Venice turpentine) is collected, although not to any great extent.

The bark, in common with that of other coniferous trees, has long been used for tanning; its medicinal use is, however, quite recent and dates only from 1858, when it was recommended as a stimulant, astringent, and expectorant. It was introduced into the British Pharmacopœia of 1867, but was subsequently omitted, and is now seldom used, as it has failed to fulfil the expectations entertained of it.

Description.—Larch bark usually occurs in flat, curved, or channelled pieces, seldom in quills. The outer portion (bark), which is commonly largely developed, especially in all but young barks, and sometimes attains a thickness of several centimetres, is rough externally and of a dark brownish red colour. It exfoliates in large flakes which can be split off without much difficulty; the surface thus exposed frequently exhibits rose-pink patches, the colour of the remainder being dark reddish brown. This difference in colour is due to the deposition of a rose-coloured substance in certain layers of cork cells, whereas the deposit in the other cork cells is reddish brown in colour.

The inner portion of the bark (bast) is nearly white, the inner surface being smooth and whitish or yellowish in colour.

The bark breaks with a short or, in the bast, a slightly fibrous fracture. The section exhibits under a lens a whitish inner portion (bast) and a dark brownish red outer portion (bark), the latter generally showing distinct curved lines, indicating the formation of outer bark by the production of successive bands of cork.

The bark has a distinctly terebinthinate odour and an astringent terebinthinate taste.

The student should observe

- (a) The *rose-pink patches of cork* disclosed when fragments of the outer bark are split off,
- (b) The *whitish bast*,
- (c) The *characteristic odour and taste*.

Constituents.—Larch bark contains tannin and a crystalline principle, larixin, $C_{10}H_{10}O_5$, which possesses a bitter astringent taste, and is allied to pyrogallol.

Uses.—Larch bark has been used as a stimulant, expectorant, and astringent, but is almost obsolete.

SECTION VIII

SUBTERRANEAN ORGANS

(RHIZOMES, CORMS, BULBS, AND ROOTS)

The subterranean organs of perennial plants serve as storage-rooms for the reserve material destined for the subsequent use of the plant. These organs often contain accumulated in them alkaloids, glucosides, and other medicinally valuable constituents, in addition to such carbohydrates as starch, sugar, inulin, &c.; hence the utilisation of such subterranean organs for medicinal purposes. They are generally collected in the autumn after the summer foliage has filled them with reserve material and before the development of the stem in the spring has partially exhausted them. Whether, however, they are in all cases richest in active constituents at this particular period has not yet been satisfactorily demonstrated.

In many herbaceous plants, such as dandelion, pellitory, &c., the aerial stem dies down in the autumn leaving the lower modified portion attached to the root into which it passes more or less imperceptibly. This lower portion of the stem bears the buds destined to develop into new stems; being a subterranean stem it is to be regarded as an erect rhizome (often called rootstock), and is collected together with the root. Such drugs as dandelion and pellitory root consist therefore of both root and rhizome.

In other cases the transition from root to rhizome is more abrupt, as it is in valerian, serpentary, &c., but here also both are collected and dried together. In other cases, again, the rhizomes are separated, as they are in ginger and turmeric, the roots being rejected; or both roots and rhizome occur simultaneously in the drug, as with liquorice, gelsemium &c. Comparatively few drugs consist either of root or of rhizome (corm or bulb) alone.

This being the case it is evidently impracticable in classifying the drugs satisfactorily to separate roots from rhizomes.

Rhizomes may be defined as stout or slender, prostrate, oblique, or erect, hypogæic or epigæic stems. They may be distinguished from roots, which in many cases they closely resemble, by the following characters :

- (i) They bear more or less evident cataphyllary leaves in the axils of which buds are present.
- (ii) In many instances they exhibit a more or less evident pith, though frequently this is not easily discernible in organs as old as these are when collected.
- (iii) The transverse section exhibits under the microscope leaf-traces in the cortex.

Bulbs may be regarded as subterranean buds, modified by the enlargement of the leaves to receive reserve material.

Corms are also modified buds, the basal stem portion of which serves as a reserve organ.

Roots may be distinguished from rhizomes

- (i) By the absence of cataphyllary leaves (or their scars) and of buds.
- (ii) By the absence of pith.
- (iii) By the absence of leaf traces in the cortex.

The treatment that these organs receive after their removal from the ground varies with their nature. Small and slender rhizomes and roots are usually dried entire ; larger ones are often peeled, cut, or sliced in various ways to facilitate rapid drying. In some cases slow drying is preferred in order to induce certain changes resulting in the production of aromatic or other bodies (e.g. valerian, gentian, orris).

HYDRASTIS RHIZOME

(Golden Seal Rhizome, *Rhizoma Hydrastis*)

Source &c.—Golden seal, *Hydrastis canadensis*, Linné (N.O. *Ranunculaceæ*), is a small herbaceous plant with perennial rhizome, widely distributed in woods in Canada and the eastern United States, being collected in Ohio, Minnesota, West Ontario, Georgia, and Missouri. The plant produces but a single leaf, or two leaves and a single flower. The rhizomes,

which are developed from a disc-like subterranean organ, are collected in the autumn after the leaves have withered; as the stems persist for some time to ripen the fruits, the remains of them are frequently found attached to the drug. The introduction of the drug into American and European medicine has been of very recent date, although, as might be expected, its yellow colour had long attracted attention.

Description.—The drug consists of small yellowish brown rhizomes varying from 1 to 4 cm. in length and averaging about 5 mm. in thickness; although they appear to be horizontal

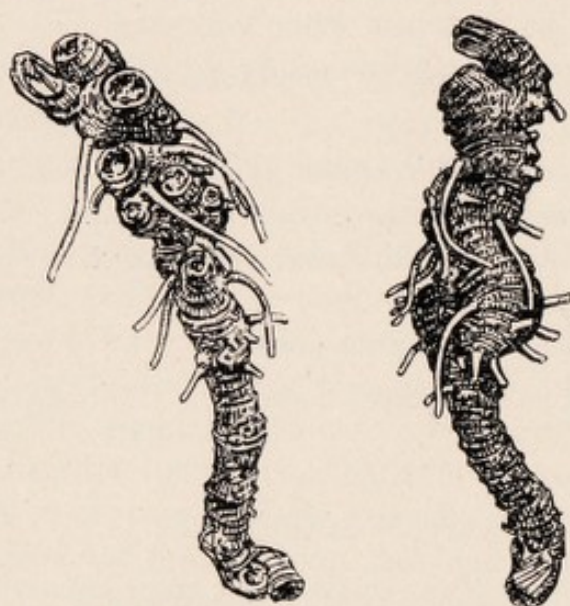


FIG. 158.—*Hydrastis* rhizome. Natural size.
(*Pharmaceutical Journal*.)

and creeping, they are often oblique or even erect, as is indicated by the direction of the buds with which some of the branches terminate, as well as by the presence of rootlets on the (apparently) upper as well as under surface. They are knotty, tortuous, and rough, frequently giving off short upright branches which are terminated by cup-shaped scars left by the aerial stems of previous years.

These branches usually bear distinct encircling scars of cataphyllary leaves, and similar scars are borne by the rhizome also, although there they are less distinct.

Thin, shrivelled, wiry brittle roots of the same colour as the rhizome proceed from all parts of it, but especially from the lateral and ventral surfaces. Many of them break off, leaving small protuberances on the rhizome, which is often therefore rough and comparatively free from roots.

The rhizome is hard, and breaks with a short resinous fracture. The transverse section varies in colour from dark yellow to very dark yellowish brown, and exhibits a comparatively thick bark¹ and a ring of bright yellow somewhat distant

¹ I have employed the term 'bark' to designate the collection of tissues exterior to the cambium of the rhizome and root as well as of the stem (compare

narrow wood-bundles surrounding a large pith. The root also exhibits a dark bark and small bright yellow wood.

The drug has a faint but characteristic odour; when it is chewed a bitter taste is developed and the saliva is coloured yellow.

The student should observe

- (a) The *yellow colour*,
- (b) The *structure visible in the transverse section* when examined with a lens,
- (c) The *characteristic odour*;

and should compare the drug with

- (i) *Bloodroot*, which usually has a dark reddish brown colour, and exhibits in transverse section a more or less prominent red colour without evident wood-bundles.

Constituents.—The principal constituents of golden seal are the alkaloids hydrastine, berberine, and canadine. The drug contains in addition resin, starch, and a trace of volatile oil. It leaves from 5 to 8 per cent. of ash on incineration.

Hydrastine, $C_{21}H_{21}NO_6$ (1.5 to 3.2 per cent.), crystallises in colourless bitter prisms melting at 132° C. It yields by oxidation hydrastinine, $C_{11}H_{13}NO_3$, and opianic acid, $C_{10}H_{10}O_5$, the latter body being also obtained when narcotine is boiled with solution of potassium hydroxide, thus indicating a close relationship between hydrastine and narcotine, the latter differing only by the presence of a methoxy group.

Canadine (xanthopuccine), $C_{20}H_{21}NO_4$, forms colourless crystals melting at 132° C. and becoming yellow when exposed to the light. Berberine (compare p. 273) occurs to the extent of about 3 per cent.

Assay.—Shake 15 gm. of the finely powdered drug for ten minutes with 150 c.c. of ether, add 5 c.c. of solution of ammonia and shake frequently during half-an-hour. Add 15 c.c. of water, shake till the drug aggregates, pour off at once 100 c.c. (=10 gm. of drug) and transfer to a separator. Add 15 c.c. of normal sulphuric acid, shake moderately for one minute and draw off. Repeat the shaking with 10 c.c. of semi-normal acid and again with 5 c.c. of water. To the

p. 270). The Pharmacopœia has adopted the word 'cortex,' but this is liable to misinterpretation owing to the restricted sense in which the term is employed by modern botanists. For the tissue exterior to and including the endodermis (in monocotyledonous rhizomes) I have used the term cortex, which is correct both in its ordinary and its botanical sense.

acid liquid add excess of ammonia and 25 c.c. of ether and shake moderately for one minute. Separate the aqueous layer and shake out again with 20 c.c. and 15 c.c. of ether. Evaporate the ethereal solutions in a tared, flat-bottomed flask, dry at 100° C., and weigh. The weight is that of the hydrastine in 10 gm. of the drug.

Uses.—Hydrastis rhizome is a bitter tonic resembling nuxvomica. It also exerts an astringent action due to the alkaloid hydrastine. It is used as a stomachic and nervine stimulant, in menorrhagia and inflammation of the uterine mucous membrane, and is employed locally in various kinds of ulceration and hæmorrhage.

Adulterants. — Accidental admixture of other rhizomes such as that of *Aristolochia Serpentaria*, Linné, *Stylophorum diphyllum*, Nuttall, *Cypripedium parviflorum*, Salisbury, have been observed, but they are all easily detected.

BLACK HELLEBORE RHIZOME

(Rhizoma (Radix) Hellebori Nigri)

Source.—Black hellebore rhizome, or, as it is often, but less correctly, termed, root, is obtained from the Christmas rose,



FIG. 159.—Black Hellebore rhizome. A, young rhizome, natural size. B, old knotty rhizome, natural size.

Helleborus niger, Linné (N.O. *Ranunculaceæ*), a low herb with a perennial rhizome, abundant on the lower Alps of Southern Europe, especially in Austria, and much cultivated in this country for its white flowers, which, as the name of the plant

indicates, appear in midwinter. Our supplies of the drug come chiefly from Germany.

The rhizome enjoyed a considerable reputation in the later middle ages as a stimulant, purgative, and digestive, but it is now seldom employed. It should be collected in the autumn.

Description.—The Christmas rose produces a horizontal creeping or frequently oblique or even upright rhizome, which is usually, when dried, about 3 to 5 cm. long, 6 mm. thick, and nearly black in colour. It is generally very irregular, tortuous and branched, the older pieces often forming small knotty masses. The branches are short and erect, marked with encircling leaf-scars, and usually terminated by the scar of the aerial stem or occasionally by the remains of a stem or bud. On the under surface the scars or short portions of

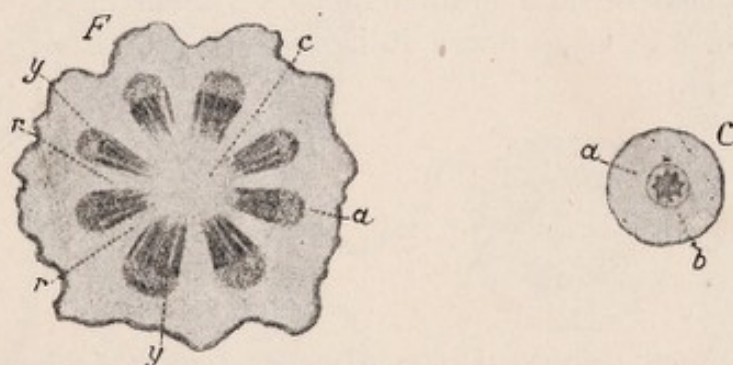


FIG. 160.—Black Hellebore rhizome. *F*, transverse section of rhizome: *a*, bark; *y*, wood-bundles; *c*, pith; *r*, medullary rays; magnified 3 diam. *C*, transverse section of root: *a*, cortex; *b*, stele; magnified 3 diam. (Berg.)

numerous roots may be seen; in the fresh plants these are long, rather stout and straight, but they are commonly removed from the drug.

The rhizome breaks easily with a short fracture; the section is yellowish and exhibits a thick bark, within which is a ring of small wood-bundles, all or some of which are narrow and radially elongated, enclosing a large pith. In the root the bark is thick and the wood tends to assume a stellate form, which, however, even in the older roots in which it is most marked, is never so conspicuous as it is in the root of *Cimicifuga racemosa*.

The odour of the drug is slight, the taste somewhat bitter and acrid. The dry powder, when inhaled, produces violent sneezing.

The student should observe

- (a) The *dark colour* and tortuous appearance,
- (b) The *short erect branches*,
- (c) The *structure of the rhizome* as exhibited by the transverse section.

Constituents.—Black hellebore rhizome contains two crystalline glucosides, helleborin and helleborein, both of which are powerful poisons. Helleborin has a burning acrid taste and is narcotic; helleborein has a sweetish taste and is a highly active cardiac poison.

The drug is free from tannin, and the infusion does not strike a dark colour with ferric chloride, in which particular it differs from *Cimicifuga racemosa*.

Uses.—Black hellebore rhizome has been employed as a drastic purgative and emmenagogue, but is now seldom administered. In large doses it is poisonous, producing violent inflammation.

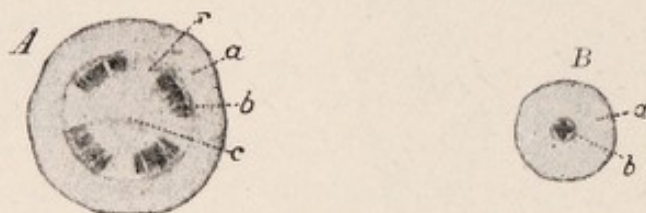


FIG. 161.—Green Hellebore rhizome. Transverse section of rhizome (A) and root (B): a, cortex; b, wood; c, pith. Magnified 3 diam. (Berg.)

Substitutes.—The rhizome of *H. viridis*, Linné, green hellebore—which should be carefully distinguished from *Veratrum viride*, often called also green hellebore—closely resembles that of *H. niger*; it is, however, far more bitter and acrid, and the transverse section exhibits wood-bundles that are broader and shorter than those of *H. niger*.

In the rhizome and root of *H. fœtidus*, Linné, the wood is more strongly developed and radiate in appearance, there being little or no visible pith.

ACONITE ROOT

(*Radix Aconiti*)

Source &c.—The aconite, monkshood, or wolfsbane, *Aconitum Napellus*, Linné (N.O. *Ranunculaceæ*), is a perennial

herb growing abundantly on the lower mountain slopes of Central Europe. It is cultivated in England as a garden plant as well as for medicinal use, and is found apparently wild in some localities, but in these cases has probably escaped from cultivation. The drug has only recently been introduced into medicine, although the poisonous properties of the plant have long been known. Both the fresh leaves and flowering tops, as well as the dried roots, have been used ; the latter are, however, now alone official.

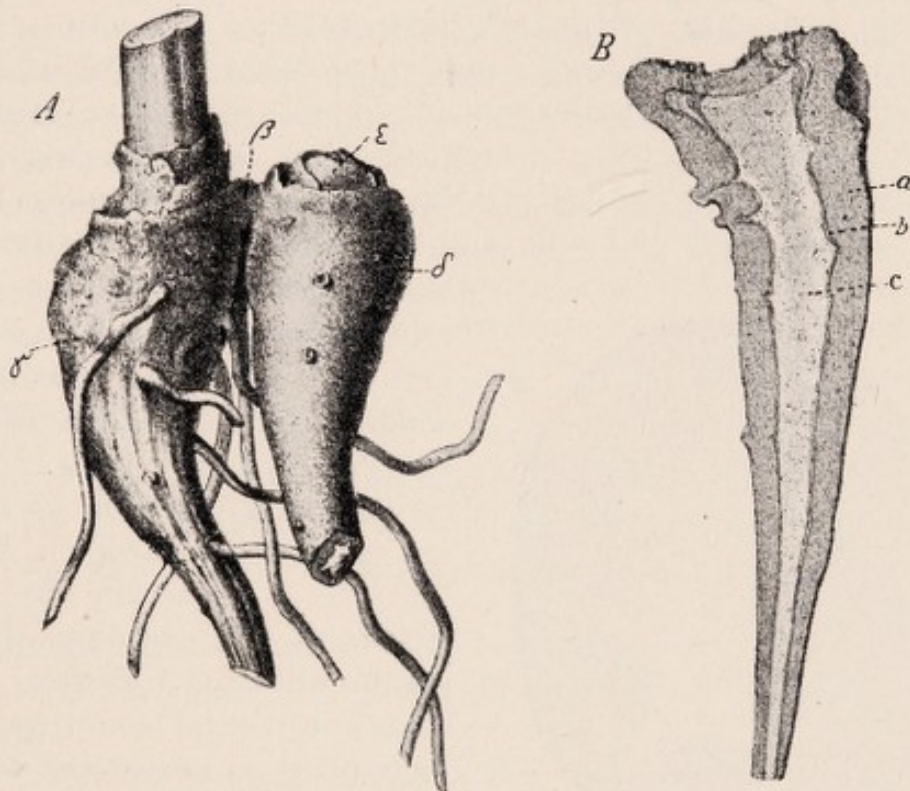


FIG. 162.—Aconite root. *A*, parent and daughter roots of the autumnal plant connected together: γ , parent root; δ , daughter root; β , short branch connecting them; ϵ , bud at the apex of the daughter root; natural size. *B*, longitudinal section through the daughter root: *a*, bark; *b*, cambium; *c*, pith; natural size. (Berg.)

The root should be collected in the autumn after the stem and leaves have died down, but before the bud destined to produce the stem for the following year has begun to develop. This bud is protected by cataphyllary leaves, in the axils of which lateral buds are situated. As the terminal bud grows and forms a flowering stem, certain (usually from one to three) of these lateral buds develop into short lateral shoots, each of which produces a long and slender, descending, adventitious root

crowned with a bud. These roots rapidly enlarge and fill with reserve material produced by the parent plant, the root of which shrivels and perishes in proportion as the daughter roots increase in size. Towards the autumn the parent plant dies down, and the daughter roots, which have then attained their maximum development, are plump and full of starch. If allowed to remain in the soil the buds that crown the daughter roots begin to grow in the late winter or very early spring, and this growth is effected at the expense of the starch in the root, which for that purpose is converted into sugar. The root therefore becomes gradually exhausted of its reserve material, and it is generally assumed that the proportion of alkaloid it contains simultaneously diminishes, although this assumption has not been confirmed by analysis, such assays as have been made having shown but little difference. On account of its extreme toxicity and the absence of any official method of

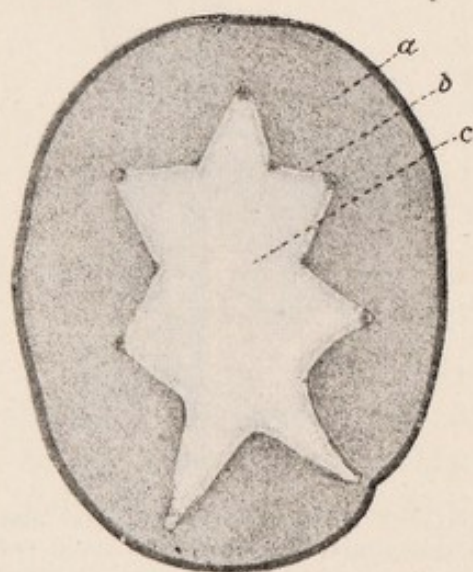


FIG. 163.—Aconite root. Transverse section of daughter root. *a*, bark; *b*, cambium; *c*, pith. Magnified 3 diam. (Berg.)

assay it is desirable that aconite root should always be grown and collected under the same conditions in order to ensure uniformity in the drug. This can best be attained by specifying, as the Pharmacopœia does, that the roots should be collected in the autumn from plants cultivated in Britain. In some continental countries the wild plant is considered to be more active than the cultivated, and as experiments have shown that *A. Napellus* is more toxic than *A. variegatum*, Linné, and its varieties, the root is directed to be gathered from wild plants

when in flower, at which time they can be most easily distinguished. Hence the aconite root that is imported in large quantities from Germany consists chiefly of the partially exhausted summer (parent) roots of the wild flowering plants.

After collection the roots are washed, freed from the rootlets, and dried, sometimes entire, sometimes longitudinally sliced to facilitate the loss of moisture.

Description.—Aconite root of commerce varies usually from 5 to 10 cm. in length, although the entire root is often considerably longer. At the upper extremity, where it is crowned with an undeveloped bud enclosed by scaly leaves, it is about 1 or 2 cm. in diameter, tapering rapidly downwards. It is dark brown in colour, and marked with the scars of rootlets. The surface is usually longitudinally wrinkled, especially if it has been dried entire. The root breaks with a short fracture, and should be whitish and starchy internally. The smoothed transverse section exhibits a thick bark, separated from the inner portion by a well-marked darker line (cambium) which often assumes a stellate appearance, with a group of vessels distinctly visible at each of the projecting angles, usually five to seven in number. Commercial aconite root is, however, often yellowish or brownish internally, and does not readily show the stellate cambium; this is probably due to its having been collected too early. The taste is at first slight, but is followed by a persistent sensation of tingling and numbness in the mouth.

The student should observe

- (a) The *elongated conical shape*,
- (b) The *starchy interior and stellate cambium*,
- (c) The *characteristic tingling taste*.

Constituents.—Aconite root contains three closely allied alkaloids, viz. aconitine, picroaconitine (benzoylaconine), and aconine.

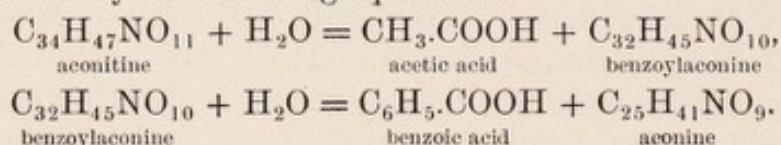
In addition to these alkaloids the root contains starch and aconitic acid, $C_3H_3(COOH)_3$, an acid fairly widely distributed in plants. The drug yields about 5 per cent. of ash.

Aconitine, $C_{34}H_{47}NO_{11}$ (m.pt. $197^{\circ} C.$), is the only one of these three that is crystalline and extremely toxic, the lethal dose being about 0.00013 gm. per kilo weight. It produces even in minute quantity the persistent tingling on the tongue that characterises aconite root. It is very readily hydrolysed by acids as well as by alkalies, yielding first acetic acid and picroaconitine; the latter by further hydrolysis yields benzoic acid and aconine. Aconitine is, therefore, acetylbenzoylaconine, and picroaconitine is benzoylaconine. Aconitine may be distinguished from benzoylaconine and aconine by its taste, by its melting point ($197^{\circ} C.$), by its solubility in ether, and by its being readily crystallisable.

Picraconitine (benzoylaconine), $C_{32}H_{45}NO_{10}$, is amorphous, but yields crystalline salts; it has a bitter taste, is much less toxic than aconitine, and is insoluble in ether.

Aconine, $C_{25}H_{41}NO_9$, is also amorphous, bitter, and insoluble in ether; it is practically non-toxic.

The relation in which these alkaloids stand to one another may be made clear by the following equations:



The amount of total alkaloid present in the root appears to be subject to great variation, from 0.2 to 1.5 per cent. having been reported. No process has yet been devised by which the aconitine can be accurately determined in the presence of the other alkaloids. That portion of the total alkaloid that is dissolved by ether is, however, largely crystalline, and consists almost entirely of aconitine. The ether-soluble alkaloid in aconite root of good quality ranges from about 0.3 to 0.5 per cent.

Assay.—Shake 10 gm. of the finely powdered drug at intervals during four hours with 75 c.c. of a mixture of alcohol seven volumes and distilled water three volumes in a small glass percolator provided with a glass tap and exit-tube plugged with wool; then percolate and continue the percolation until 150 c.c. have been collected. Evaporate to dryness at a temperature not over 60° C. Dissolve the extract in 5 c.c. of decinormal sulphuric acid mixed with 10 c.c. of water and filter into a separator, washing with 40 c.c. of water. Add 25 c.c. of ether and 2 c.c. of solution of ammonia and shake for one minute, separate and repeat the shaking out with 15 c.c. and with 10 c.c. of ether. Filter the ethereal solutions into a flat-bottomed flask. Evaporate to dryness, dissolve in 3 c.c. of decinormal sulphuric acid and titrate back with fiftieth-normal potassium hydroxide using hæmatoxylin as indicator. Each c.c. of decinormal sulphuric acid indicates 0.064 gm. of ether-soluble alkaloid.

Uses.—Preparations of aconite and of its principal alkaloid, aconitine, when applied to the skin, produce tingling followed by numbness; they are used in certain forms of neuralgia and rheumatism. Administered internally, aconite produces a steady fall of temperature, moistening of the skin, increase in the amount of urine, and lowering of the sensibility; it is given in cases of fever and pain, usually in the form of small doses of the tincture frequently repeated.

Varieties and Substitutes.—*English Aconite Root*, as described above, may generally be recognised by the bud which crowns most of the roots, indicating that the root is a daughter root and not parent root.

Foreign Aconite Root.—Much aconite root is imported from Germany. It is collected from wild plants when in flower, and consists largely of the parent roots, as shown by their being crowned with the lower portions of the stems. Comparative assays of German and English aconite root tend to show that the German is at least not inferior to the English in the proportion of ether-soluble alkaloid it contains.

Japanese Aconite Root (generally but probably incorrectly referred to *A. Fischeri*, Reichenbach) is regularly imported in considerable quantities. It tapers gradually, and is either dark grey and nearly smooth (daughter root) or brownish, and marked with not very prominent, paler, longitudinal ridges (parent root). Both kinds of root are smaller than the English; they are, however, very starchy, less wrinkled than the English root, and exhibit, in transverse section, the groups of vessels arranged in a more regular circle. The root has evidently been carefully collected and dried. It contains japaconitine, which closely resembles, but is not identical with, aconitine, being acetylbenzoyl-japaconine.

Indian Aconite Root (*A. laciniatum*, Stapf) is much larger than the English, measuring frequently 15 cm. in length and 4 cm. in thickness near the crown; it is crowned with the remains of a bud and is coarsely wrinkled, the outer portions often separating from the inner portion, which is yellowish and horny. This horny character is due to the starch having been completely gelatinised by the prolonged application of heat, the roots being, according to some accounts, boiled in cow's urine to preserve them. The drug contains pseudaconitine (acetylveratroyl-pseudaconine), which is about twice as toxic as aconitine.

CIMICIFUGA

(*Rhizoma Cimicifugæ*, *Radix Actææ Racemosæ*,
Black Snakeroot)

Source &c.—*Cimicifuga racemosa*, Elliott (*Actæa racemosa*, Linné), is a tall herbaceous plant belonging to the natural order

Ranunculaceæ. It grows freely in shady woods in Canada and the United States, extending southwards as far as Florida, and produces a stout perennial rhizome. In the autumn after the plant has fruited and the leaves have died down, the rhizome is collected, cut into pieces, and dried. It was introduced into medical practice in the United States about 1823, and in this country about 1860.

Description.—The drug consists of a thick, hard, and knotty horizontal rhizome with numerous stout ascending branches.



FIG. 164.—Black Snakeroot, showing branches curving upwards and marked with leaf-scars. Natural size.

The rhizome averages about 5 to 8 cm. in length and 1 cm. in diameter, but may attain as much as twice these dimensions; the commercial drug consists, however, usually of pieces 2 to 5 cm. long. The branches, which are so close together as almost to conceal the rhizome, are about 1 cm. thick and 3 cm. or more long; they curve upwards, and terminate

either in the remains of a bud or more frequently in a circular cup-shaped scar exhibiting a distinctly radiate structure. Both the rhizome and its branches bear encircling scars of cataphyllary leaves, those on the branches being the more conspicuous.

From the under surface of the rhizome numerous straight stout roots are given off. These are dark brown in colour and



FIG. 165.—Black Snakeroot. Transverse section through a branch of the rhizome, and through roots. Natural size. (Maisch.)

obscurely quadrangular or longitudinally furrowed; they are rather brittle, and are usually broken off near the rhizome. The interior of the drug is hard and horny. The transverse section of the rhizome exhibits a thin dark horny bark surrounding a ring of numerous paler narrow wedges of wood alternating

with wide dark medullary rays; the centre is occupied by a large dark pith. The branches have a similar structure.

The transverse section of the root frequently exhibits a thick bark and four (or sometimes five or six) distinct wedges of

porous whitish wood, arranged in the form of a Maltese cross, the medullary rays being broad and dark; this characteristic structure is usually best seen in the stoutest roots.

The drug has no marked odour, but a bitter acrid taste.

The student should observe

- (a) The numerous *stout branches curving upwards*,
- (b) The *structure of the rhizome*, and of the *root*, exhibited by the transverse section;

and should compare the drug with

Black hellebore rhizome, which is tortuous and provided with irregular branches not exhibiting a prominent curve upwards; the section of the rhizome exhibits a thicker bark and few wood-bundles; in that of the roots the wood is much less distinctly cruciate.

Constituents.—The acrid bitter taste is due to a crystalline substance, racemosin. The drug also contains a substance allied to quercitrin, which strikes a dark green colour with ferric salts. This reaction is a useful means of distinguishing black snakeroot from black hellebore, an infusion of the former being darkened by ferric chloride. The drug yields about 7 per cent. of ash. The term *cimicifugin*, *macrotin*, or *macrotyn* is applied to a mixture of resinous substances obtained by pouring a concentrated alcoholic tincture into water.

Uses.—*Cimicifuga* influences the gastric secretion, like any other bitter, and, to a slight extent, depresses the rate but increases the force of the pulse. It has been used as a stomachic in diseases of the heart, but is more frequently employed as a remedy for rheumatism, neuralgia, dysmenorrhœa, dyspepsia, &c. Its value is questionable.

PAREIRA BRAVA

(Pareira Root, Radix Pareiræ)

Source &c.—The drug official in the British Pharmacopœia under the name Pareira Root, is derived from *Chondrodendron tomentosum*, Ruiz and Pavon (N.O. *Menispermaceæ*), a climbing

plant with a stout woody stem, growing to a considerable height. It is a native of Peru and Brazil, from the latter of which countries the drug is exported.

It is regarded by the Brazilians as a valuable medicine, and was introduced into Europe towards the end of the seventeenth century. Its botanical origin remained long in an obscurity that was increased by Linnæus, who founded a species of *Cissampelos* (*C. Pareira*) and quoted it as the source of Pareira brava.

Description. — True Pareira brava occurs in long, woody, nearly cylindrical pieces averaging 2 to 4 cm. in diameter, but attaining 5 cm. or even more. It is nearly black in colour, tortuous and knotty. It is marked externally with longitudinal furrows and transverse ridges and fissures.

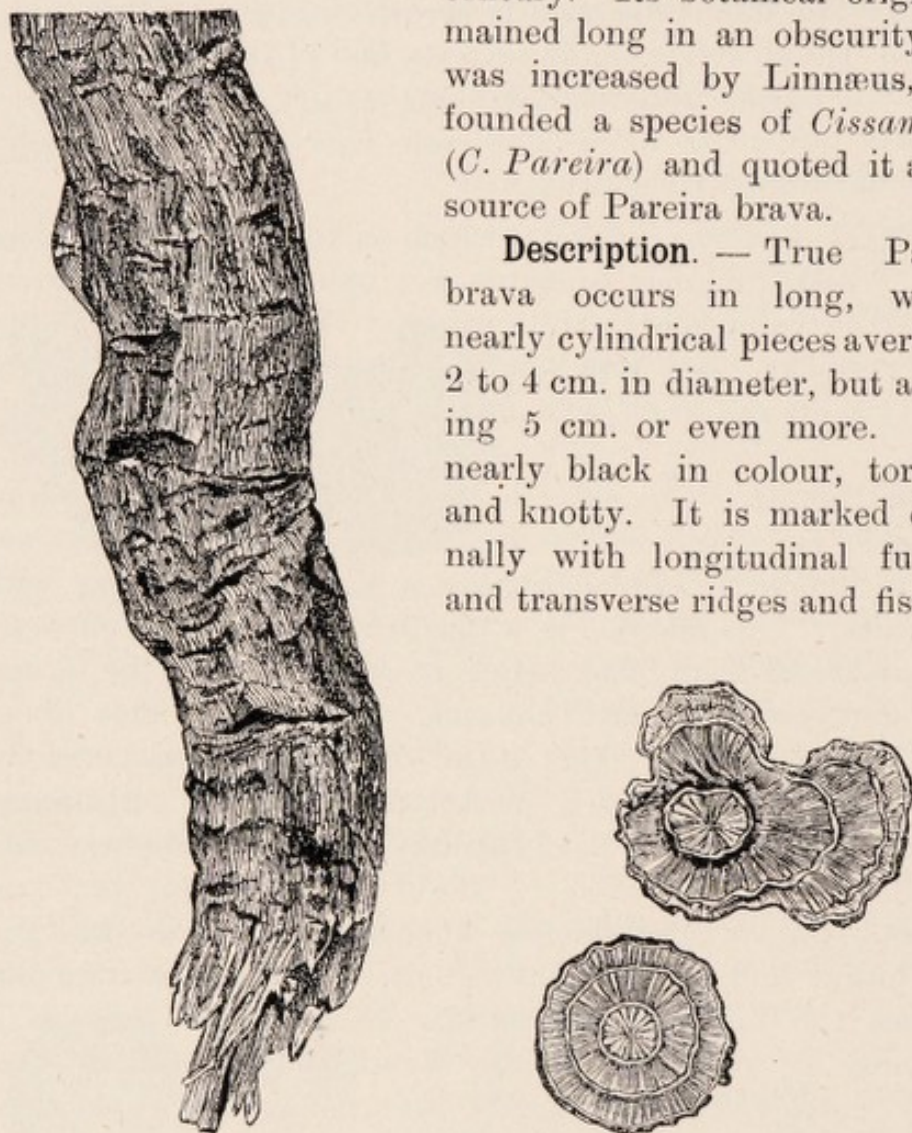


FIG. 166. — True Pareira Brava. Portion of a root, and transverse sections.
(Bentley, after Hanbury.)

It is hard and heavy, breaking with a coarsely fibrous fracture; internally it is yellowish or brownish grey. The fractured root, when cut with a knife, exhibits a glossy, waxy, rather than woody surface. The transverse section shows four or five crenate, concentric or more or less eccentric zones, separated from each other by lighter lines of parenchymatous tissue.

Each zone consists of a varying number of wedge-shaped wood-bundles with large pores alternating with wide medullary rays. A similar abnormal structure is found in many Menispermaceous stems and roots. The innermost zone is usually from 6 to 12 mm. in diameter.

The drug has no odour, but a decidedly bitter taste.

The student should observe

- (a) The *nearly black outer surface*,
- (b) The *crenate outline of the zones*,
- (c) The *waxy cut*,
- (d) The *bitter taste*.

Constituents.—Pareira brava contains about 2.5 per cent. of beberine (compare bebeeru bark, p. 316), to which its bitter taste is due; to this alkaloid the name pelosine (derived from *Cissampelos*) was given until its identity with beberine was proved. An unusually large quantity (about 9 per cent.) of fatty acids, chiefly stearic, is said to be present, but this statement requires confirmation. Other constituents are tannin and starch. The genuine drug yields about 12 per cent. of (cold) aqueous extract and about 4 per cent. of ash. Spurious Pareira brava often yields much less aqueous extract (see below).

Uses.—Pareira brava is used in inflammatory affections of the urinary tract; it is considered to relieve pain and promote healing and cessation of mucopurulent discharge. It is not now much used, owing possibly to the substitution of other roots for the genuine drug.

Varieties and Substitutes.—Genuine Pareira brava appears at uncertain intervals on the London market. Its place has for some years been frequently taken by the root of a Menispermaceous plant of unknown botanical origin. This, the common substitute, may be distinguished by its distinctly brownish colour, the larger number of narrower zones which are not distinctly crenate, the larger vessels in the wood, and the less bitter taste. The drug is, further, not so heavy as true Pareira brava, and does not exhibit, when cut transversely, the same waxy nature. In addition to the above differences this false Pareira contains scarcely any fat, yields less ash (about 1.3 per cent.), and less aqueous extract (about 6 per cent.).

Occasionally the stems of the plant are mixed with true *Pareira brava*; these are paler in colour, frequently bear the minute apothecia of lichens, and exhibit a small pith.

Other substitutes have occurred, and are likely to occur; it is essential therefore, in this as in all cases, that the student should make himself familiar with the characters of the true drug, so as to be able to distinguish it from any substitute that may occur at any time.

CALUMBA ROOT

(Colombo Root, *Radix Calumbæ*)

Source &c.—Calumba root is obtained from *Jateorhiza Columba*, Miers (N.O. *Menispermaceæ*), a lofty climbing plant with annual herbaceous stems and swollen fleshy roots. It is indigenous to Portuguese East Africa, growing in abundance in the forests in the region of the Zambesi. The root is much used by the natives as a remedy for dysentery and other diseases, and also on account of the yellow colouring matter it contains. It was brought to Europe towards the end of the seventeenth century, and after being long neglected came at last into general use. The roots are dug in the dry season, cut into transverse slices, and dried. The drug as imported is of a dingy brown colour and has a quantity of brown powder (soil) adhering to it ('natural' calumba root). It is cleaned by washing and brushing and is then graded for sale ('washed' calumba root). The following description applies to the washed root, which is the official variety.

Description.—Calumba root occurs in commerce in irregular, elliptical or nearly circular slices averaging about 4 cm. in diameter and 6 mm. in thickness, but often much larger and thicker. They are usually depressed in the centre on both sides, the tissue there being apparently less loaded with starch and less woody than the outer portions, and consequently contracting more on drying. The exterior of the root is covered with a thin, dark brownish, wrinkled cork, which readily separates, disclosing the yellowish brown bark beneath. The transverse surface is of a dull greyish colour passing to greenish yellow towards the outer margin of the wood and bark. When smoothed with a knife the interior is seen to

be much brighter and the section exhibits a thick bark marked with radiating lines (sieve tissue), separated by a dark line (cambium) from the large central portion (wood), in which the vessels are arranged in narrow, rather distant, radially elongated groups. The parenchyma of the wood, like that of the bark, is loaded with starch-grains which under the microscope are seen to be large (20 to 70 μ) and mostly simple with eccentric hilum; near the cork characteristic sclerenchymatous cells with yellow, irregularly thickened walls and containing prismatic crystals of calcium oxalate are to be found.

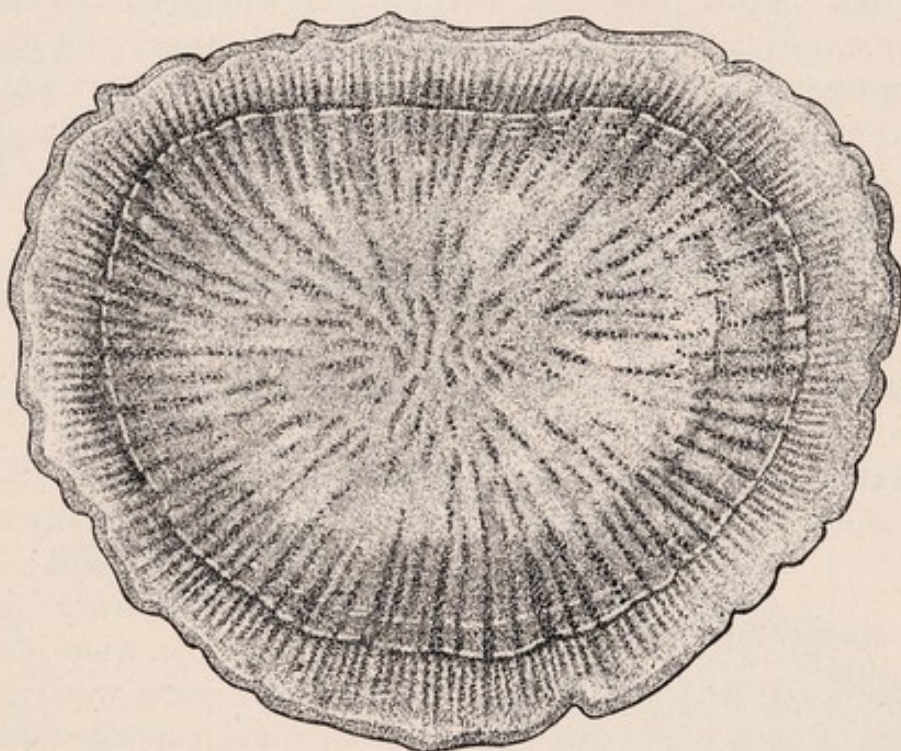


FIG. 167.—Calumba root. Transverse section, magnified. (Moeller.)

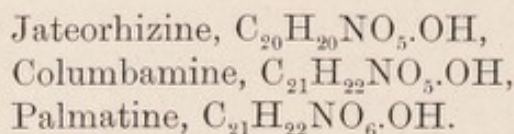
The drug breaks with a short starchy fracture; it has a slight, musty odour and a marked bitter taste.

The student should observe

- (a) The *yellow colour* and *depressed centre* of each slice,
- (b) The *thick bark* and largely developed *parenchymatous tissue*,
- (c) The *short fracture* and *abundance of starch*.

Constituents.—Calumba root contains three yellow crystalline alkaloids, viz. jateorhizine, columbamine, and palmatine, the latter in small quantity only. These three alkaloids are

closely allied to one another, as may be seen from their composition:



They are also closely related to corydaline (from *Corydalis tuberosa*, De Candolle) and berberine, forming, like the latter, a crystalline compound with acetone.

The drug also contains two colourless, crystalline, non-alkaloidal bitter principles, one only of which, columbin, has been investigated; this appears to be a lactone, and yields, when treated with acid or alkali, yellow amorphous columbic acid, previously believed to be a constituent of the root. Traces of a fluorescent substance, also obtainable from columbin, are present in the drug.

In addition to these principles, mucilage and abundance of starch are present, but no tannin. The drug yields from 4 to 7 per cent. of ash.

Uses.—*Calumba* is employed as a stomachic and bitter tonic.

Substitutes &c.—*Calumba Rhizome*.—This is not unfrequently present in small quantity and occasionally to a considerable amount; the pieces are narrower (often about 2 to 3 cm. wide), deeper in colour, more woody, and more conspicuously radiate; they also yield more ash (12 to 17 per cent.).

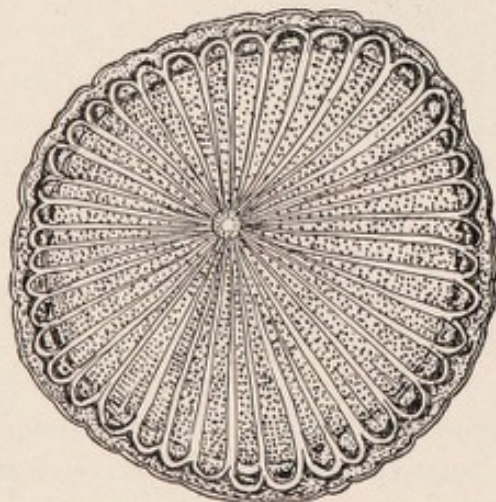


FIG. 168. — *Coscinium fenestratum*.
Transverse section of stem. Natural
size. (*Pharmaceutical Journal*.)

Coscinium fenestratum, Colebrooke (N.O. *Menispermaceae*). The stems are occasionally imported from Ceylon under the name of Ceylon *Calumba*; these may be cut into slices about the size of *calumba*, but are readily distinguished by their

dark yellow colour, flat surface, not depressed in the centre, and hard, woody (not starchy) nature.

Frasera caroliniensis, Walter (N.O. *Gentianeæ*).—Slices of the root of this plant have been found substituted for calumba, but the occurrence is rare; the slices are smaller, thicker, and free from starch, but contain tannin.

PODOPHYLLUM RHIZOME

(May-apple Root, Rhizoma Podophylli)

Source &c.—The May-apple, *Podophyllum peltatum*, Linné (N.O. *Berberideæ*), is a small herb with a long perennial creeping rhizome. It is a native of and common in the eastern United States and Canada, producing, when it flowers, but two leaves and a single flower. The drug was well known



FIG. 169.—Podophyllum rhizome. A, plump autumnal rhizome without roots showing the scar left by the aerial stem. B, transverse section of the same. C, shrivelled summer rhizome with roots attached. All natural size.

to the North American Indians as an emetic and vermifuge; it was introduced into the British Pharmacopœia in 1864.

The rhizome, which grows to a length of several feet, is collected in the late summer and dried; it is usually cut into pieces about 10 cm. in length.

Description.—Podophyllum root, or more correctly rhizome, is seen in commerce usually in nearly cylindrical pieces 10 or more cm. in length and about 1 cm. in thickness. These are of a dark reddish brown colour, and are nearly smooth or slightly longitudinally wrinkled. At intervals of about 5 cm. the rhizome is enlarged and bears on the upper surface a concave

scar surrounded by several circular leaf-scars; these have been left by an aerial flowering stem and its cataphyllary leaves. Below the stem-scar, on the under surface of the rhizome, are the scars of several stout roots, which are occasionally left attached to the rhizome, but which more commonly have been removed. The rhizome occasionally forks, but produces very few lateral branches. When a flowering stem is produced the growth of the main axis is terminated; a bud in the axil of one of the cataphyllary leaves then develops, forming a sympodial system and continuing the growth of the plant.

The rhizome breaks with a short fracture. The transverse section is usually white and starchy, but if the heat employed in drying the rhizome has been sufficient to gelatinise the starch it is yellowish and horny; it exhibits a very thin cork and a circle of small, oval, distant, fibro-vascular bundles.

The drug has a characteristic but not strong odour, and a bitter acrid taste.

The student should observe

- (a) The *straight cylindrical rhizome* with occasional stem, root, and leaf scars,
- (b) The *structure shown by the transverse section*.

Constituents.—The most important constituents of podophyllum rhizome are a neutral crystalline substance, podophyllo-toxin, and a resin, podophylloresin, both of which are purgative. In addition the drug contains picropodophyllin, quercetin, and starch. It yields about 3 per cent. of ash on incineration.

Podophyllotoxin, $C_{15}H_{14}O_6$ (0.2 to 1.0 per cent.) crystallises in colourless needles melting at $117^{\circ}C.$, and easily soluble in alcohol, chloroform, and boiling benzene, but very sparingly in water. Alkalies convert it readily into salts of an unstable gelatinous acid, podophyllic acid, which easily loses water and passes into crystalline, non-toxic picropodophyllin (m.pt. $227^{\circ}C.$), which is isomeric with podophyllotoxin.

Podophylloresin is an amorphous resin of the nature of which little definite is known.

Quercetin, $C_{15}H_{10}O_7 \cdot 2H_2O$, is contained in bearberry leaves and other drugs (see p. 52).

A concentrated alcoholic tincture of the drug poured into 10 volumes of acidulated water throws down a copious resinous

precipitate, podophyllin (yield from 2 to 6 per cent.). This podophyllin contains as its chief constituents podophyllotoxin (about 20 per cent.), podophylloresin, and picropodophyllin, together with quercetin and other bodies. The yield of podophyllin is very variable, but whether this is due to the time at which the rhizome is collected or to other conditions is not at present definitely known. The rhizome is said to be most active in the spring when beginning to shoot.

Uses.—Podophyllum rhizome, or at least the podophyllin obtained from it, is a gastro-intestinal irritant. In large doses it produces inflammation of the stomach and intestines which has proved fatal. In moderate doses it is a drastic purgative with some cholagogue action, and is much used in cases of constipation from hepatic trouble.

Substitutes.—*P. Emodi*, Wallich, a plant growing freely on the lower slopes of the Himalayas, produces a much stouter, knotty rhizome, from the under surface of which an abundance of stout roots proceed. The rhizome and roots have been imported in the hope that they might replace the American drug. They yield more resin (podophyllin), viz. 10 to 12 per cent. (Dunstan and Henry, 1897), and are said to contain from four to five times as much podophyllotoxin as the American drug. Indian podophyllin appears to be about twice as active as American, and should not therefore be substituted for it. According to Dott (1904) the two bodies may be distinguished by their behaviour to 5 per cent. aqueous ammonia, Indian podophyllin leaving 50 to 60 per cent. undissolved, but the American only 5 to 12 per cent.

BLOODROOT

(*Rhizoma Sanguinariæ*)

Source &c.—Bloodroot is the rhizome of *Sanguinaria canadensis*, Linné (N.O. *Papaveraceæ*), a herb with a perennial rhizome, widely distributed throughout Canada and the United States, growing freely in shady places on rich soils; the plant produces in early spring a single flower succeeded by one or two leaves 10 to 15 cm. high, and exudes, when cut, an orange-red juice. The rhizome is collected in the autumn and dried.

Description.—Bloodroot varies usually in length from 2 to 5 cm., and in thickness from 5 to 10 mm. It has a dark grey

or dark reddish brown colour, and is generally plump, straight, or somewhat curved, and nearly cylindrical, but it is sometimes much shrivelled and shrunken, and then contains less starch, due probably to its having been gathered before the end of the period of active growth. It is bluntly conical at the apex, and shows only traces of a bud or aerial stem. From the lower surface numerous dark, thread-like, brittle, wiry roots spring, commonly more or less interlaced, but easily breaking off, leaving inconspicuous raised scars; in the commercial drug the roots are mostly detached. The rhizome bears also more or less distinct encircling leaf-scars, and sometimes short knob-like branches at right angles to it.

The rhizome breaks with a short fracture; the fractured surface is sometimes whitish and starchy, with numerous minute



FIG. 170.—Bloodroot. Natural size.

deep red dots (cells containing secretion), sometimes of a more or less uniform deep blood-red or nearly black colour, and then hard and resinous instead of starchy, a difference due to the escape of the deep red secretion from the cells in which it was originally contained into the

surrounding tissue. The appearance of the section varies not only in different rhizomes, but even in different parts of the same rhizome. The fibro-vascular bundles are distributed in a circle near the bark, but they are so inconspicuous as to be with difficulty discernible even under a lens. The drug has little odour, but an unpleasant bitter and acrid taste.

The student should observe

- (a) The *cylindrical shape* and comparative *absence of roots*,
- (b) The *colour of the transverse section*;

and should compare the drug with

Hydrastis rhizome (see before).

Constituents.—Bloodroot contains several remarkable and interesting alkaloids, the chief of which are sanguinarine, chelerythrine, and protopine. It also contains a red resin and abundance of starch.

1. *Sanguinarine*, $C_{20}H_{15}NO_4 \cdot \frac{1}{2}H_2O$ (m.pt. $213^\circ C.$), forms colourless crystals, but yields with acids deep red crystalline salts. It is also found in small quantity in the root of the greater celandine (*Chelidonium majus*, Linné), of *Glaucium luteum*, Scopoli, &c. This alkaloid should not be confused with the mixture of resinous substances known as sanguinarin, which is obtained in the same way as cimicifugin, podophyllin, and other so-called 'eclectic' remedies.

2. *Chelerythrin*, $C_{21}H_{17}NO_4 \cdot \frac{1}{2}H_2O$ (m.pt. $203^\circ C.$), a colourless bitter alkaloid yielding bright yellow salts; it is also found in *Chelidonium majus*, *Glaucium luteum*, &c.

3. *Protopine*, $C_{20}H_{19}NO_5$ (m.pt. $207^\circ C.$), also found in opium, celandine, &c.

4. β - and γ -*homochelidonine*, two colourless closely related alkaloids.

Uses.—Bloodroot in full doses depresses the action of the heart, and produces nausea and vomiting; in smaller doses it increases the appetite and improves digestion. It has been used in atonic dyspepsia, croup, bronchitis, and asthma. The powdered rhizome is a powerful irritant to the respiratory passages.

HORSERADISH ROOT

(*Radix Armoraciæ*)

Source &c.—The horseradish, *Cochlearia Armoracia*, Linné (N.O. *Cruciferae*), is indigenous to Eastern Europe, but is naturalised in several parts of Britain, and is cultivated in this country as well as in many others. It possesses a large perennial root, and produces stout, erect, flowering stems about 1 metre high.

Description.—The root, which is used in the fresh state only, attains a length of over half a metre and a thickness of 3 cm. or more. It is nearly cylindrical except at the crown, where it often divides into a few short branches, each of which is enlarged in its upper part and marked with closely approximated, semi-amplexicaul leaf-scars. It gives off but few slender, lateral roots, is pale yellowish or brownish white in

colour, and fleshy in consistence. The transverse section exhibits a thick bark and a distinct cambium, within which is a wood consisting principally of parenchymatous tissue, groups of vessels being visible as minute points, especially near the cambium.

The root is odourless until broken, bruised, or scraped, when a pungent mustard-like odour is evolved; the taste is also pungent.

The student should observe

- (a) The *pale yellowish colour* and *cylindrical shape*,
- (b) The *pungent odour (when crushed)* and *taste*.

Constituents.—Horseradish root contains sinigrin and myrosin, and yields, when crushed and distilled with water, about 0.05 per cent. of allyl isothiocyanate. The decomposition is the same that takes place in the case of black mustard seed, and the pungent principle is identical with that obtained from the latter drug (compare p. 172).

Uses.—Horseradish root has properties similar to those of black mustard seed, viz. stimulant and rubefacient.

SENEGA ROOT

(*Radix Senegæ*)

Source &c.—Senega root is obtained from *Polygala Senega*, Linné (N.O. *Polygalææ*), a small plant producing a perennial knotty rootstock, from which numerous slender stems 15 to 30 cm. high arise. It is widely distributed over the United States and the southern parts of British America, the root being collected largely in Minnesota and Manitoba (western senega) and in the north-western of the United States (northern senega). It was formerly collected in the more southern States, but is now nearly exterminated there. The root was used by the Seneca Indians as a remedy for snake-bite, and was introduced into medicine about the middle of the eighteenth century.

Description.—Senega root consists of a slender, greyish or brownish yellowish root surmounted by a knotty crown, to which are attached the remains of numerous slender aerial stems and small shoots beset with the scars or remains of pur-

plish scaly leaves. The root is usually about 3 to 6 mm. thick at its upper extremity, but it soon divides into two or three spreading branches. It is frequently curved and contorted, and is longitudinally and sometimes, especially near the crown, transversely wrinkled. Very frequently, but not always, it exhibits a prominent keel resembling a contracted sinew and following a gently spiral course; this keel may generally be found on the concave surface of the curves of the tap-root, and often extends a considerable distance.

The root breaks with a short fracture, the fractured surface exhibiting a whitish wood and yellowish translucent bark. The former frequently presents an abnormal appearance. Instead of a complete circle of wood a wedge-shaped portion, or sometimes two, of varying extent, is replaced by paren-

chymatous tissue, and the wood therefore appears to have had a segment cut out of it. This appearance varies in different parts of the same root, the segment that is missing being sometimes narrow and wedge-shaped or occasionally increasing to nearly a semicircle, thus reducing the wood to one-half its normal amount. If a keeled root is soaked in water and the bark stripped from it, the wood will be seen to have transverse cracks or a longitudinal fissure on the convex surface, the latter usually extending for some distance and widening from a narrow crack into a broad fissure. These cracks and fissures are filled with easily removable parenchymatous tissue.

The concave sides of the curved roots bear the keels, and these are seen in the transverse sections to be due to a largely developed bast; the keels do not arise from any abnormal development of the wood.

The root has a distinct odour, recalling wintergreen; the taste is at first somewhat sweet, but soon becomes sour and acrid. The powdered root is very irritating to the throat and

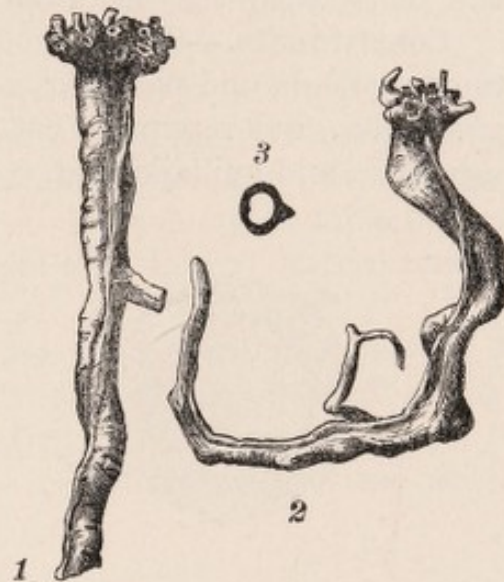


FIG. 171.—Senega root. 1 and 2, roots, showing the keel; 3, transverse section. Natural size. (Vogl.)

nostrils when inhaled, and imparts to water the property of frothing.

The student should observe

- (a) The *prominent keel*,
- (b) The *irregular wood in transverse sections*,

and should strip the bark from the root and examine the wood.

Constituents.—Senega root contains as principal constituents senegin and polygalic acid. These substances are both glucosides, and resemble, but are not identical with, quillajasapotoxin and quillajic acid, constituents of quillaja bark, their

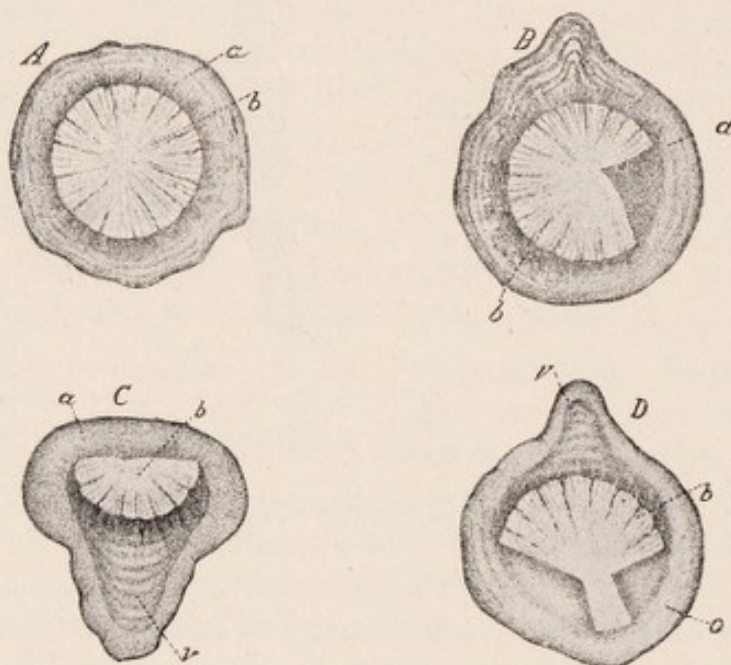


FIG. 172.—Senega root. A, transverse section of normally developed root; B, C, D, of abnormally developed roots. a, bark; b, wood; v, bast. Magnified. (Berg.)

action being qualitatively the same, but quantitatively different (Atlass, 1890). Polygalic acid is sternutatory, and imparts to water the property of frothing. Senegin is decidedly toxic. Both these bodies require, however, further investigation.

The drug often contains a small percentage of methyl salicylate (oil of wintergreen), probably produced by the gradual decomposition of an unknown glucoside; its presence has been utilised as a test of the identity of the drug, but it is unreliable. Senega root also contains about 5 per cent. of fixed oil, but is free from starch; it yields about 4 per cent. of ash.

Use.—Senega is used as a stimulant expectorant in bronchitis.

Varieties.—*Northern senega*, collected in the north-western States, is considerably larger than the usual variety (western senega), and darker in colour; it is less contorted and shows the keel less distinctly, but it has a very acrid taste, and is undoubtedly a good senega. It is said to be derived from *Polygala Senega*, var. *latifolia*.

White senega, from *Polygala alba*, Nuttall, is collected to some extent in the southern States. The root is more slender than western senega, has descending branches rather than spreading, and is lighter in colour. It has no keel and a normal wood. The taste is much less acrid than that of western senega, and it is presumably less active.

Other roots occasionally find their way into parcels of senega, frequently as a result of careless collection; the characters given sufficiently distinguish the genuine drug; to enumerate all the accidental or occasional admixtures would serve no useful purpose.

RHATANY ROOT

(*Radix Krameriæ*)

Source &c.—Two varieties of rhatany root, commercially distinguished as Pará rhatany and Peruvian rhatany, are official; they are derived from two distinct species of *Krameria* belonging to the natural order *Polygalææ*.

1. *Peruvian rhatany* is the root of *K. triandra*, Ruiz and Pavon, which grows on the mountain slopes of Peru and Bolivia.

2. *Pará rhatany* is presumably obtained from *K. argentæa* Martius, a shrubby plant growing in Brazil.

Rhatany root has apparently been used for many years by the Peruvians for cleaning and preserving the teeth. The Spaniards became acquainted with it in Lima and introduced it into Europe.

Description.—1. The root of Peruvian rhatany is large and knotty at its upper extremity, but divides near the crown into several long stout branches, from which again smaller branches proceed. The larger pieces have a dark reddish brown

colour and a rugged, scaly bark; the smaller are usually rather brighter and smoother, not exhibiting any conspicuous transverse fissures. The bark, which can easily be separated from the smaller roots, is rather fibrous, but the wood breaks with a splintery fracture. The transverse section exhibits a pale reddish or yellowish wood and a comparatively narrow reddish



FIG. 173.—Peruvian Rhatany root. A, portion of an older root, showing scaly cork; natural size. B, portion of a younger root, natural size.

brown bark occupying about one-fourth of the radius of a root of medium size. The wood is dense, and marked with numerous narrow medullary rays and minute vessels. The drug is quite odourless; the bark has a strongly astringent taste, but the wood is practically tasteless.

Pará rhatany is usually imported in long, nearly straight, cylindrical pieces, not often exceeding 15 mm. in thickness.



FIG. 174.—Pará Rhatany. Natural size.

They are well characterised by their dark purplish brown colour, and by the presence of deep transverse cracks at more or less regular intervals in the bark, which in this variety is never rough or scaly, although transversely fissured and longitudinally wrinkled. The transverse section shows a reddish wood and a dark reddish brown bark, which, in this case,

occupies about one-half the radius of a root of medium size. In respect to odour and taste Pará rhatany resembles Peruvian.

The student should carefully compare these two roots, and observe in Peruvian rhatany

- (a) The *reddish brown bark*, which is *scaly in large pieces, smoother in the smaller, and free from deep transverse cracks*,
- (b) The *proportion of bark to wood* as exhibited in the transverse section ;

in Pará rhatany

- (a) The *dark purplish brown colour of the bark*, which is *not scaly, but exhibits deep transverse cracks*,
- (b) The *proportion of the bark to wood* in the transverse section, which is greater than in Peruvian rhatany.

Large pieces of Indian sarsaparilla occasionally bear a considerable resemblance to small pieces of Pará rhatany, both in colour and in the presence of transverse cracks. They may be distinguished by their agreeable odour and by the difference in the transverse section.

Constituents.—The principal constituent of rhatany root is the tannin (krameria-tannic acid) that it contains. The proportion in which this substance is present has not been satisfactorily determined, but it has been stated to be 8·4 per cent. in the Peruvian root. The Pará variety contains about the same quantity, one assay of the root showing rather more, and another rather less tannin than the Peruvian. These analyses, are, however, of comparatively little value, since the proportion of bark, in which alone the tannin resides, varies in different roots of each variety. The Peruvian root appears to contain a much larger amount of substances soluble in absolute alcohol than the Pará root does (23·0 per cent. against 12·6 in the Pará—Dunwody, 1890), and certainly yields a tincture possessing different properties, that from the Peruvian giving a cloudy and that from the Pará a clear mixture with water. Notwithstanding this difference the Pharmacopœia retains both, since the supply of each is subject to considerable irregularity.

The root contains in addition a dark red phlobaphene, krameria-red, produced by decomposition of the tannin, as well as starch, and about 2 per cent. of inorganic matter.

Use.—Rhatany root is employed solely as an astringent.

Varieties.—Several other species of *Krameria* are known to yield astringent roots, but none are of commercial importance.

MARSHMALLOW ROOT

(*Radix Althææ*)

Source &c.—The marshmallow, *Althæa officinalis*, Linné (N.O. *Malvaceæ*), is not uncommon in moist or marshy places in Southern England, and is widely distributed in similar situations in Central and Southern Europe. Our supplies are derived from plants cultivated in Germany, France, and Belgium.

The roots are collected in the autumn from plants about two years old, trimmed, and deprived of their cork by scraping; they are then dried. Sometimes the root is also split longitudinally, or cut into transverse slices.

Description.—After being trimmed, scraped, and dried, the roots as met with in commerce are generally in straight, tapering, whitish pieces about 15 or 20 cm. in length, and attaining 2 cm. or more in diameter at their upper extremity. They are usually obscurely quadrangular or rounded, with a few broad and deep longitudinal furrows. The surface is softly fibrous from the presence of bast fibres that have been liberated by the scraping, and bears brownish scars of lateral roots. The bark, which can readily be removed in long strips, is tough and fibrous, but the wood breaks with a short granular fracture; internally the root is

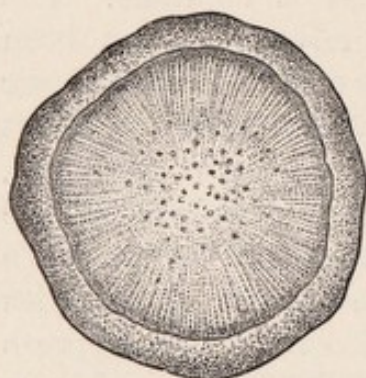


FIG. 175.—Marshmallow root.
Transverse section. Magnified. (Moeller.)

whitish and starchy. It can easily be cut, and the smoothed transverse section exhibits a bark of moderate thickness, separated by a yellow sinuate cambium line from the wood. Both bark and wood possess a radiate structure that is more distinct when the surface of the smoothed section is moistened; numerous cells containing a translucent mucilage then become also visible.

The drug has a faint but characteristic odour, and a mawkish, mucilaginous taste. To improve its appearance it is sometimes limed, but this sophistication can easily be detected by rinsing the drug with 1 per cent. hydrochloric acid, filtering, and adding excess of sodium carbonate, when the liquid should remain clear.

The student should observe

- (a) The *fibrous bark*,
- (b) The *yellow cambium line*,
- (c) The *radiate structure of the wood*,
- (d) The *presence of mucilage*;

and should compare the root with

- (i) *Belladonna root*, which closely resembles *unpeeled* marshmallow root, but may be distinguished by the non-fibrous nature of the bark, by the absence of mucilage, and by the scarcely radiate structure of the wood,
- (ii) *Liquorice root*, the transverse section of which is yellow, and the taste sweet.

Constituents.—The principal constituent is mucilage, of which the root is said to contain as much as 25 to 35 per cent., but these figures require confirmation. The drug contains also an abundance of starch together with asparagin and a substance allied to lecithin. Asparagin, $C_4H_8N_2O_3$, is the amide of aspartic (amidosuccinic) acid, and is found in many plants, especially in marshmallow root and in etiolated plants.

Uses.—Marshmallow root is used as an emollient and demulcent.

LIQUORICE ROOT

(*Radix Glycyrrhizæ*)

Source &c.—The liquorice plant, *Glycyrrhiza glabra*, Linné (N.O. *Leguminosæ*), is widely distributed over Southern Europe, extending to Central Asia; it is cultivated to a limited extent in England (Yorkshire), but our supplies of the official drug are derived chiefly from Spain.

The plant produces a tall, erect, herbaceous stem, and a stout perennial root, dividing, a few inches below the surface,

into several long, straight, descending branches. Near the surface it also throws out long horizontal runners provided with scaly cataphyllary leaves with buds in their axils. In England the plant is dug up in the late autumn, and either sold in the fresh state or cut transversely and dried. The drug consists therefore of both runners and roots, the former constituting the major part.

Spain and the south of France furnish considerable quantities of carefully dried liquorice root; in the former country the plant is cultivated in the northern provinces of Murcia, Aragon, and Toledo. In Southern Italy large quantities of liquorice root are grown, but it is chiefly converted into extract, although some of the root also is exported.

Description.—Spanish liquorice is exported in large bales or in bundles of long straight cylindrical pieces from 1 to 2 cm. thick.

These have a rather dark reddish brown colour, and are usually longitudinally wrinkled. On the surface they also bear small scars of roots, and, on the majority of pieces (the runners), here and there minute dark buds may be seen.

The drug breaks with a fracture that is fibrous in the bark, splintery in the wood; the fractured surface exhibits, when smoothed, a yellow wood surrounded by a moderately thick yellowish grey bark, the pieces of runner being distinguished by the presence of a small pith. Under the lens the wood is

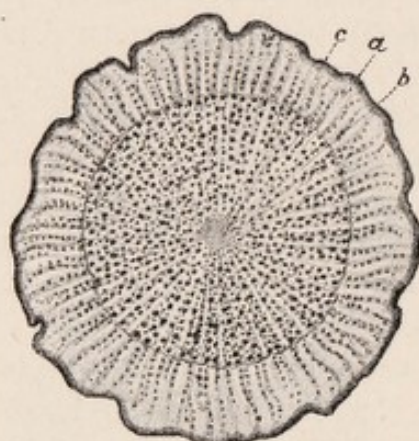


FIG. 176.—Spanish Liquorice root. Transverse section of rhizome (runner). *a*, bark; *b*, wood; *c*, pith. Magnified 3 diam. (Berg.)

seen to consist of very numerous medullary rays, between which are very narrow, porous wedges of vascular tissue: opposite to these in the bark are radial rows of dark points (groups of bast fibres).

Peeled root (including runner), which alone is official, has a pale yellow, slightly fibrous exterior and exhibits no trace of the small buds; otherwise it resembles the unpeeled.

The drug has a characteristic but not powerful odour, and a very sweet taste without perceptible bitterness or acidity.

The student should observe

- (a) The *yellow colour of the section, and fibrous bark,*
- (b) The *minute buds on the unpeeled root,*
- (c) The *pith in most of the pieces,*
- (d) The *characteristic sweet taste, free from acridity ;*

and should carefully compare this (the Spanish) variety with the Russian, which is not official.



FIG. 177.—Bales of decorticated Liquorice root.

Microscopical Characters.—In transverse section the cork-cells are brown and flattened. The cells of the cortex contain small (1.5 to 20 μ) starch grains and prismatic crystals of calcium oxalate. The bast-ring is characterised by the presence of numerous bundles of strongly thickened, striated, yellowish bast fibres accompanied by calcium oxalate cells. The wood contains vessels of varying size (often 100 μ) accompanied by wood fibres closely resembling the bast fibres.

The powder is characterised by the very thick-walled, grouped bast fibres with calcium oxalate cells frequently attached; by the portions of large, thick-walled vessels with closely packed, bordered pits; by the small starch grains and by the prevailing yellowish colour which is changed to orange yellow by sulphuric acid. It should be free from polygonal, brownish cork cells (unpeeled root) and from sclerenchymatous cells (olive-stones, almond shells &c.)

Constituents.—The principal constituent of liquorice root is the sweet principle, glycyrrhizin, which, when quite pure, is a white, crystalline, intensely sweet powder, soluble in water. This has been shown to consist of the potassium and calcium salts of glycyrrhizinic acid, a colourless crystalline acid, slightly soluble in water, but imparting a sweet taste to it in a dilution of 1 in 20,000; it is not a glucoside as was formerly supposed, since it yields on hydrolysis glycyrrhetinic acid and glycuronic acid, but no sugar. Liquorice root contains about 3 per cent. of it. The drug also contains sugar, starch (29 per cent.), proteids, asparagin, fat, and resin. It yields from 3 to 4 per cent. of ash, and from 15 to 27 per cent. of aqueous extract dried at 100° C.

Glycyrrhizin, or at least a substance closely resembling it, has been isolated from other plants besides liquorice, as, for instance, the rhizome of *Polypodium vulgare*, Linné, the leaves of *Myrrhis odorata*, Scopoli, the bark of *Lucūma glycyphlæa*, Martius, &c., and appears therefore to be somewhat widely distributed.

Uses.—Liquorice root is a demulcent and expectorant; the liquid extract is frequently employed to mask the taste of nauseous medicines.

Varieties.—*Russian Liquorice Root.* Very large quantities of liquorice root are collected in Southern Russia, where the

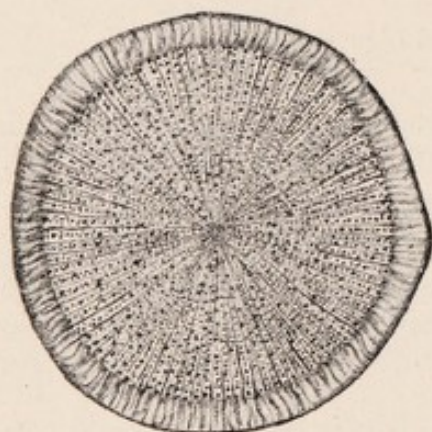


FIG. 178.—Russian Liquorice root. Transverse section. Magnified $1\frac{1}{2}$ diam. (Berg.)

plant grows wild on the banks of the Volga and other rivers, needing no cultivation. The plant that yields this root is *G. glandulifera*, Waldstein and Kitaibel. Instead of producing numerous runners this plant forms a large rootstock, from which long perennial roots are given off. These are usually freed from the purplish brown cork by scraping.

Nearly all the Russian liquorice root that reaches this country has been peeled, and presents therefore a smooth yellow exterior, to which

loose fibres are attached, the larger pieces being often longitudinally split. It attains a much larger size than the Spanish,

the crown of the root, which shows the remains of several stems, being occasionally as much as 10 cm. in diameter. The texture is commonly looser and more fibrous than that of the Spanish drug, and the taste, although sweet, is accompanied by a more or less perceptible but not strong bitterness or acridity.

Unpeeled Russian liquorice shows a close resemblance to the Spanish. It consists, however, chiefly of roots (instead of



FIG. 179.—Compressed bales of natural (unpeeled) Liquorice root.

runners) which are destitute of pith and exhibit no traces of buds; their colour is purplish rather than brown, and the cork is often scaly. The bitterness is said to be due to an amorphous glucoside, glycyramarin. It is not official, the Pharmacopœia admitting only the peeled roots or runners of *G. glabra*.

Persian Liquorice Root.—Liquorice root is also largely collected in the valleys of the Tigris and Euphrates from *G. glandulifera*, and exported in bales from Bussorah. It is

usually unpeeled and in rather large coarse pieces closely resembling the unpeeled Russian root; it is largely consumed in America.

Stick Liquorice.—The manufacture of stick or block liquorice is carried on chiefly in Southern Italy, but also to some extent in Spain. The runners and roots of both wild and cultivated plants are collected, crushed, boiled with water, and pressed. The decoction thus obtained is allowed to clear by standing, and is then run off into large pans, where it is concentrated by boiling until it has acquired a suitable consistence, when it is formed into blocks or sticks, which are stamped with the name of the manufacturer (e.g. Solazzi), and dried.

Stick liquorice contains about 17 per cent. of water and about 60 or 70 per cent. of substances soluble in water, the brown, slimy residue that is left consisting principally of more or less altered starch, together with inorganic matter and a little glycyrrhizinic acid, which can be removed by treatment with dilute ammonia.

BRYONY ROOT

(*Radix Bryoniæ*)

Source &c.—The common bryony, *Bryonia dioica*, Jacquin (N.O. *Cucurbitaceæ*) is a climbing and trailing plant, with rough, hairy leaves, common in hedges and thickets in Southern England. It must not be confounded with black bryony (*Tamus communis*, Linné), a very different plant with entire shining leaves.

The root is collected in the autumn and used in the fresh state. It was well known to, and much used by, the Greeks and Romans.

Description.—The plant produces in the spring aerial stems attaining a great length and springing from a large tuberous rhizome which is continuous with a thick fleshy root. This subterranean part of the plant is often of very considerable size and weight, measuring occasionally at the upper extremity 15 cm. or more in diameter, and reaching a length of half a metre, the whole weighing several kilogrammes. It tapers more or less gradually towards the tip, and is usually simple,

though sometimes it divides into two nearly equal descending branches. When fresh it is of a greyish yellow colour externally, and marked at close intervals with prominent transverse corky ridges often extending half round the root. Internally the root is whitish and fleshy, exuding when cut a juice that is milky from the presence of numerous minute starch grains. The transverse section exhibits a fine line separating a narrow bark from a large fleshy wood; the latter contains, more or less uniformly distributed over it, small groups of vessels, radially arranged and extending from the centre to the bark.

The fresh root has an unpleasant odour and a nauseously bitter and acrid taste.

It is sometimes cut into transverse slices and dried; the slices average about 5 cm. in diameter and have a thin yellowish grey cork, a whitish wood marked with concentric rings and radially arranged vessels; they somewhat resemble calumba, but may be distinguished by their yellowish grey cork and whitish wood.

The student should observe

- (a) The *large size and gradually tapering shape*,
- (b) The *transverse corky ridges*,
- (c) The *nauseously bitter taste*;

and should compare small specimens with horseradish root, which is cylindrical and smooth, and has a pungent taste.

Constituents.—Bryony root contains a white, amorphous, very bitter glucoside bryonin, and a resinous substance bryoresin. The autumnal root contains, further, large quantities of starch, the grains of which are exceedingly small and impart a milky appearance to the juice that exudes from a freshly cut surface.

Uses.—The root when taken internally in full doses acts as a cathartic and diuretic; applied to the skin it is irritant and may cause vesication. It has been recommended for pleurisy, whooping cough, and bronchitis, and has been given in cases of dropsy.

Varieties.—*Bryonia alba*, Linné, a Continental species, is distinguished by its monœcious flowers and black berries, the common bryony having dioecious flowers and scarlet berries. It produces a similar root containing probably the same constituents.

SUMBUL RHIZOME

(Sumbul Root, Musk Root, Radix Sumbul)

Source &c.—The botanical origin of the drug at present known in commerce and official in the British Pharmacopœia under the name of Sumbul Root is not definitely known. It is generally referred to *Ferula Sumbul*, Hooker filius (N.O. *Umbelliferae*), a plant of considerable size, growing in Turkestan. This plant, however, according to Holmes, produces a large napiform root that could scarcely furnish the cylindrical pieces, 3 to 6 cm. long, that form much of the commercial drug, although it was probably the source of the drug of twenty-five



FIG. 180.—Sumbul root. Slightly reduced. (*Pharmaceutical Journal*.)

years ago, which was apparently obtained from a large fragrant root. *F. suaveolens*. Aitchison and Hemsley, has been suggested as yielding the commercial drug.

Description.—Sumbul root occurs in short, more or less cylindrical pieces that are remarkable for their extreme lightness; they vary considerably in size, but are usually from 3 to 6 cm. in width and about the same in length, often dividing in the upper part into two, three, or more branches. The latter are occasionally not more than 1 cm. in diameter, and some of them bear a depressed scar left by the aerial stem after it has perished. Most of the pieces bear numerous short bristly

fibres arranged in encircling lines, or at least show the scars of such; these fibres are the remains of the fibro-vascular bundles of leaves that have perished, and prove that most of the commercial drug consists of rhizome, not root. All the pieces exhibit regular transverse wrinkles and are covered with a thin but tough cork, which often shows a disposition to exfoliate, or at least can easily be stripped off.

Internally the drug is whitish or yellowish, spongy and irregularly fibrous, exhibiting numerous fissures which have possibly originated during the process of drying, and more or less abundant soft resin to which dust &c. rapidly adheres. The transverse section of a small rhizome shows a pale bark, within which is a ring of narrow, finely porous yellow wood-bundles; the central portion is parenchymatous tissue through which vascular bundles pass in varying directions, a peculiarity that is exhibited by many rhizomes, and to which in this case the fibrous nature of the drug is due. In the larger pieces the structure is usually less distinct. The drug has an agreeable musky odour and a bitter, slightly aromatic taste.

The student should observe

- (a) The *transverse wrinkles*, from which *short fibres* proceed,
- (b) The *whitish, fibrous and spongy interior*,
- (c) The *musky odour*.

Constituents.—Of the constituents of the sumbul root of commerce very little is known. Hahn (1896) found it to yield to petroleum benzin 17.25 per cent. of a yellow viscid oil, from which crystals of a substance not further investigated were obtained. The drug yielded 8 per cent. of ash.

Utech (1893) obtained 6.1 per cent. of an aromatic amber-coloured resin having a bitter taste and possessing the aromatic odour of the root.

The drug also contains free umbelliferone and traces of volatile oil.

Uses.—Sumbul is considered to possess stimulant and antispasmodic properties resembling those of valerian. It has been given in hysteria and certain nervous disorders, but is now not much prescribed.

IPECACUANHA ROOT

(Radix Ipecacuanhæ)

Source &c.—Ipecacuanha root is obtained from *Psychotria* (*Cephaelis*) *Ipecacuanha*, Stokes (N.O. *Rubiaceæ*), a small



FIG. 181.—A, Brazilian Ipecacuanha (*P. Ipecacuanha*) cultivated in Selangor.
B, Cartagena Ipecacuanha. Large specimens. Natural size.

plant about 30 cm. in height with a stem that is at first prostrate or ascending and afterwards becomes erect. It is found in most parts of Brazil, but especially in the province of Matto Grosso, in the interior, whence much of the drug is obtained; it is also cultivated in the province of Minas Geraes and is exported chiefly from Rio de Janeiro.

Endeavours have not been wanting to cultivate the ipecacuanha plant in other countries, and they have met with some success. From the state of Selangor (near Singapore) ipecacuanha root of unusually fine appearance and rich in alkaloid is exported in considerable quantity. In Java, Ceylon, and China the cultivation has not been successful.

From the slender, prostrate stem fibrous roots are given off at intervals; some of these in the course of their growth develop an abnormally thick bark in which abundance of starch is deposited, whilst the wood remains comparatively small. These thickened roots should constitute the commercial drug; they are collected by raising the plants, which usually form clumps, from the earth, removing the roots, drying them, and sifting them from adherent sand and earth. The drug is exported in compact canvas bales. Very frequently much of the prostrate or ascending stem finds its way into the drug.

Ipecacuanha appears to have long been used in Brazil for dysentery; it was introduced into Europe about 1672.

Description.—The official ipecacuanha root, which is distinguished as Brazilian

or Rio ipecacuanha, is slender and rather tortuous, seldom exceeding, in the commercial drug, 15 cm. in length or 5 mm. in thickness. The colour varies from dark brick-red to dark brown, the former being due, partly at least, to adhering particles of earth. Very characteristic of the root is the annulated appearance that it presents, the bark of typical pieces being constricted at short intervals so as to resemble a number of discs somewhat irregularly strung together; the constrictions are sometimes quite shallow, but sometimes they penetrate nearly to the wood. These annulations seldom, however, take the form of distinct, rather distant, narrow, raised ridges (compare Cartagena ipecacuanha).

The root is hard and breaks with a very short fracture.

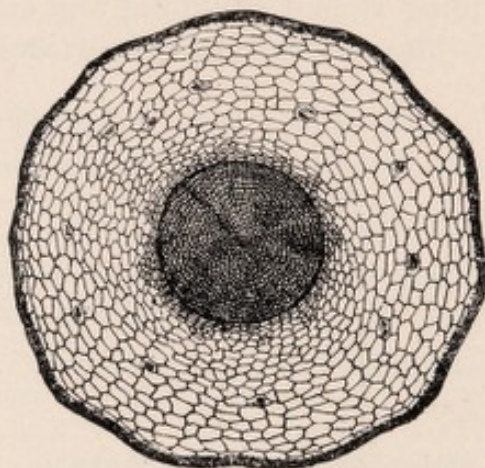


FIG. 182.—True Ipecacuanha (*Psychotria Ipecacuanha*). Transverse section, showing dense wood. Magnified. (Planchon and Collin.)

The transverse section exhibits a thick, dark grey bark which is usually horny, but sometimes starchy, and a small wood in which no distinct pores or pith can be discerned when examined with a lens. The bark, when examined under the microscope, is found to contain abundance of starch grains that are mostly compound and, in addition, acicular crystals of calcium oxalate; the wood is free from vessels. These characters are useful in distinguishing ipecacuanha from certain substitutes that appear from time to time, and are referred to below.

The drug has a slight odour which to many persons is particularly unpleasant; the taste is slightly bitter. The powder is often very irritating to the throat and nostrils, producing violent coughing and sneezing.

The student should particularly observe

- (a) The *closely approximated disc-like annulations*,
- (b) The *thick, starchy bark*,
- (c) The *small, dense wood*;

and should compare this variety with Cartagena ipecacuanha, which is usually rather thicker, and in which the annulations assume the form of distinct, somewhat distant, narrow, raised ridges.

Microscopical Characters.—Below the narrow cork is a largely developed cortex consisting of thin-walled parenchymatous cells most of which are filled with starch, but a few contain acicular calcium oxalate. The bast ring is narrow, and both this and the cortex are free from sclerenchymatous cells and fibres and from cells containing colouring matter. The wood is composed of tracheids, wood fibres, and parenchyma and is free from typical vessels. The tracheids, when isolated, exhibit moderately thick walls, and often near the pointed extremities a large perforation.

The powder is characterised by the starch grains which are either oval or rounded (not over $15\ \mu$) or compound with from 2 to 5 constituent grains, by the acicular calcium oxalate, by the characteristic tracheids and by the absence of sclerenchymatous cells, spiral vessels (ipecacuanha stem), cells containing colouring water, calcium oxalate in other than acicular crystals, and typical sclerenchymatous fibres or vessels.

Constituents.—Ipecacuanha root contains three alkaloids; two of which, emetine and cephaeline, have been more closely

examined, whilst the third, psychotrine, which occurs in much smaller quantity, awaits further investigation. These alkaloids exist in good root to the extent of from 2 to 3 per cent., and are contained chiefly in the bark, the wood yielding only about 1 per cent.

Emetine, $C_{15}H_{22}NO_2$, is a white amorphous alkaloid which darkens on exposure to light, gradually assuming a yellow colour; it yields crystalline salts and has been shown to be methyl-cephaeline, but is less powerfully emetic and about half as toxic as cephaeline. It constitutes about 72 per cent. of the total alkaloid.

Cephaeline, $C_{14}H_{20}NO_2$, crystallises in white, silky needles, but yields uncrystallisable salts; though a more powerful emetic, it is a less efficacious expectorant than emetine. It constitutes about 26 per cent. of the total alkaloid.

Psychotrine exists in small quantity only (about 2 per cent. of the total alkaloid).

The drug contains in addition a glucosidal acid, ipecacuanhic acid allied to quillajic acid, calcium oxalate, and an abundance of starch.

Assay.—Shake 15 gm. of ipecacuanha in No. 80 powder for five minutes with 115 c.c. of ether and 35 c.c. of chloroform. Add 3 c.c. of solution of ammonia and shake at intervals during half an hour. Add 10 c.c. of water, shake until the powder aggregates, transfer 100 c.c. (=10 gm. of drug) to a separator and shake out with 20 c.c. of semi-normal sulphuric acid followed by 10 c.c. of one-third normal acid and by 10 c.c. of water. Make the aqueous solutions alkaline with ammonia and shake out with 25 c.c., 20 c.c., and 10 c.c. of ether. Distil off the ether in a flat-bottomed flask, dissolve the residue in 12 c.c. of decinormal sulphuric acid and titrate back with fiftieth-normal potassium hydroxide, using hæmatoxylin as indicator. Each c.c. of decinormal acid neutralised by the alkaloid indicates 0.0238 gm. of alkaloid.

Varieties.—1. *Matto Grosso*: this is the variety above described.

2. *Minas*: Minas ipecacuanha is the produce of the plant cultivated in the province of Minas Geraes; it very closely resembles the Matto Grosso variety, but usually bears evidence of careful cleaning.

3. *Indian or East Indian*: this variety also closely resembles the Matto Grosso, but is usually distinctly larger and brighter in colour. It contains about the same amount of total alkaloid.

4. *Cartagena Ipecacuanha*.—This variety is imported from Colombia; it is distinguished from the Brazilian drug by being usually of larger size and by the annulations which in this case assume the form of narrow, distinct, transverse, raised ridges arranged at a little distance from one another, and the root does not therefore assume the appearance of a number of discs strung together. The starch grains are also rather larger than those of Brazilian ipecacuanha. The drug has been attributed to *Psychotria acuminata*, Karsten, but definite evidence on this point has not yet been adduced. *Cartagena ipecacuanha* contains the same alkaloids as Brazilian, and about the same amount. The chief difference in this respect lies in the proportion in which each of the alkaloids emetine and cephaeline is present rather than in the amount of total alkaloid contained in the root. In *Cartagena ipecacuanha* the emetine amounts to only 40 per cent. of the total alkaloid, whilst the cephaeline reaches as much as 57 per cent.; in other words, it contains twice as much of the latter alkaloid as the Brazilian root, and its physiological action is therefore much more emetic and less expectorant. For this reason the *Cartagena* variety has been excluded from the Pharmacopœia.

Uses.—*Ipecacuanha* is largely used as an expectorant and emetic; it also possesses diaphoretic and cholagogue properties. One of its most important uses is as a remedy for dysentery, for which purpose large doses are given (30 to 90 grains). In such cases a remarkable tolerance of the drug is often readily established, or the drug deprived of its alkaloids (de-emetinised *ipecacuanha*) is administered.

Substitutes.—1. *Ipecacuanha Stem*.—Much of the Brazilian drug is imported mixed with the stems of the plant. These are slender and longitudinally striated, exhibiting no annulations. The transverse section shows a thin bark surrounding a ring of wood within which is a distinct pith. They contain less alkaloid than the root, various assays yielding from 0·97 to 1·8 per cent., and should therefore be excluded from the drug.

2. *East Indian Root*.—Under this name the rhizome of a small monocotyledonous plant, probably *Cryptocorÿne spirālis*, Fischer (N.O. *Aroideæ*), has been imported from the south of India. It occurs in short, nearly cylindrical pieces, 1·5 to 5 cm. long, often tapering at one end and there bearing the remains of leaves; they are slightly enlarged and constricted at regular

intervals, which gives them an annulated appearance somewhat resembling ipecacuanha, and are marked with encircling leaf scars. The transverse section exhibits a typically monocotyledonous structure, and distinguishes this drug at once from genuine ipecacuanha; for instead of the central column of dense wood there is a parenchymatous stele, through which scattered bundles run, surrounded by a white starchy cortex. This substitute for ipecacuanha contains no emetine or cephaeline.

3. *Undulated Ipecacuanha*, derived from *Richardsonia scabra*, Saint Hilaire (N.O. *Rubiaceæ*, Brazil), occurs in

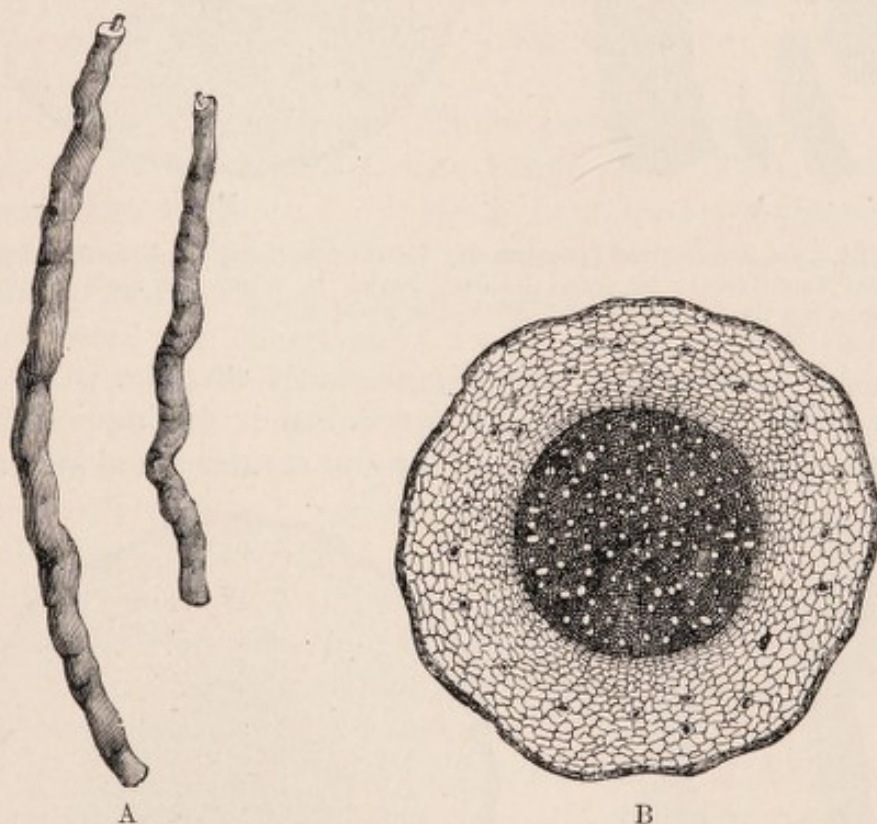


FIG. 183.—Undulated Ipecacuanha (*Richardsonia* sp.). A, root, natural size. B, transverse section, magnified, showing porous wood. (Planchon and Collin.)

tortuous pieces, the upper part being cylindrical and bearing at the crown the remains of numerous very slender aerial stems. On one side of the root the bark is occasionally fissured nearly to the wood, and this gives the drug a somewhat annulated appearance, which, however, is quite different from the regular annulations of Brazilian ipecacuanha. The transverse section exhibits a porous wood, and a thick, starchy bark that often possesses a violet colour.

4. *Lesser Striated Ipecacuanha*.—This drug, which is occasionally found on the market, is apparently derived from a

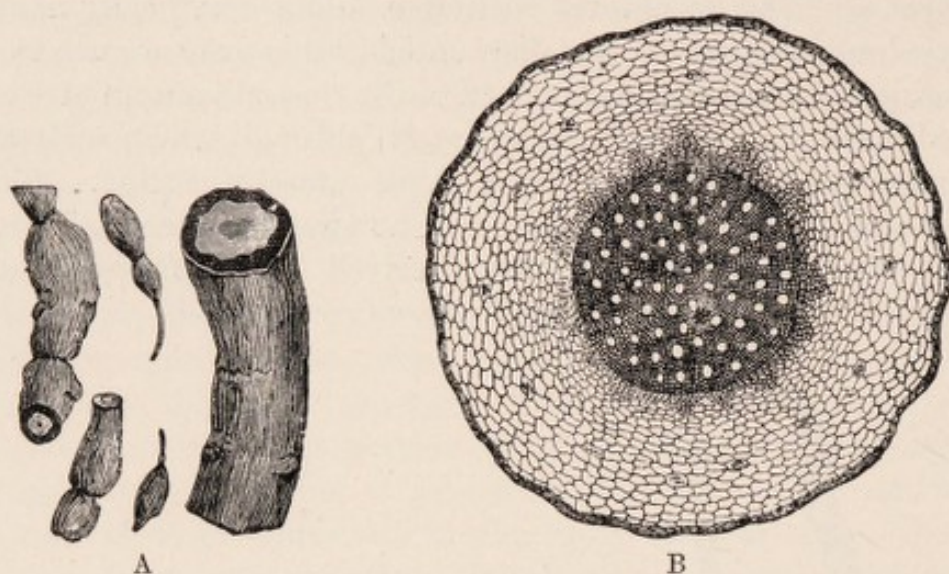


FIG. 184.—Lesser Striated Ipecacuanha (*Richardsonia* sp.). A, root, natural size, cut transversely to show the dark bark. B, transverse section, magnified, showing the porous wood. (Planchon and Collin.)

species of *Richardsonia*, as it possesses a starchy, violet (often dark violet) bark and porous wood, but is distinguished from the foregoing by its darker colour and stouter aerial stems.

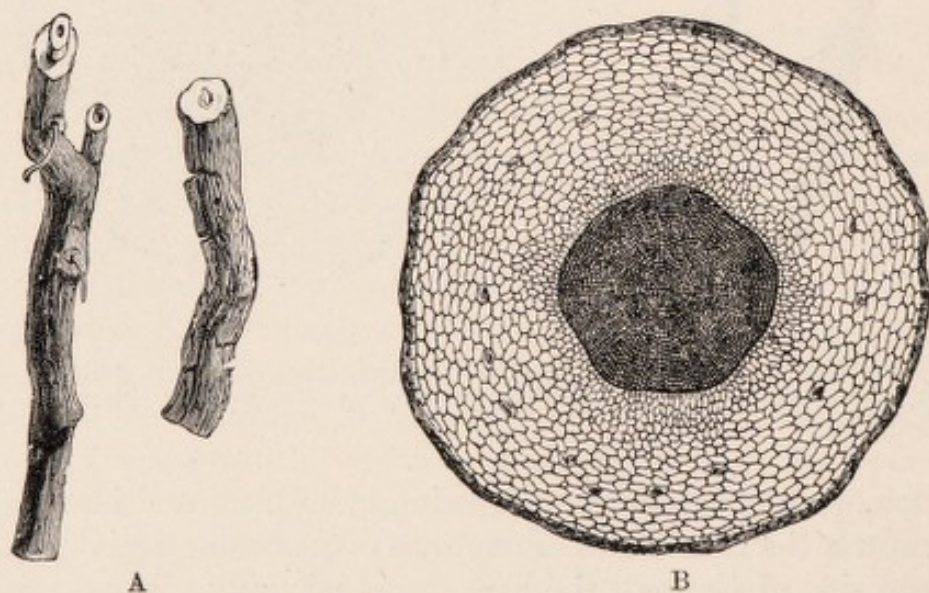


FIG. 185.—Greater Striated Ipecacuanha (*Psychotria emetica*). A, root, natural size. B, transverse section, magnified, showing the dense wood. (Planchon and Collin.)

5. *Greater Striated Ipecacuanha* is the root of *Psychotria emetica*, Linné. It is about the size of Cartagena ipecacuanha

and closely resembles the foregoing, being irregularly constricted, dark in colour, and exhibiting in transverse section a dark, violet-coloured bark; it may be distinguished by its dense wood, and by the presence of sugar in the bark, starch being completely absent. The colour of the bark and the absence of starch easily distinguish this root from either Brazilian or (which it closely resembles in appearance) *Cartagena ipecacuanha*.

6. *White Ipecacuanha* is the root of *Ionidium Ipecacuanha*, Ventenat (N.O. *Violaceæ*, Brazil). It is greyish white or yellowish in colour, 1·5 to 3 mm. thick, and frequently branches. The section exhibits a large, porous, yellowish wood and narrow, darker bark.

7. *Trinidad Ipecacuanha*.—Under this name the rhizome and root of *Asclēpias curassavica*, Linné (N.O. *Asclepiadææ*), has been offered for sale. It is 2 to 4 mm. in diameter, yellowish brown externally and whitish internally; it bears wiry rootlets and has an unpleasant bitter taste.

Other roots are occasionally found in the market mixed with or substituted for ipecacuanha; the enumeration of these would be beyond the scope of the present work.

With the exception of ipecacuanha stem, none of these substitutes, all of which reappear from time to time on the London market, contain any emetine or cephaëline.

The following test for emetine is useful in distinguishing roots containing that alkaloid from numerous substitutes which do not:—0·5 gramme of the finely powdered root is mixed with 20 c.c. of strong hydrochloric acid and 5 c.c. of water; to 2 c.c. of the filtrate 0·01 gramme of potassium chlorate is added; if emetine is present the liquid assumes a yellow colour, changing in the course of an hour to red.

VALERIAN RHIZOME

(*Rhizoma Valerianæ*)

Source &c.—The common valerian, *Valeriana officinalis*, Linné (N.O. *Valerianææ*), is an herbaceous plant widely diffused over Europe and Northern Asia. It is common in England in moist situations, attaining a height of 1 to 1·5 metres, and producing terminal corymbs of small white or pinkish flowers,

each with a gamopetalous corolla and three stamens. It is cultivated in England (Derbyshire), and also in Holland and Germany, our supplies being derived partly from English and partly from foreign sources, but chiefly from cultivated plants. The drug, or at least a species of valerian, was well known to the Greeks and Romans; whilst the common valerian, or 'all-heal' as it is sometimes called, was a domestic medicine of the Anglo-Saxons. In the middle ages the root was used not only as a medicine but also as a spice, and, curiously enough, even as a perfume.

The plant produces a short upright rhizome from which slender horizontal branches are emitted; the buds that terminate these branches develop into aerial shoots, which in their turn form erect rhizomes, and continue the life of the plant, the mother-rhizome perishing after flowering and fruiting. The drug is collected in the autumn, the lateral shoots are cut off for the propagation of the plant, and the rhizomes usually, especially if of large size, sliced longitudinally and dried.

In Derbyshire the wild plants are collected and planted out; the stems of the larger which would otherwise produce flowers are topped to prevent this from happening. In September or October all the tops above ground are cut off with a scythe, the rhizomes dug up, washed and dried, the larger being generally sliced.

Description.—The commercial drug consists of short erect conical rhizomes not more than 12 mm. thick and 25 mm. long,



FIG. 186.—Valerian rhizome. A, transverse, B, longitudinal section through the rhizome: *a*, bark; *b*, wood; *c*, pith; *rd*, roots. Natural size. (Berg.)

of a dull yellowish brown colour, usually halved, or quartered if large, but entire if small, and sometimes crowned with the remains of the stem and leaves. Internally the rhizome is firm and horny and of a whitish or yellowish colour; sometimes

it becomes hollow, portions of the tissue remaining as transverse septa.

From the rhizome numerous brittle roots of the same colour and about 1.5 mm. thick are given off, as well as occasionally short, slender, lateral branches. In the commercial drug the roots seldom exceed 10 cm. in length and 2 mm. in diameter; they are plump or longitudinally striated, but usually not much shrivelled.

Sometimes the drug consists of small rhizomes about 5 mm. long, which are crowned with the remains of several leaves and bear rather short slender roots. These are formed from the lateral branches (runners) produced by the principal rhizome, which bear cataphyllary leaves; the buds in the axils of these develop leaves, roots are developed below, and independent plants are produced. Such plants may occasionally be found mingling their roots with those of the principal rhizome. Had they been allowed to continue their growth, they would ultimately have developed rhizomes as large as those of the parent plant.

The transverse section of the rhizome is irregular in outline and exhibits a comparatively narrow bark separated by a dark line (cambium) from an irregular circle of wood-bundles of varying size. The section of a root shows a thick bark and small wood.

Valerian rhizome has a powerful characteristic disagreeable odour and a camphoraceous, slightly bitter taste. The odour of the fresh rhizome, though disagreeable, is not strong, but it develops, during the drying, into the penetrating unpleasant odour of the drug. This change is due to the action of an enzyme ferment, and may be prevented by boiling the root previous to drying it.

The student should observe

- (a) The *colour* and *odour* of the drug;
- (b) The *short erect rhizome* surrounded by numerous roots,
- (c) The characters of the *section of the rhizome* as given above;

and should compare the drug with

- (i) *Serpentary rhizome*, which is slender, usually horizontal, and has a distinctive odour and taste,
- (ii) *American veratrum*, which has a yellowish brown colour and is odourless.

Constituents.—The principal constituent of valerian root is the volatile oil which is contained in the sub-epidermal layer of cells in the root, not in isolated oil-cells or glands. Good valerian root yields about 1 per cent. of volatile oil, one of the constituents of which is bornyl isovalerianate. This constituent is gradually decomposed by the ferment present, yielding free isovalerianic acid, an oily liquid possessing an unpleasant odour of valerian; to this body the unpleasant odour of valerian root is to be ascribed, and its gradual production from bornyl isovalerianate explains the development of the odour as the root dries.

Valerian root also contains two alkaloids, chatinine and valerianine, which require further investigation.

Chevalier (1907) found in the fresh rhizome an alkaloid, a glucoside, and a resin, all of which were physiologically active, and considered that the fresh root was preferable from a medicinal point of view to the dry.

Uses.—The drug is used as a powerful carminative, stimulant, and antispasmodic; it is given chiefly in hysteria, palpitation of the heart, &c.

ELECAMPANE ROOT

(*Radix Inulæ*)

Source &c.—Elecampane, *Inula Helenium*, Linné (N.O. *Compositæ*), is a tall, herbaceous plant, with perennial rhizome, distributed over temperate Europe and Asia. It was formerly much cultivated in gardens in this country, and is found apparently wild in some parts of Southern England and Wales. For medicinal use the plant is cultivated in Holland, Thuringia, and Switzerland.

The plant produces a short, thick, fleshy rhizome and large, fleshy roots. Both rhizome and roots are collected when the plants are about three years old and dried, the larger being often sliced longitudinally.

Description.—The drug consists of both rhizome and roots. The former is usually cut longitudinally, and occurs in thin, irregularly rounded slices about 4 or 5 cm. in diameter. The roots vary much in size, the smaller being the thickness of a pencil or even less, the larger sometimes exceeding 3 cm. in

diameter. They are nearly cylindrical (if entire), tapering very gradually towards the tip, but are seldom quite straight,

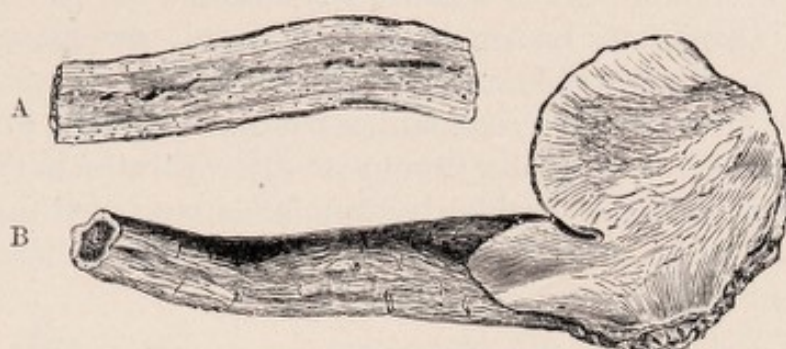


FIG. 187.—Elecampane root. A, longitudinally cut; B, entire, with portion of the rhizome attached. (Planchon and Collin.)

usually curling irregularly as they dry, especially if they have been sliced.

Both rhizome and root are hard and horny, or, if slightly moist, tough, and are of a dark brownish grey colour externally whitish or pale brownish internally. They break with a short fracture. The transverse section is more or less uniform in colour and exhibits a number of shining, brown oil-glands scattered over the whole of the surface, both in the bark and in the central portion (wood) which is separated from it by a dark and often very indistinct cambium line. In the wood small, radially elongated groups of vessels occur, but are difficult to discern with a lens. The root has an agreeable aromatic odour and an aromatic, slightly bitter taste.

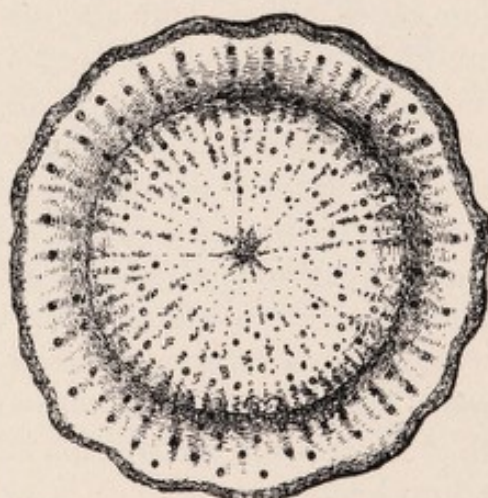


FIG. 188.—Elecampane root. Transverse section, showing the distribution of the oil-glands. Magnified. (Planchon and Collin.)

The student should observe

- (a) The *horny (not starchy) nature of the drug,*
- (b) The *presence of oil-glands,*
- (c) The *absence of distinct radiate structure in the wood;*

and should compare the root with

- (i) *Belladonna root*, which has no oil-glands, and which should possess a starchy fracture,
- (ii) *Dandelion root*, which has no oil-glands, a small yellow wood, and thick ringed bark,
- (iii) *Marshmallow root*, which has no oil-glands, a radiate structure, and a fibrous, easily separated bark,
- (iv) *Pellitory root*, which has oil-glands, but is distinguished by its yellow, radiate wood, distinctive odour and taste.

Constituents.—By distillation with water elecampane root yields from 1 to 2 per cent. of a crystalline mass associated with a little volatile oil. The crystalline mass consists of alantolactone, isoalantolactone (helenin), and alantolic acid, all of which are nearly colourless and crystalline and have but slight odour or taste. Alantol is an oily liquid with a peppermint-like odour found in the distillate. Elecampane root contains also in large quantity, as reserve material, inulin. The roots gathered in the autumn, when they are richest in inulin, contain as much as 45 per cent. of this substance, in the spring about 19 per cent.

Inulin, $C_6H_{10}O_5$, can be obtained as a white crystalline powder, slightly soluble in cold water but easily soluble in hot water without gelatinising. It may be distinguished from starch by these characters as well as by the cooled decoction not assuming a blue colour with iodine. It takes the place of starch as a reserve material in many plants belonging to the order *Compositæ*, and in several belonging to *Campanulaceæ* &c. Hydrolysis by means of a dilute mineral acid converts it into levulose.

Uses.—Elecampane root has been used in bronchitis and tuberculosis; helenin is an effective antiseptic particularly for the tubercle bacillus.

PELLITORY ROOT

(*Radix Pyrethri*)

Source &c.—Pellitory root is obtained from *Anacyclus Pyrethrum*, De Candolle (N.O. *Compositæ*), a small plant with

perennial root indigenous to Algeria. In habit and general appearance the plant resembles the chamomile. The root is collected in the autumn and dried.

Description.—Pellitory root varies from 7 to 15 cm. in length and is usually simple. It is nearly cylindrical in shape, tapering slightly towards the tip, and often towards the crown as well, where there is frequently to be found a tuft of grey hairs on the remains of leaves. The outer surface is brown and deeply and irregularly wrinkled.

The root is tough and breaks with a short fracture. The bark is closely adherent to the wood, which exhibits a prominently radiate structure, narrow yellowish wedges of vascular tissue

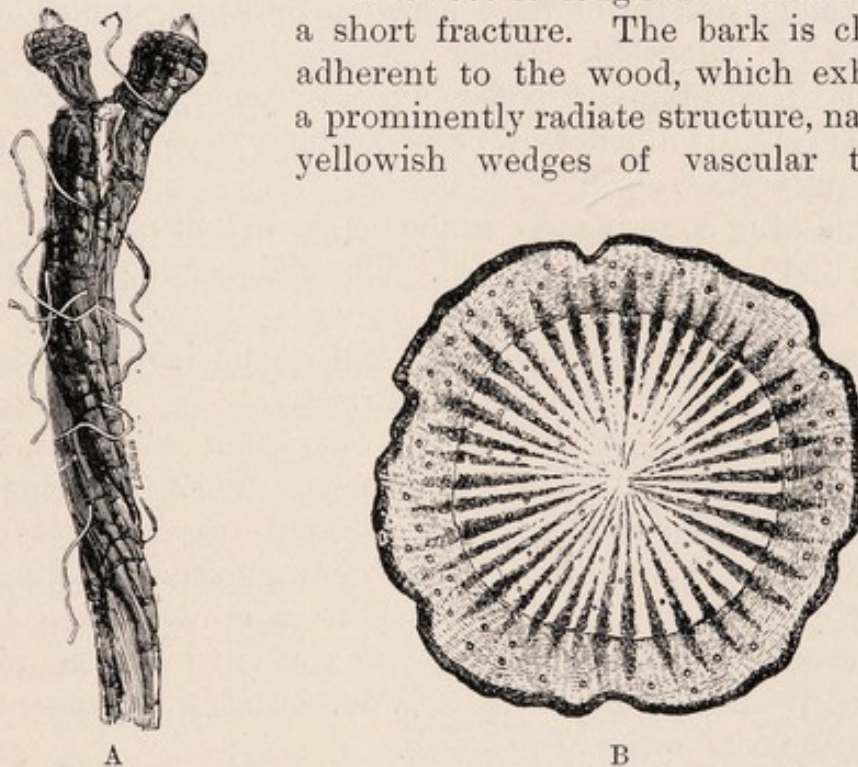


FIG. 189.—Pellitory root. A, root, natural size. B, transverse section, showing radiate structure of the wood and the distribution of the oleo-resin glands, magnified. (Planchon and Collin.)

alternating with whitish medullary rays of equal or even greater breadth. In the latter, as well as in the bark, yellow or brown oleo-resin-glands are scattered. The drug when cut is of a horny, not starchy, or fibrous nature. It has a characteristic though not strong odour, and, when chewed, a pungent taste, exciting a copious flow of saliva.

The student should observe

- (a) The *distinctly radiate structure of the wood*,
- (b) The *wide medullary rays*,
- (c) The *presence of oleo-resin-glands*;

and should compare the root with

- (a) *Belladonna* root, which has no oil-glands and should be starchy,
- (b) *Dandelion* root, which has a small yellow wood and thick, ringed bark,
- (c) *Liquorice* root, which has no oil-glands, and much narrower medullary rays.

Constituents.—Pellitory contains, as principal constituent, an alkaloid, pyrethrine (also called pellitorine), which can be obtained in colourless acicular crystals insoluble in water but soluble in alcohol and possessing an intensely pungent taste. It is apparently allied to piperine, which it resembles in some of its properties.

The drug contains also inulin to the extent of about 50 per cent., and traces of volatile oil. The sialogogue properties are due to the pyrethrine.

Uses.—Pellitory is used as a sialogogue in dryness of the throat and as an addition to dentifrices.

Adulteration.—The root of *Corrigiola littoralis*, Linné (N.O. *Illecebracæ*), is not unfrequently found in commercial pellitory root, sometimes in considerable quantity. It closely resembles pellitory, but may be distinguished by the small, warty protuberances with which it is crowned and by the section which exhibits three or four concentric circles, whereas that of pellitory is radiate. It is devoid of the pungency and sialogogue properties of pellitory.

ARNICA RHIZOME

(Arnica Root, Rhizoma *Arnicae*)

Source &c.—Arnica rhizome, or arnica root as the drug is commonly termed, consists of the rhizome and roots of *Arnica montana*, Linné (N.O. *Compositæ*), a small plant with a creeping perennial rhizome, indigenous to central Europe. In the warmer districts it is common in the meadows on the lower mountain spurs; in the more northern districts it grows in the valleys. It should be collected in the autumn, after the aerial parts have died down, and dried.

Description.—The rhizome, which is horizontal or oblique, is slender, nearly cylindrical in shape, and usually curved. It averages about 5 cm. in length and about 5 mm. in thickness, and varies in colour from yellowish brown to nearly black. From the flanks and under surface numerous dark, brittle, wiry, curved and twisted roots about 8 cm. in length are given off, and the scars that are left, when these break off or

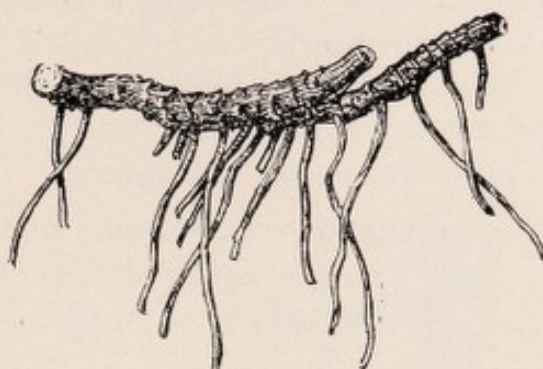


FIG. 190.—Arnica rhizome. Natural size. (Holmes.)

perish, together with the encircling scars of cataphyllary leaves, render the surface of the rhizome, which is in addition longitudinally shrivelled, distinctly rough. Usually it is simple and often terminated by the hairy remains of leaves; sometimes, after the plant has flowered, the growth of the rhizome, which has thus been terminated, is continued in the same direction by the development of a bud on its under surface; the rhizome thus formed will in due course itself flower, and the further growth will again be ensured by the development of one of the lower buds. Thus the rhizome occasionally assumes a jointed appearance.

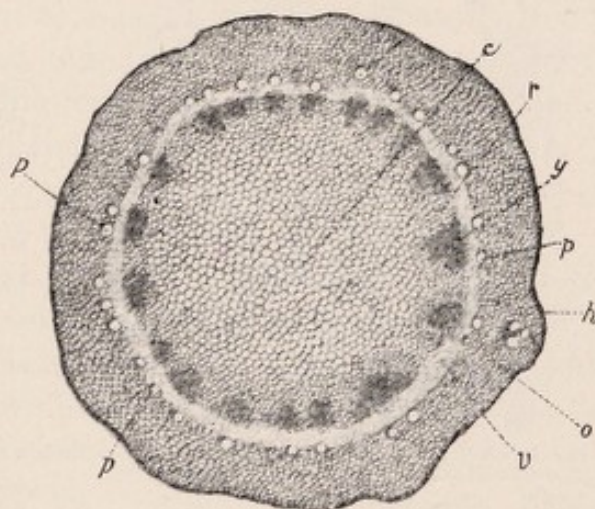


FIG. 191.—Arnica rhizome. Transverse section of rhizome. *v*, bast; *o*, primary cortex; *y*, wood-bundles; *r*, medullary rays; *c*, pith; *p*, oleo-resin ducts. Magnified 10 diam. (Berg.)

The rhizome breaks with a short fracture, and is often discoloured in the interior. The transverse section of a favourable specimen shows a comparatively thick whitish or yellowish bark, in which near the wood is a circle of darker oleo-resin ducts. The wood consists of yellow wedge-shaped wood-bundles and broad

medullary rays enclosing a large whitish pith which in longitudinal sections is seen to be continuous. The root also shows a thick white bark with a ring of oleo-resin ducts and a yellowish wood.

The drug has a faint but rather agreeable apple-like odour and a bitter acrid taste.

The student should observe

- (a) The *curved rhizome* with *wiry roots*,
- (b) The *characters of the transverse section*,
- (c) The *scars of cataphyllary leaves*.

Constituents.—Arnica rhizome contains about 0·5 per cent. of volatile oil, and a bitter and acrid principle, arnicin, which has been obtained in the form of a minutely crystalline yellow powder. It also contains tannin, but no starch, the reserve material being inulin, the latter character being useful in distinguishing it from any starch-forming rhizome. The drug yields about 8 per cent. of ash.

Uses.—The tincture diluted with water is a popular application for bruises, preventing swelling and hastening the absorption of effused blood. It appears to increase the activity of the circulation in the skin, but should be used with caution, as it is liable to produce extensive dermatitis.

Arnica is not often given internally; it has a depressing or, in over doses, irritant action, causing vomiting, pain, and purging.

Substitutes &c.—Foreign roots and rhizomes are occasionally present in the drug as imported, and have to be separated by hand-picking. Amongst these may be mentioned the erect rhizome of the common avens (*Geum urbanum*, Linné), which has an odour recalling cloves, and the rhizomes of species of *Hieracium*, which have no oleo-resin ducts.

DANDELION ROOT

(*Radix Taraxaci*)

Source &c.—The common dandelion, *Taraxacum officinale*, Wiggers (N.O. *Compositæ*), is widely distributed over Europe, Asia, and North America, and is in many cultivated districts a troublesome weed. In this country it has long been used as a domestic medicine.

Both the fresh and the dried roots are official, the former for the preparation of the extract and juice, the latter for the fluid extract.

For these purposes the root is directed to be gathered in the autumn, when, judging from analogy, it may be expected to be most active. This, however, has been denied, the assertion being made that the root is most active in the spring or summer. A method for the quantitative determination of the bitter principle not being at present known, this point cannot be definitely settled, but

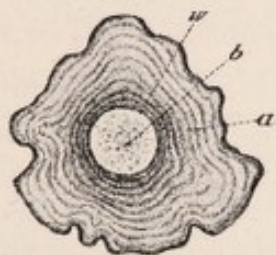


FIG. 192.—Dandelion root. Transverse section. *a*, bark; *b*, wood; *w*, cambium. Magnified 4 diam. (Berg.)

roots collected in the spring or summer contain much sugar, which is more objectionable than inulin, so that, unless positive evidence can be adduced to the contrary, the autumn must be regarded as the proper season in which to collect dandelion root.

The roots are collected from wild plants, washed, and, if necessary, dried. Much of the drug is imported from Germany.

Description.—Dandelion root consists of a simple straight root, which, towards the upper part, passes imperceptibly into an erect rhizome; the latter sometimes remains simple, but often divides into several erect branches. It attains a length

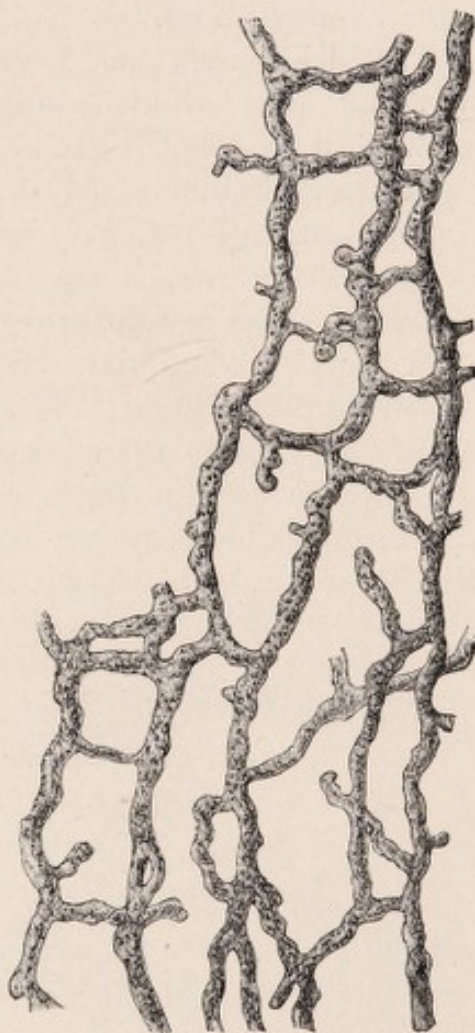


FIG. 193.—Anastomosing laticiferous vessels of Dandelion root. Magnified 140 diam. (Vogl.)

of 30 cm. or more, and a thickness varying from 15 to 25 mm. Whilst fresh it is yellowish brown externally, whitish and fleshy within. From the freshly cut surface, as indeed from all parts of the plant, an abundance of a very bitter, milky juice exudes, which on careful examination may be observed to rise from concentric rings of tissue. In the centre of the root is a small yellow wood.

The dried root has a dark brown colour and is much shrivelled and wrinkled longitudinally; it tapers but little below, and often divides in the upper part (rhizome) into several erect branches, the rhizome being distinguishable from the root only by its slightly varying structure. These branches (or the rhizome itself) are crowned with the short remains of the leaves which bear brownish hairs near the point of insertion.

It breaks when dry with a short fracture, the section exhibiting a very small, yellow, porous, central wood surrounded by an abnormally thick, whitish bark in which numerous brownish concentric rings (of laticiferous tissue) are visible. The root, which is rather hygroscopic, becomes tough when slightly moist. It has no odour, but a bitter taste, which, however, is often not nearly so pronounced as it is in the milky juice that exudes from the fresh root.

The student should observe

- (a) The *small, yellow wood*,
- (b) The *thick, whitish bark* marked with *distinct, darker, concentric rings*,
- (c) The *absence of starch* (see below);

and should compare the root with

- (i) *Pellitory root*, which has oil-glands and a large radiate wood with conspicuous medullary rays,
- (ii) *Liquorice root*, which also has a large radiate wood.

Constituents.—Dandelion root contains a small quantity of a crystalline, bitter substance taraxacin, and also an acrid principle, neither of which, however, has been closely examined. The former, taraxacin, appears to be very susceptible of decomposition, which is probably induced by an enzyme, possibly an oxydase; the extract prepared from the fresh root is often almost devoid of bitterness.

The drug also contains in the autumn abundance of inulin, which in the fresh root is dissolved in the cell sap, but in the

dry root forms amorphous, transparent lumps not again readily soluble in cold water. The absence of starch, which is so commonly present in roots, especially in the autumn, is a valuable negative character, and is often of service in detecting substitution. The autumn root has been found to contain 25 per cent. of inulin, whereas the spring root contained 18 per cent. of levulin and 17 per cent. of uncrystallisable sugar. Levulin, $C_6H_{10}O_5$, is a soluble carbohydrate converted by hydrolysis into dextrose and levulose.

Uses.—Dandelion is a simple, bitter, and mild laxative, and is given in atonic dyspepsia attended by habitual constipation.

HEMIDESMUS ROOT

(Indian Sarsaparilla, *Radix Hemidesmi*)

Source &c.—Indian sarsaparilla or hemidesmus root is obtained from *Hemidesmus indicus*, Robert Brown (N.O.



FIG. 194.—Hemidesmus root. Reduced.

Asclepiadaceæ), a climbing shrub indigenous to India and Ceylon. It has long been employed in India, but was not introduced into European medicine till 1831, and is already practically discarded.

Description.—Hemidesmus root usually occurs in long, slender, rigid pieces, often more than 30 cm. in length, but

seldom exceeding 6 mm. in thickness, which branch occasionally and bear a few fibrous rootlets. Portions of the slender aerial stems are attached to the upper extremity, and the student should observe that these are marked with opposite leaf scars.

The root varies in colour from brick-red to dark brown or nearly black ; it is rather tortuous, nearly cylindrical in shape, and marked with longitudinal wrinkles, and, at rather distant intervals, with conspicuous transverse cracks. The thin cork with which the root is covered shows a disposition to separate from the cortex, and on one side may often be observed to be distinctly raised above it.

The root is hard and woody ; the transverse section exhibits a large, porous, but not distinctly radiate yellowish wood surrounded by a thin greyish or sometimes dark grey bark. It has an agreeable odour, distinctly recalling tonco beans ; the taste is slightly aromatic and sweetish, but not otherwise characteristic.

The student should observe

- (a) The *rigid, tortuous character* of the root,
- (b) The *transverse cracks*,
- (c) The *easily separable cork*,
- (d) The *large yellowish wood* ;

and should compare the root with sarsaparilla, which is destitute of transverse cracks, has a firmly adherent cork, and a small wood.

Constituents.—The constituents of hemidesmus root are quite unknown. The agreeable odour is probably due to coumarin or a similar substance, but no particular active constituent is known.

Use.—It has been used as an alterative, but is of doubtful value.

GELSEMIUM RHIZOME

(Yellow Jasmine Root, *Radix Gelsemii*)

Source &c.—The yellow jasmine, *Gelsemium nitidum*, Michaux (*G. sempervirens*, Aiton) (N.O. *Loganiaceæ*), is an elegant climbing plant indigenous to the southern United States ; it ascends lofty trees and forms festoons, scenting the

atmosphere with its fragrant yellow flowers. It has long been known, but its medicinal use is of recent date. The rhizome and roots should be collected in the autumn.

This plant should not be confounded with *Jasminum nudiflorum*, Lindley, a yellow-flowering jasmine commonly cultivated in this country.

Description.—The drug consists of the rhizomes, to which portions of both slender aerial stems and small and large roots are sometimes attached; usually the rhizomes and larger roots, cut into pieces about 15 cm. in length, constitute the commercial drug.

The rhizomes are generally in nearly straight cylindrical pieces varying from 5 to about 20 mm. in thickness, of a dark purplish brown colour, or at least marked with a more or less distinct network of purplish lines, the intervening spaces being yellowish brown. This difference in colour is due to the fact that the outer cork-cells are filled with a dark reddish brown substance, the inner with a yellowish deposit; by the growth of the rhizome the outer dark layer is fissured, disclosing the paler inner layer. The rhizomes are hard and woody, and break with an irregular splintery fracture, frequently exhibiting in the bast silky fibres, which, however, are much more conspicuous in the aerial stems.

The roots are, on the average, rather smaller than the rhizomes; they may be distinguished by their uniform yellowish brown colour and finely wrinkled surface, and by their rather more sinuous course.

The aerial stems are usually slender, but may attain 15 mm. in thickness. They are of a dark purplish brown colour, longitudinally wrinkled or nearly smooth, internally whitish and hollow in the centre. The fractured bark exhibits projecting strands of bast fibres.

Both rhizome and root exhibit in transverse section a comparatively narrow bark enclosing a large yellowish white wood; the latter consists of narrow wood-bundles with small vessels alternating with distinct, straight, whitish medullary rays, the section thus assuming an elegant radiate appearance. The section of the rhizome is distinguished from that of the root by the presence of a small pith, which, however, is more evident in the smaller (younger) than in the larger (older) pieces; it differs also from that of the aerial stem in the arrangement of

the fibres in the bark; in the stem these are grouped into bundles, whilst in the rhizome they form an interrupted ring of isolated fibres or groups of two or three (Sayre, 1897).

The drug has a bitter taste, especially conspicuous in the bark, and a very slight aromatic odour.

The student should observe

- (a) The *splintery fracture*,
- (b) The *radiate structure* of the transverse section,
- (c) The *purplish colour* and small pith of the rhizome,
- (d) The *yellowish colour* and slightly *tortuous appearance* of the root.

Constituents.—The chief constituents of gelsemium rhizome are the two alkaloids, gelseminine and gelsemine (total alkaloid 0·2 to 0·7 per cent.). Gelseminine is an intensely poisonous, amorphous (or according to some authorities crystalline) base which yields amorphous salts. Gelsemine has been obtained in the crystalline form; it is far less toxic than gelseminine and possibly owes what toxicity it has exhibited to traces of gelseminine contained in it as impurity. Both of these principles must be carefully distinguished from the eclectic resinoid gelsemin which is a powdered alcoholic extract.

The drug also contains a crystalline substance, β methyl-æsculetin, $C_9H_5(CH_3)O_4$ (Schmidt), previously called gelsemic acid, which exhibits an intense bluish green fluorescence in alkaline solution; evidence of the presence of this body can easily be obtained by macerating a little of the powdered bark in lime water, which will acquire a distinct fluorescence. β methyl-æsculetin (scopoletin, Eykman; chrysotropic acid, Kunz) is also present in scopola rhizome (derived from *S. carniolica*, Jacquin) and in belladonna root; it is a product of the hydrolysis of methyl-æsculin, æsculin itself being a fluorescent body found in the bark of the horse-chestnut (*Æsculus Hippocastanum*, Linné).

Other constituents of the drug are fixed oil (about 6 per cent.), resin (about 4 per cent.), and ash (about 2 per cent.).

Uses.—Gelsemium resembles hemlock in action but is more strongly depressant. It has been much used for, and appears to relieve, certain forms of neuralgia and sick headache as well as rheumatic and ovarian pains.

GENTIAN ROOT

(Radix Gentianæ)

Source &c.—Gentian root is the dried root and rhizome of the yellow gentian, *Gentiāna lutea*, Linné (N.O. *Gentianeæ*), a stately herb with large, opposite, broadly ovate leaves and yellow flowers. It is indigenous to central Europe, growing abundantly on the lower slopes of the Jura and Vosges mountains, in the Black Forest, and in the Pyrenees. The root has



FIG. 195.—Bale of Gentian root.

long been used as a medicine, and is also employed at the present day in Switzerland for the preparation of an alcoholic liquor, by fermenting an infusion of the fresh root, and distilling the fermented liquid.

The plant produces an erect rhizome, from which large fleshy roots are given off; the latter take a more or less horizontal course a short distance below the surface of the earth, and attain a considerable length. Both rhizome and roots are collected in the autumn and dried; they are occasionally, but not often, sliced longitudinally. When fresh they are whitish internally and almost odourless, but during the slow drying to

which they are subjected the colour changes to a yellowish brown, and a distinctive odour is developed. So much are the particular colour and odour required, that in some districts the practice is said to prevail of heaping the fresh root and allowing it to heat and ferment before drying it; by this treatment it darkens in colour and acquires the desired odour. Gentian root that has been longitudinally sliced or strung upon strings and quickly dried is paler and more bitter, and has an odour less



FIG. 196.—Gentian root. A, root, showing surface with longitudinal wrinkles. B, rhizome, showing fine transverse lines (leaf scars), and dividing into two branches, each terminating in a bud. Natural size.

strong than that which has not been so treated. The drug is exported in large bales.

It is often cut into thin transverse slices for pharmaceutical use.

Description.—Gentian root is accordingly usually seen in nearly cylindrical pieces of varying length and thickness, but seldom more than 15 mm. in diameter. The roots, which differ in appearance from the rhizomes, are of a yellowish brown

colour, and much shrivelled and wrinkled longitudinally. They are tough and flexible when slightly moist, but when quite dry they are brittle. They break with a very short fracture, and internally are usually of a reddish brown colour and spongy. The transverse section exhibits a dark line (cambium) separating a rather thick bark from a large central portion (wood) in which vascular tissue can with difficulty be discerned, as, like the bark, it consists almost entirely of parenchyma; neither bark nor wood exhibits any radiate structure.

The rhizome is easily distinguished from the root by the absence of conspicuous longitudinal wrinkles, and the presence of close, transverse annulations. It often exceeds the root in diameter, and may attain a length of 30 cm. or more. Each transverse annulation represents a year's growth, and bears the scars of fallen leaves, the minute fibro-vascular bundles of which are evident under a lens. The rhizome, which occasionally branches, is usually crowned with a large bud protected by dry, scaly leaves.

Roots that have been longitudinally sliced before they were dried frequently exhibit transverse instead of longitudinal wrinkles, and are paler internally; otherwise they correspond to the description given.

Both roots and rhizome have the same distinct and characteristic odour, and a sweetish, afterwards agreeably bitter, taste.

The student should observe

- (a) The *uniform yellowish brown colour*,
- (b) The *longitudinal wrinkles of the root, the transverse annulations and leaf scars on the rhizomes*,
- (c) The *absence of any evident structure in the transverse section*,
- (d) The *absence of starch* (see below).

Microscopical Characters.—The transverse section exhibits a narrow cork and a largely developed cortex which, like the bast-ring, is

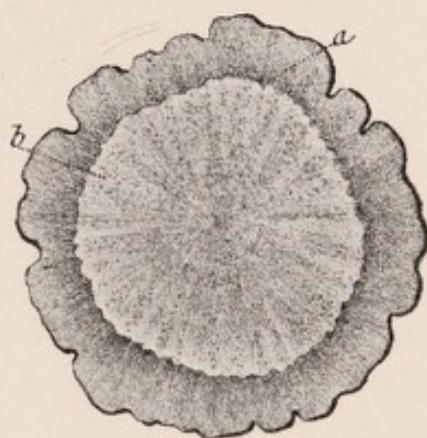


FIG. 197.—Gentian root. Transverse section. *a*, bark; *b*, wood. Magnified 2 diam. (Berg.)

free from sclerenchymatous cells or fibres, and from more than an occasional starch grain. The cells have rather thick walls and contain small oil globules, and, frequently collected at one end of the cell, groups of very minute acicular crystals of calcium oxalate. The wood consists principally of parenchymatous tissue; the vessels are isolated or in small groups. In longitudinal section the vessels exhibit porous, annular, or reticulate thickening.

The powder is characterised by the abundant parenchymatous cells with rather thick walls, inclined to swell in water, and containing oily globules and minute calcium oxalate crystals, by the vessels with characteristic thickening, and by the absence of sclerenchymatous cells and fibres and of more than an occasional starch grain.

Constituents.—Fresh gentian root contains three bitter principles, viz. gentiopicroin, gentiin, and gentiamarin. During the drying of the root, however, the gentiopicroin disappears and the dry root contains only gentiin and gentiamarin; this decomposition is probably induced by the fermentative processes which take place during the drying.

Gentiopicroin is a pale yellow crystalline bitter substance, and is hydrolysed by emulsin and also by dilute mineral acids to gentiogenin and dextrose. Gentiin is also a crystalline glucoside, but gentiamarin is amorphous.

Gentian root contains further a yellow crystalline acid, gentisic (gentianic) acid, sucrose, and (in the fresh state) a sugar gentianose, together with pectin and oily globules, probably of a cholesterol compound; it is free from starch, or contains at most but minute traces of the latter. It yields from 3 to 4 per cent. of ash.

Gentianose is a hexatriose yielding by partial hydrolysis gentiobiose and levulose; further hydrolysis converts the gentiobiose into two molecules of dextrose. During the drying of the root the sucrose completely disappears and the gentianose is converted into dextrose, levulose, and gentiobiose. If the root is unduly exposed to fermentation these sugars are further converted into carbon dioxide and alcohol, so that highly fermented root may yield as little as 13 per cent. of extract to cold water, whereas good gentian root should yield 40 per cent. or even more. Whether the darkening that takes place on the addition of ferric chloride to an infusion of gentian root is due to the gentisin has not yet been definitely decided.

Fresh gentian root is largely used in Germany and Switzerland for the production of an alcoholic beverage. The roots are cut, macerated with water, fermented and distilled; the distillate contains alcohol and a trace of volatile oil which imparts to it a characteristic odour and taste.

Use.—Gentian is a favourite bitter tonic.

Varieties, Substitutes, &c.—The roots of other species of gentian are often collected and dried; *Gentiana purpurea*, Linné (Switzerland &c.), *G. pannonica*, Scopoli (Austria), *G. punctata*, Linné (Austria), all yield gentian roots. They are, however, all smaller than those of *G. lutea*. The roots of *G. purpurea*, which approach nearest to the official gentian, attain about half the size and are crowned with several (eight to ten) aerial stems clothed below with many scaly remains of leaves. The top of the root has thus a peculiar branched appearance never found in the root of *G. lutea* (Pharmacographia). All these species appear to possess similar properties.

ALKANET ROOT

(Alkanna Root, Radix Anchusæ)

Source &c.—Alkanet root is obtained from *Alkanna tinctoria*, Tauscher (N.O. *Boraginæ*), a small herbaceous plant with perennial root growing in sandy soil in Southern Europe, Hungary, and Asiatic Turkey, our supplies being derived chiefly from Hungary.

Description.—The drug consists of deep reddish purple, simple, tapering roots averaging about 15 cm. in length, and 12 mm. in thickness near the crown, to which slender branches and the remains of leaves are attached; the latter have a purplish colour, and bear numerous bristly hairs.

The root has a very remarkable appearance. The outer layers, which are deeply coloured, easily exfoliate, separating from the wood in large papery flakes or strips; these are readily removed, and the exterior of the root is then the inner layers of cortical tissue. It is not smooth but more or less deeply furrowed longitudinally, the furrows being often so deep as to divide the wood into separate woody strands. Cut transversely in the upper part the root exhibits a dark violet spot in the centre of the pith, and a woody ring containing several radiating

strands of dense woody tissue separated by large wedge-shaped masses of parenchyma; the bark is yellowish near the wood, but becomes coloured and laminated towards the exterior. From near the crown of the root downwards the violet spot in the centre becomes larger, and the colouring matter in the bark penetrates deeper, until by their union the separation of the strands of wood is complete.

The root when handled stains the fingers red. It has no perceptible odour or taste.

The student should observe

- (a) The dark reddish purple colour of the parenchymatous tissue and whitish colour of the wood,
- (b) The hairy remains of the leaves;

and should cut a root transversely at successive points, noting the gradual separation of the strands of wood.

Constituents.—Alkanet root contains two red colouring substances, viz. anchusic and alkannic acids, the former turning green with alkalies and the latter blue. Alkannin is the name given to an oleo-resinous mixture of deep red colour obtained by extracting the root with petroleum spirit or benzene and evaporating. These substances are produced in the parenchymatous cells of the root, first in the bark and then in the medullary rays. As the formation of them proceeds the cells perish, and thus the cork is exfoliated, and the wood wedges in the root become separated from one another by the destruction of the medullary rays. Thus the remarkable appearance of the commercial drug is explained.

Uses.—Alkanet is used for colouring oils, ointments, &c., the tincture, diluted with an equal volume of water, is used for the microscopical detection of fat and oil, which it colours red.

Varieties.—Many other plants furnish roots containing a similar red colouring matter, e.g. *Onosma echioides*, Linné (S. Europe), *Macrotomia Cephalotes*, De Candolle (Armenia and Syria), &c.; they are occasionally substituted for the root of *Alkanna tinctoria*, the Syrian drug being apparently more than half as rich again in colouring matter as the Hungarian. Both of these substitutes are larger than alkanet root.

SCAMMONY ROOT

(Radix Scammoniae)

Source &c.—Scammony root is obtained from *Convolvulus Scammonia*, Linné (N.O. *Convolvulaceæ*), a twining plant indigenous to the eastern Mediterranean countries, and resembling



FIG. 198.—Portion of a small Scammony root. Natural size.

the common bindweed but much larger. It produces a root, often of very considerable size, from which a number of slender aerial stems spring. The root, which yields by incision the gum-resin scammony, is collected and dried. It is exported from Odessa, Batoum, &c.

Description.—Scammony root is usually simple and often of large size. Small roots measure about 12 mm. in diameter and 15 to 30 cm. in length, but larger specimens attain as much as 8 or 10 cm. in thickness and a metre in length; they are nearly cylindrical in shape, tapering gradually towards the tip but slightly enlarged at the crown, and there rugged from the remains

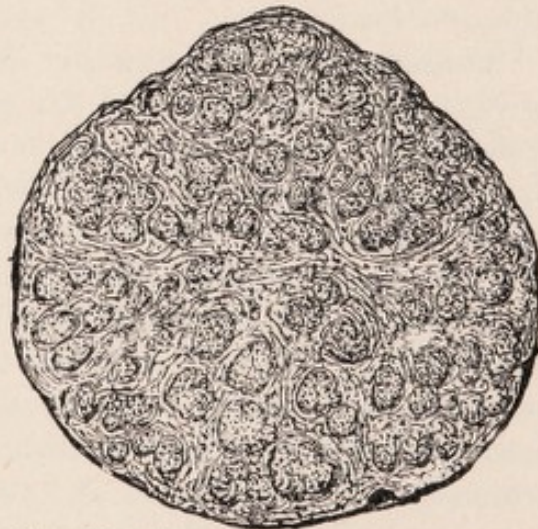


FIG. 199.—Scammony root. Transverse section. (*Pharmaceutical Journal*.)

of aerial stems. The drug is of a greyish brown colour, hard, heavy, and woody, rough and furrowed externally, and often spirally twisted. Lateral rootlets occasionally spring from

it and commonly split into fibrous strands. It breaks with an irregular fracture, from which short fibres (strands of wood) project. Internally the root is whitish, and the transverse section, when smoothed, exhibits an abnormal and characteristic structure. There is no distinct central wood, but the root exhibits instead several not very well defined circles, in each of which a central portion containing groups of vessels can be distinguished from a surrounding parenchymatous portion; in the latter numerous dark points (resin cells) can be discerned with a lens. The root is invested with a thin bark, which however is not very conspicuous.¹ The whole of the parenchymatous tissue contains starch.

The root has a characteristic odour distinctly recalling that of jalap, and especially noticeable when the surface is freshly cut; the taste is sweetish and slightly acrid.

The student should observe

- (a) The *large size and greyish brown colour*,
- (b) The *characteristic jalap-like odour*,
- (c) The *remarkable structure of the transverse section*,
- (d) The *presence of resin cells*;

and should compare the root with belladonna, which is usually smaller, darker externally, odourless, and has an entirely different structure.

Constituents.—Scammony root contains from 3 to 13 (average about 9) per cent. of a glucosidal resin which can be isolated by mixing a strong tincture with water, washing and drying the precipitated resin. The latter should be entirely, or almost entirely, soluble in ether, and in this respect differs from the resin obtained in a similar manner from jalap, which is only partially (not more than 10 per cent.) soluble in that menstruum. The purified resin, scammonin, which can be obtained as a white powder is converted by alkalies into scammonic acid, together with other organic acids, all of which are soluble in water and are therefore not reprecipitated, as most resins would be, on acidification. Scammonic acid yields by hydrolysis with mineral acid scammonolic acid and sugar (Kromer, 1895), but scammonin itself, under similar conditions, yields scammonol (the anhydride of scammonolic

¹ For further anatomical details see Planchon and Collin, *Les Drogues Simples*, i. 623.

acid), valerianic acid, and a sugar. Scammonin is identical with the ether-soluble resin of jalap, with orizabin, the resin of male or woody jalap (*Ipomœa orizabensis*, Ledanois), and with tampicin, the resin of Tampico jalap (*I. simulans*, Hanbury).

Scammony root contains also about 7 per cent. of saccharose, about 3 per cent. of a reducing sugar, as well as starch; the latter is in grains of characteristic appearance, an important fact, as it is sometimes necessary in examining scammony to distinguish the starch of the scammony root from other starches that may possibly have been fraudulently added.

Uses.—Scammony root is employed only as a source of scammony resin, which can be more economically prepared from the root than from the expensive gum-resin. Much of the commercial resin is, however, at present obtained from male or woody jalap (compare p. 411).

JALAP

(*Radix Jalapæ*)

Source &c.—Jalap is obtained from *Ipomœa Purga*, Hayne (N.O. *Convolvulaceæ*), a plant with climbing, twining stems indigenous to the eastern slopes of the Mexican Andes. It sends out slender runners which are provided at intervals with scaly, cataphyllary leaves in the axils of which are buds; below the buds roots are produced, some of which thicken rapidly and form fusiform or napiform organs, often of considerable size. These tuberous roots (tubercles) are collected and dried in nets over fires, the smaller entire, but the larger longitudinally incised to allow of the free escape of moisture. When fresh they are fleshy and white internally, but by drying, especially in the manner indicated, they darken in colour.

The jalap plant has been cultivated with success in India and Jamaica. Although these colonies do not at present compete with Mexico in the supply of the drug, there is no reason why they should not do so; the plant grows freely, and has been found to yield, with suitable manuring, roots with a high percentage of resin. The drug is imported in sacks from the east coast of Mexico, and distinguished as 'Mexican' or 'Vera Cruz' jalap.

The Spaniards became acquainted with this and similar purgative Convolvulaceous plants early in the sixteenth century, and exported considerable quantities of them to Europe.

Description.—Jalap occurs in pieces of very varying size, most commonly about that of a hen's egg, although sometimes they attain 10 cm. or more in diameter. They vary also much in shape, being sometimes napiform, sometimes fusiform or irregularly oblong. The small are usually entire, but the larger bear gashes that have been made to facilitate the drying.

Towards the lower extremity they taper off and show a fractured end where the slender part of the root has been broken off. The surface is dark brown, furrowed and wrinkled



FIG. 200.—Jalap root. Small specimen, natural size, showing the transverse lenticels.



FIG. 201.—Jalap root. Transverse section. Slightly reduced. (*Pharmaceutical Journal*.)

(but not conspicuously convoluted), and marked with numerous, paler, elongated transverse scars (lenticels). They are heavy and compact, and so hard as to be broken with difficulty, but softening readily in water. Internally they have a yellowish grey or dingy-grey colour, and are very tough or horny, the section exhibiting irregular dark lines often concentrically arranged. These lines are due to the formation of secondary cambiums, an abnormal development that is occasionally, although not often, met with. Under the lens numerous dark

resin cells are visible, especially in the cortical portion, but woody tissue is not easily discerned.

Jalap has a distinct and characteristic odour which is often ascribed to the smoke from the fire over which the roots have been dried, but which is, partly at least, inherent in the drug. The taste is at first sweetish, but afterwards disagreeably acrid.

The heat to which the drug is subjected during the drying is generally sufficiently high to gelatinise the starch, especially in the interior of the roots, where the moisture is retained longer than in the outer portions; hence the horny and not starchy appearance of the drug. Roots obtained from cultivated plants in India and Jamaica are usually more carefully dried, and present a mealy, not horny, appearance in the interior.

Microscopical Characters.—Powdered jalap is characterised, when examined under the microscope, by the abundant starch which may be intact or in any stage of gelatinisation; the grains are either simple or compound; the former, measuring mostly 25 to 40 μ , are rounded or ovoid and exhibit concentric striæ; compound grains may contain 2 to 6 constituents. Numerous globules of resinous emulsion, varying in size, are evident or can be made evident by solution of iodine in potassium iodide. There are occasional sclerenchymatous cells, and fragments of vessels with areolated pits. Cluster crystals of calcium oxalate are frequent.

Constituents.—Jalap contains as principal constituent a resin which can be isolated by extracting the root with alcohol, adding water, concentrating, and washing the separated resin with water (*Resina Jalapæ*, B.P.).

Other constituents of jalap are sugar and starch. Calcium oxalate is present in the form of cluster crystals, a character that is useful in distinguishing jalap from other undetermined Convolvulaceous roots that are occasionally mixed with it, in which the calcium oxalate is present in the form of acicular needles.

The resin separated as above described is not a homogeneous substance, but a mixture of two distinct resins, one of which, constituting not more than 10 per cent. of the total, is soluble in ether, the remainder (about 90 per cent.) being insoluble. The composition of the resin and properties of the constituents are important points, as they form a valuable means of distinguishing the resin from other resins, such as scammony resin,

which are soluble in ether, and of indicating the absence of such ether-soluble resins.

The resin insoluble in ether has been termed convolvulin; it has been obtained as a white powder soluble in alcohol. Alkalies convert it into convolvulinic acid, together with other organic acids, all of which are soluble in water; convolvulinic acid is hydrolysed by mineral acids yielding convolvulinolic acid and a sugar.

The resin soluble in ether appears to be identical with scammony resin.

Assay.—Percolate 10 gm. of jalap in No. 60 powder with ether until 50 c.c. of percolate are obtained. Evaporate to dryness and weigh; the weight is that of ether-soluble resin in 10 gm. of the jalap.

Percolate the marc in the percolator with alcohol until 100 c.c. are obtained. Transfer 20 c.c. to a separator, add 20 c.c. of chloroform and mix; then add 20 c.c. of water and shake for one minute. Separate the chloroform, wash the liquid and separator with 5 c.c. of chloroform, evaporate the chloroformic solutions, dry and weigh. The weight is that of ether-insoluble resin in 10 gm. of the jalap.

The sum of the weights of ether-soluble and ether-insoluble resins is that of the total resin in 10 gm. of the jalap.

Good jalap should yield not less than 10 per cent. of total resin when treated by such a process as that outlined above. Much of the drug that at present reaches the market contains considerably less, and its exclusion from use in making the official preparations of jalap is ensured by the minimum requirement of 10 per cent. adopted by the British Pharmacopœia. On the other hand there seems to be little doubt that the quality of the drug has deteriorated during the last twenty-five years, from 12 to 18 per cent. being formerly the usual amount of resin contained in it. Under exceptional circumstances the quantity has risen in roots cultivated in India to upwards of 20 per cent.

Uses.—Jalap is a powerful stimulant of the intestinal secretion, producing in small doses a laxative effect, and in large doses active purgation. It is much used as a hydragogue cathartic.

Varieties.—*Tampico jalap* is afforded by *Ipomœa simulans*, Hanbury, a plant resembling *I. Purga* and growing on the eastern slopes of the Mexican Andes. The roots are exported

from Tampico (a town on the Gulf of Mexico, about 200 miles north of Vera Cruz), whence it derives its name. This root, which frequently appears on the London market, is distinguished by its irregular shape and remarkable, convoluted surface, which does not exhibit the small transverse scars characteristic of true (Vera Cruz) jalap. It yields about 10 per cent. of resin, which is distinguished from the resin of true jalap by its complete solubility in ether. This resin (tampicin) is probably identical with the ether-soluble resin of jalap and scammony (scammonin).

Orizaba jalap, also known as light, woody, stalk, or male jalap, is produced by *Ipomæa orizabensis*, Ledanois, and derives its name from the town of Orizaba, 65 miles south-west of Vera Cruz. The drug, which has recently been imported into Europe in large quantities and known under the name of 'Radix Scammoniae Mexicanæ,' occurs mostly in large slices 5 to 10 cm. in diameter and 1 to 2 cm. thick, or in irregular rectangular portions of larger slices; the transverse surfaces show concentric rings from which coarse woody fibres protrude; small entire roots may be 2 to 3 cm. in diameter and 8 to 10 cm. long. It yields from 6 to 22 (average about 17) per cent. of resin, of which 82 per cent. is soluble in ether and identical with scammonin.



FIG. 202.—Tampico Jalap root.
Natural size.

BELLADONNA ROOT

(Radix Belladonnæ)

Source &c.—The deadly nightshade, or belladonna, *Atröpa Belladonna*, Linn. (N.O. *Solanaceæ*), is a tall branching herb, attaining a height of 2 metres. It is widely distributed over Central and Southern Europe; in England it is confined chiefly to the southern counties, but it is cultivated in Bedfordshire,

Hertfordshire, and elsewhere, and is grown for medicinal use in Germany also.

Belladonna possesses a stout, branching, tap root which for medicinal use should be collected in the autumn when about three or four years old, cut into pieces, and carefully dried. The commercial drug, much of which is imported from Germany, is often of inferior quality.

Description.—Good root, as found in commerce, occurs in pieces varying from 15 to 20 cm. in length, and from



FIG. 203.—Belladonna root. *a*, portion of young root, natural size; *b*, transverse section of the same, magnified; *c*, transverse section of the upper part of the root, magnified. (Holmes.)

1 to 2 cm. in diameter. It is of a pale greyish brown colour, and finely wrinkled longitudinally, usually cylindrical or gradually tapering, and often crowned with the remains of hollow aerial stems. Sometimes the roots are cut longitudinally to facilitate drying. They break with a short fracture, and should be whitish and starchy internally. The smooth section exhibits a greyish bark separated by a dark line (cambium) from a whitish central portion (wood) in which, especially near the

cambium ring, dark groups of vessels and fibres are scattered ; these groups, however, seldom exhibit more than an indistinctly radiate arrangement except close to the crown of the root, where one or more rings of radiate yellowish wood may be found, the root passing imperceptibly into rhizome. The bark is not fibrous, and adheres closely to the wood. Most of the parenchymatous cells of both bark and wood contain small compound starch-grains, and some of them are filled with numerous very minute crystals of calcium oxalate ; these characters, visible only under the microscope, serve as additional means of identifying belladonna root.

Old roots become woody, and may then exhibit a prominently radiate structure, whilst roots gathered in spring contain sugar and but little starch, and hence show a shrunken outer surface and a dark, spongy interior. In both cases the drug is believed to contain less alkaloid than the young root collected in the autumn and possessing the characters given.

Notwithstanding the fact that the preparations of belladonna root are standardised, the official description is framed so as to exclude such old or partially exhausted roots.

The root has an odour recalling liquorice root, and a slightly bitter taste.

The student should carefully observe

- (a) The *firm, plump appearance* of typical belladonna root,
- (b) The *short, mealy fracture*,
- (c) The *dark cambium line*, and *distribution of the groups of vessels and fibres* ;

and should compare the root with

- (i) *Elecampane root*, in which oil glands are present, and the groups of vessels inconspicuous,
- (ii) *Scammony root* (small pieces), which have a very characteristic structure,
- (iii) *Marshmallow root*, which has a radiate wood, in which scattered groups of vessels are not visible, and a fibrous bark.

Constituents.—The principal constituent of belladonna root is the alkaloid hyoscyamine which appears to be accompanied by a little atropine, although it is possible that the

atropine found has been produced from hyoscyamine during the process of extraction, a change which is readily effected. Traces of scopolamine appear also to be present, but belladonnine and apoatropine, which are found in the mother liquors from which the other alkaloids have been crystallised, probably do not exist as such in the root, but are formed during the various manipulations in the course of their isolation (compare p. 56).

The root also contains β methyl- α -esculetin (chrysotropic acid, scopoletin), a crystalline fluorescent principle widely distributed throughout the natural order Solanaceæ, and found also in gelsemium rhizome.

The total amount of alkaloid that the root contains varies as a rule between 0.4 and 0.6 per cent., but may occasionally rise to 1.0 per cent. (Cripps). Gerard has shown that the plant is more active when about four years old than when younger, and that the wild plant is rather richer in alkaloid than the cultivated, while Schmidt's experiments indicate that the roots of young plants contain more alkaloid than those of old plants. The Pharmacopœia therefore directs the root to be collected in the autumn, and excludes old roots by the limitation of the size and by the description of the transverse section.

Uses.—Belladonna acts as a local anæsthetic and anodyne, and is often applied as such externally. Internally it is given to check the sweating in phthisis, as a sedative to the respiratory nerves, to relieve spasmodic cough, and in numerous other cases.

Adulterants.—*Scopola Rhizome.* The rhizome of *Scopola carniolica*, Jacquin (N.O. Solanaceæ), is not unfrequently found in the belladonna root imported from Germany. The plant grows in the Carpathian Mountains and other parts of Austro-Hungary. It produces a horizontal rhizome from which aerial stems from 30 to 60 cm. high arise bearing leaves which resemble belladonna leaves but are thinner, more lanceolate in shape, and taper more towards the base (compare p. 56). The rhizome, which is collected in large quantities and forms an important source of the alkaloids hyoscyamine, atropine, and scopolamine, may attain 10 cm. or more in length and about 2 cm. in thickness. It is nearly black in colour and tortuous, and bears on the upper surface numerous large depressed stem-scars. It contains hyoscyamine, scopolamine,

and possibly also atropine, the total alkaloid (0·6 to 0·7 per cent.) somewhat exceeding in amount that present in belladonna root.

Phytolacca Root. The root of *Phytolacca decandra*, Linné, (N.O. *Phytolaccaceæ*), a plant indigenous to North America but naturalised in Southern Europe, has been used to adulterate belladonna. It may, however, readily be detected by the transverse section which exhibits several concentric rings of wood bundles, in consequence of which large roots readily fissure longitudinally. As it attains a much larger size than belladonna root it is often cut into pieces for admixture. It contains a resinoid substance, phytolaccin, and has a purgative action.

RHUBARB RHIZOME

(*Rhizoma Rhei*, *Radix Rhei*)

Source &c.—The structure of commercial rhubarb indicates that the drug is derived from two species of *Rheum*. One of these is certainly *R. officinale*, Baillon; the other is probably *R. palmatum*, Linné, var. *tanguticum*, Maximowicz. The former occurs abundantly in Central and Western China at an elevation of 3,000 to 4,000 metres, and is collected chiefly in the mountains separating Thibet from the Chinese province of Szechuen and extending eastwards to Hupeh. The plant produces a rhizome which may attain a very great size, and to which large thick roots are attached. The plants are dug up towards the end of September and the roots cut off. The rhizomes are cleaned, and the crown and the bark removed, the larger being cut either longitudinally or transversely. They are then dried under the eaves of the houses, being often strung on cords for this purpose, or they may be partly dried in the sun or on heated stones. The drug is conveyed chiefly by river to Chung-King on the Yang-tse-Kiang river, and thence to Shanghai, whence it is shipped to Europe, after having undergone further trimming and sorting on its journey.

Rheum palmatum, Linné, var. *tanguticum*, Maximowicz, occurs in the province of Kansu. Large quantities of the drug are collected near Lake Kokonor in Thibet, and are apparently derived from this plant. It is carried over the

mountains to the Han river, and thus reaches Hankow. Further quantities of rhubarb are also produced in the province of Shensi, and may possibly be obtained from a third, at present unknown, species of *Rheum*.

Practically all the Chinese rhubarb now exported passes through Hankow to Shanghai for shipment to Europe, and consists of rhizome only.

Formerly the drug was conveyed by caravan *viâ* Persia to the Syrian ports, whence it reached Europe and was known as



FIG. 204.—Case of Chinese Rhubarb.

Turkey rhubarb; some was sent direct from China (China or Canton rhubarb), and some was shipped *viâ* India (East Indian rhubarb), the latter being the most common variety as early as 1640. Subsequently, by a commercial treaty between Russia and China, the trade was diverted to the Russo-Siberian route, and the drug was conveyed *viâ* Irkutsk to Moscow, still retaining its designation of Turkey rhubarb. Later, however, when the Chinese opened some of their northern ports to European trade, the drug was exported by the route which it now takes, and the trade names of Turkey and East Indian

rhubarb indicate nothing more than the routes by which the drug formerly found its way to the European market.



FIG. 205.—*Rheum officinale*. Entire plant, much reduced. A, flower. B, longitudinal section of same: d, disc. C, ovary. D, half-ripe fruit of *R. compactum*, Linné. (Luerssen.)

Description.—The official drug occurs in pieces of very varying size and shape. Those derived from smaller rhizomes that have not been sliced occur in cylindrical, conical, or barrel-

shaped pieces varying in size, but frequently from 7 to 10 cm. in length and 3 to 6 cm. in thickness, although of course they may be larger or smaller. The larger rhizomes, which are usually cut longitudinally, yield plano-convex pieces, frequently tapering more or less towards either end; such pieces often measure 8 or 10 cm. in length or breadth and 4 cm. in thickness. These two principal forms are known as 'rounds' and 'flats' and are commonly sold in separate cases. They are



FIG. 206.—Chinese Rhubarb (Shensi flat), showing network of whitish lines.

frequently drilled, a piece of string being occasionally found in the perforation. The outer surface is dusted over with a fine bright yellow powder, and bears evidence of having been not only peeled with a knife, but carefully dressed with a file or scraped after the drug has been dried. Here and there small portions of a dark layer may still be found. These characters are common to the commercial varieties of Chinese rhubarb generally, but the following apply more particularly to the finest variety, viz. Shensi rhubarb.

If the outer surface, freed from the yellow powder that adheres to it, is examined with a lens, a number of minute, longitudinal, dark reddish brown lines and dots can be observed imbedded in a white ground mass, which latter frequently forms a delicate network, in the meshes of which the alternating white and dark red lines alluded to can be seen. The dark lines are medullary rays containing brown colouring matter; the white lines consist of bast parenchyma containing starch and calcium oxalate. Occasionally minute dark points or projections may be detected which, when carefully shaved off with a knife, exhibit radiating red and white lines; these are the remains of fibro-vascular bundles from the leaves (leaf-traces) and pass through the bark into the central portion of the rhizome.



FIG. 207.—Chinese Rhubarb. Transverse section, showing the remains of the bark (as a narrow exterior layer), the cambium (as a dark line), the wood (with a more or less distinctly radial structure), and an irregular circle of star-spots (abnormal fibro-vascular bundles). (Planchon and Collin.)

The drug is firm, heavy, and compact, the outer surface showing little sign of shrinkage during the drying; it breaks with an uneven fracture, the fractured surface, which varies from bright pink to dull grey in colour, exhibiting under the lens dark reddish brown lines alternating with white ones ('nutmeg' fracture). The transverse section shows near the periphery a more or less continuous ring of large, conspicuous, star-like spots, each of which consists of dark red lines (medullary rays) radiating from a common centre through a white groundwork (parenchyma). These star-spots are fibro-vascular bundles which also traverse the inner part of the drug in varying directions. Exterior to this ring the drug exhibits a radiate appearance due to the

formation of a narrow ring of secondary wood by the cambium, which is sometimes evident as a dark line about 1 mm. from the margin (compare fig. 207), but is often not seen, as not only the whole of the bark but even part of the secondary wood may have been removed by the peeling. If the peeling has been sufficiently deep to remove the bark and the secondary wood as well, then the star-spots appear on the outer surface, but until then they are indistinct. They can always be seen on the flat (inner) surface of the plano-convex pieces. Beyond the

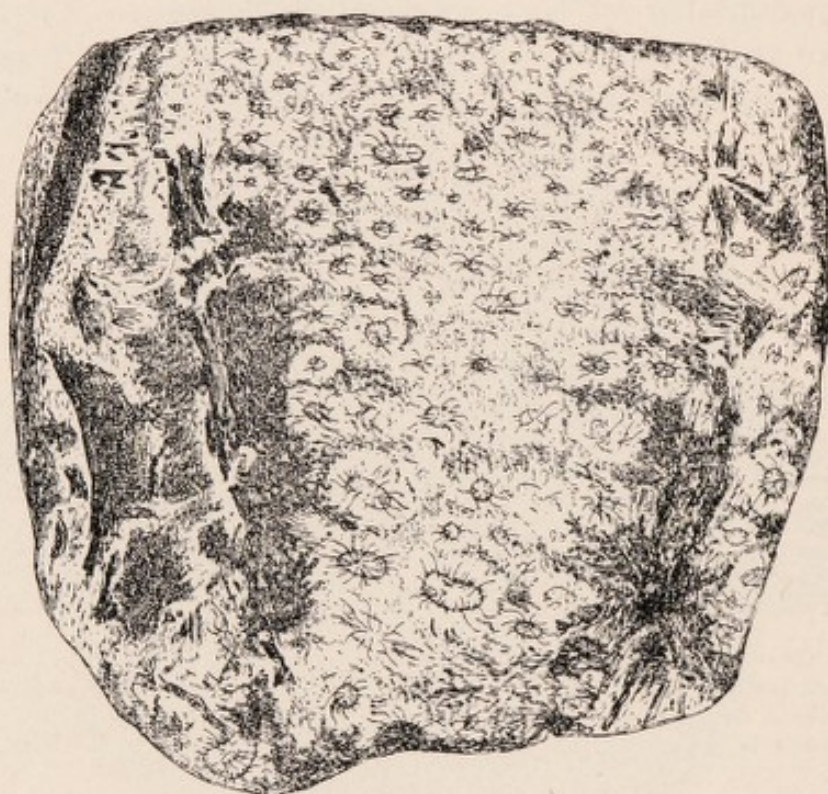


FIG. 208.—Chinese Rhubarb. Flat (inner) surface of a plano-convex piece, showing irregularly distributed star-spots. (Planchon and Collin.)

secondary wood is the cambium, usually visible as a dark line, and here and there are the narrow remains of the bark. Small cylindrical pieces are generally more favourable for examination than flat slices of a larger rhizome.

The structure of this drug is complex, but it must be remembered that it is a very fleshy rhizome, the internodes of which are so closely approximated as to be almost suppressed.

The drug possesses a characteristic odour and bitter, astringent taste; when chewed it is very gritty between the

teeth, a character due to the calcium oxalate, which occurs in considerable quantity in large cluster-crystals.

The student should particularly observe

- (a) The *firm, compact, texture,*
- (b) The *outer surface, seldom much wrinkled,*
- (c) The *continuous ring of star-spots on the transverse section,*
- (d) The *network of white lines on the outer surface* (not shown when the peeling has been carried too deep).

Constituents.—Recent investigations of rhubarb indicate that the most important constituents are a number of substances which may be divided into two groups, viz. tannoid constituents and purgative constituents, several of which have been isolated in a pure state.

Tannoid Constituents :

Glucogallin, $C_{13}H_{16}O_{10}$, forms small crystals melting at $200^{\circ}C.$, and soluble in 80 per cent. alcohol and in water; it yields when hydrolysed gallic acid and dextrose.

Catechin, $C_{15}H_{14}O_6$: in whitish needles closely resembling the catechin of gambier.

Tetrarin, $C_{32}H_{32}O_{12}$: crystallising in thin plates melting at $205^{\circ}C.$, and soluble in 80 per cent. alcohol, but not in water; it yields when hydrolysed gallic acid, cinnamic acid, rheosmin, and dextrose. *Rheosmin*, $C_{10}H_{12}O_2$, is an aldehyde crystallising in rhombic prisms.

Gallic acid, $C_7H_6O_5$, is also present in the free state.

Purgative Constituents :

Rheopurgarin: slender yellow needles with a bitter taste, but no odour, insoluble in cold water, but soluble in hot water, and in aqueous solutions of gallic acid and of glucogallin, and hence dissolved out in making the infusion; it is soluble also in diluted alcohol. *Rheopurgarin* appears to consist of four glucosides of which two, chrysophanein and rheochrysidin, have crystallised, while the other two, which yield by hydrolysis emodin and rhein, have not yet been obtained pure.

Chrysophanein, $C_{21}H_{20}O_9$: slender yellow prisms melting at $243^{\circ}C.$, insoluble in solutions of carbonated alkalies, but soluble in caustic alkalies with production of a brownish red colour. By hydrolysis it yields chrysophanic acid, $C_{15}H_{10}O_4$, and glucose.

Rheochrysin, $C_{22}H_{22}O_{10}$, closely resembles chrysophanein but melts at $204^{\circ}C.$; it yields on hydrolysis rheochrysidin, rhubarberon, iso-emodin, $C_{16}H_{12}O_5$, and glucose.

Chrysophanic acid, emodin, iso-emodin, and rhein are all derivatives of anthraquinone, chrysophanic acid being dioxy-methyl-anthraquinone and emodin and iso-emodin trioxymethyl-anthraquinone, while the constitution of rhein is not yet definitely established. The attempt has been made to assay rhubarb by colorimetrically determining the amount of emodin and allied substances, free and combined, which is contained in it, but the process is of very doubtful value.

Other constituents of Chinese rhubarb are fat, a pectinaceous body, cholesterin, a dextro-rotatory sugar, an oxydase enzyme, starch, and calcium oxalate. The latter occurs in very large cluster-crystals and is the cause of the gritty taste of rhubarb. The quantity present is very variable, as little as 3 and as much as 45 per cent. having been found; these are, however, exceptional figures, the ash of good rhubarb ranging usually from 7.5 to 15 per cent. The amount of extract yielded to 60 per cent. alcohol varies usually from 40 to 45 per cent.

Uses.—In small doses rhubarb is a bitter stomachic and intestinal astringent; in larger doses it causes purgation, which is followed by an astringent effect due to the tannoid constituents. It is given in cases of indigestion with diarrhoea and as a mild laxative.

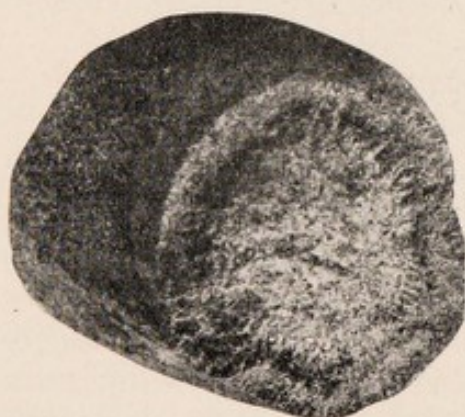


FIG. 209.—Chinese Rhubarb (Canton round), showing granular fracture. Natural size.

Varieties.—Three varieties of Chinese rhubarb are recognised on the market, viz. Shensi, Canton, and High-dried, each of which may occur in 'flats' or 'rounds.'

Shensi Rhubarb is characterised by its very compact nature, bright yellow coat, distinct whitish reticulations, and 'nutmeg' fracture (fig. 207); the odour is agreeable and free from marked empyreuma, the taste slightly bitter. That which exhibits a bright pink fracture is preferred.

Canton Rhubarb may be distinguished from Shensi by the fracture, which is more or less uniformly granular, exhibiting no

marked marbling, and by the odour and taste which are more distinctly empyreumatic and disagreeable. It is more fibrous in its nature and less compact, the coat is not so bright, and the whitish reticulations are less marked. Formerly the pieces bore a deep triangular nick, but this is now more often wanting. It is less esteemed than Shensi rhubarb.

High-dried Rhubarb may resemble either Shensi or Canton in the fractured surface, but the coat is much duller and rougher,



FIG. 210.—Chinese Rhubarb (flat High-dried). Slightly reduced.

and the odour and taste more empyreumatic than Canton. The rounds are often much shrunken, and frequently exhibit the remains of the bud, dark patches being often visible on the outer surface. The flats show distinct severe paring, and are often so hard as to spring when broken with the hammer; they are usually of better quality than the rounds.

English Rhubarb.—In England two species of *Rheum*, viz. *R. officinale* and *R. rhaponticum*, Linné, are cultivated (Oxfordshire, Bedfordshire, &c.). The rhizomes are dried and sold separately from the roots. Those of *R. officinale* resemble the Chinese drug, but, being more spongy, shrink and wrinkle as they dry, and are softer to cut; the white reticulations are commonly absent, the white and red lines being parallel to one



FIG. 211.—English Rhubarb (*R. officinale*), showing the star-spots on the radial section. Natural size.

FIG. 212.—English Rhubarb (*R. rhaponticum*). Rhizome. Slightly reduced.

another; the star-spots are also fewer and more scattered. The roots are readily distinguished by their long cylindrical shape and distinctly and entirely radiate transverse section. The constituents of this variety of English rhubarb are similar to those of the Chinese.

The rhizomes of *R. rhaponticum* are also much shrunken and usually pinkish in colour; they may be readily distinguished

by the transverse section which exhibits a diffuse circle of isolated star-spots. Rhapontic rhubarb contains no emodin, iso-emodin, or rhein, but in their place a crystalline glucoside, rhaponticin (rhapontin, ponticin), the presence of which can be demonstrated by the following test :

Boil 10 gm. with 50 c.c. of dilute alcohol for 15 minutes, filter, concentrate to 10 c.c., and shake with 10 to 15 c.c. of



A



B

FIG. 213.—English Rhubarb (*R. rhaponticum*). A, transverse section of rhizome ; B, transverse section of root. Natural size.

ether ; on standing a considerable quantity of minutely crystalline rhaponticin will be deposited. This test serves to identify the drug derived from *R. rhaponticum*.

Rhapontic rhubarb also contains chrysophanic acid, a crystalline substance chrysopontin, $C_{16}H_{16}O_5$, and a glucoside yielding by hydrolysis chrysorhapontin, $C_{16}H_{16}O_4$.

SERPENTARY RHIZOME

(Serpentary Root, Virginian Snakeroot,
Rhizoma Serpentariæ)

Source &c.—Two varieties of serpentary, or, as it is sometimes termed, snakeroot, are official in the British Pharmacopœia, viz. *Virginian snakeroot* and *Texan* or *Red River snakeroot*.

Virginian snakeroot is obtained from *Aristolochia Serpentaria*, Linné (N.O. *Aristolochiaceæ*), a small herbaceous plant

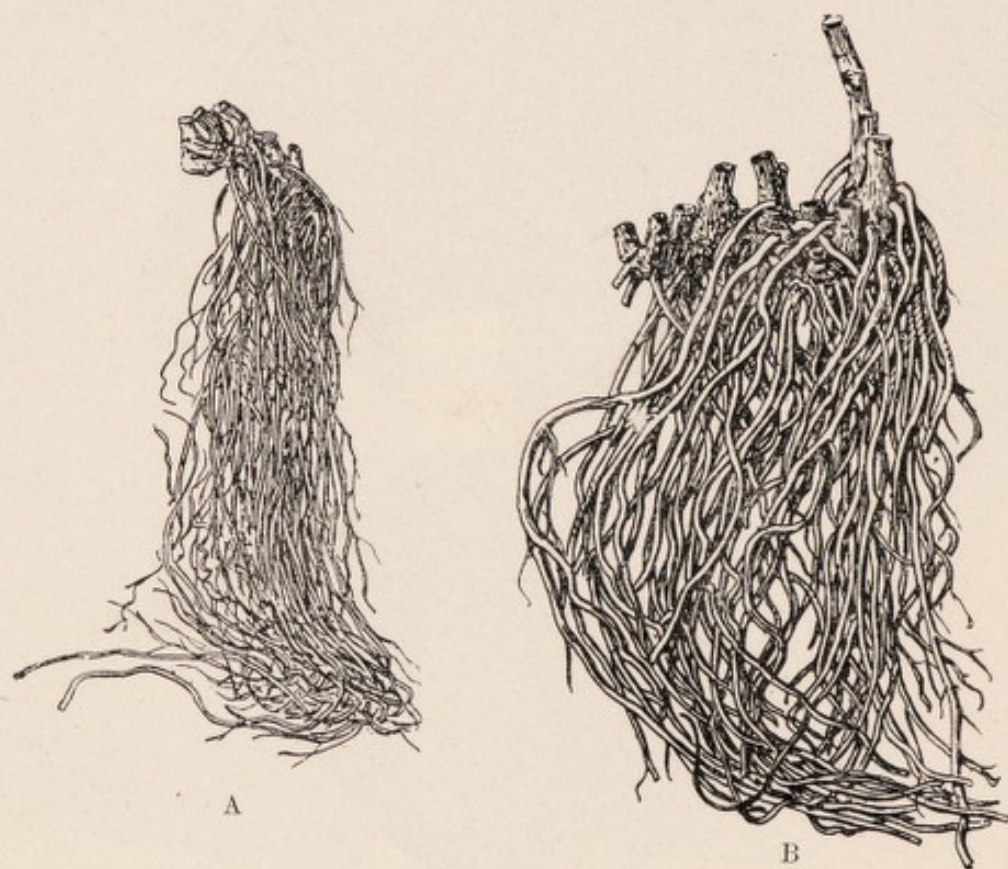


FIG. 214.—Serpentary rhizome. A, Virginian; B, Texan. Natural size.
(*Pharmaceutical Journal*.)

with slender perennial rhizome, growing in the United States, to the east of the Mississippi.

Texan or *Red River snakeroot* is the produce of *Aristolochia reticulata*, Nuttall, a rather stouter plant, growing, as its name indicates, in the south-western States.

The drug is collected in the autumn and dried. It was known in England in 1632, its use having been undoubtedly

learnt from the American Indians, and it found a place in the London Pharmacopœia of 1650.

Description.—The snakeroot at present in commerce is the variety known as Texan, and is derived from *A. reticulata*. It consists of a short, slender, rather tortuous rhizome about 25 mm. long and 3 mm. thick, to the flanks and lower surface of which are attached numerous long, curved, but not wiry or interlacing roots; these are comparatively stout, being frequently half the thickness of, or even as thick as, the rhizome itself, and seldom much shrivelled. The latter is usually horizontal, but not unfrequently assumes an oblique or even vertical position, and gives off from its upper surface (or from one side) numerous closely approximated slender aerial stems. These, when they die down, leave short portions, bearing the scars of leaves, attached to the rhizome; occasionally a fruiting stem may also be found.

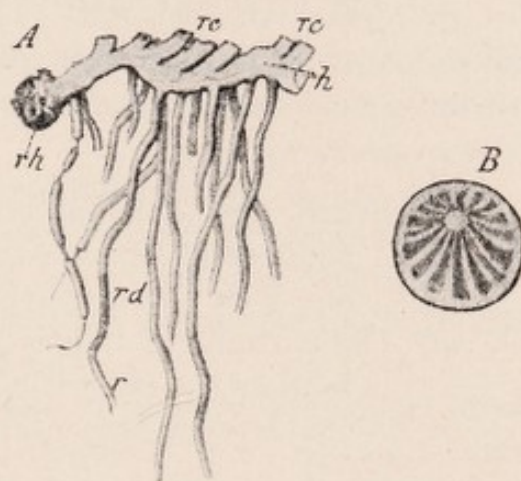


FIG. 215.—Serpentry rhizome. A, longitudinal section of rhizome and roots: rc, remains of aerial stems; rd, roots; rh, rhizome. B, transverse section of rhizome, magnified 3 diam. (Berg.)

Both rhizome and roots are brittle, breaking with a short fracture. The former exhibits in transverse section a whitish pith that is distinctly eccentric, being much nearer to the upper than the under surface of the drug; the wood-bundles are numerous, yellow and curved, the bark yellowish brown and thin; the section of the root shows a slender yellow wood and a thick white bark.

The drug, by far the greater part of which consists of the roots, has a tolerably uniform yellowish brown colour, a characteristic camphoraceous odour, and a strong, disagreeably bitter and acrid taste.

Virginian snakeroot, which appears to be seldom imported, differs from the foregoing in having a shorter and thinner rhizome and thinner, wiry, interlacing roots forming little matted masses, but resembles it in colour, odour, and taste.

The student should observe

- (a) The slender rhizome with portions of the stem arising from the upper surface in close succession,
- (b) The eccentric position of the pith,
- (c) The very characteristic odour and taste;

and should compare the two varieties with one another, noting the differences alluded to. He should further compare the Texan variety with

- (i) Small specimens of *valerian root*, which possess a short erect rhizome from which a single stem arises and which has a very different odour and taste.
- (ii) The rhizome of *Indian pink*, which is darker and has neither the eccentric pith, the odour, nor taste that characterise serpentary.

Constituents.—Serpentary rhizome contains volatile oil (about 1 per cent.), tannin, and a bitter principle, apparently an alkaloid, crystallising in light yellow needles. The latter is probably identical with Chevalier and Fenuelle's amorphous aristolochine, and with the aristolochine isolated by Hesse from *A. argentina*, Grisebach.

Uses.—Serpentary possesses local and general stimulant and tonic properties closely resembling those of valerian and cascarilla. It is occasionally used in nervous, despondent, and excitable conditions, as well as in low fevers and febrile states.

SASSAFRAS ROOT

(*Radix Sassafras*)

Source &c.—The sassafras, *Sassafras officinale*, T. Nees and Ebermayer (N.O. *Laurineæ*), is a tree of medium size, widely distributed over the eastern United States, extending from Canada southwards to Florida. All parts of the plant secrete in special cells an aromatic volatile oil, but this is especially the case with the bark of the root, which is therefore to be regarded as medicinally the most active, although the entire root is official in the British Pharmacopœia.

Description.—The tree produces large, woody, branching roots covered with a dark reddish or greyish brown spongy

bark, from which, however, they are often entirely freed, the bark constituting in America a separate article of trade, and realising, on account of its greater fragrance, a higher price than the wood. The latter is greyish yellow or greyish red in colour, soft, and easily cut; it exhibits in transverse section distinct annual rings traversed by thin, dark, medullary rays and containing large vessels. Both bark and wood, but especially the former, have an agreeable, fragrant odour, and an aromatic, slightly astringent taste.

Constituents.—The root contains about 2 per cent. of volatile oil, which is obtained from it by distillation, and employed in large quantities as a perfume and flavouring agent; its chief constituent is safrol (80 per cent.). The bark yields from 6 to 9 per cent. of oil.

Uses.—Sassafras is supposed to increase the action of the skin in syphilis and rheumatism, and thus to be an alterative, but its physiological action is not definitely known.

TURMERIC

(*Rhizoma Curcumæ*)

Source &c.—The plant yielding turmeric, *Curcuma longa*, Linné (N.O. *Scitamineæ*), is apparently a native of Southern Asia, though no longer known in the wild state. It is cultivated to a large extent in India, China, Java, and other tropical countries. The rhizome has long been employed both as a spice and as a colouring agent, the latter quality gaining for it the name of *Crocus indicus*. It was certainly known to Dioscorides, and described by him as a root resembling ginger, but having a yellow colour and bitter taste. During the middle ages it fell into disuse, and is now considered much inferior to ginger and other spices, whilst in India it is largely employed as a dye and as a condiment.

The rhizomes are dug up after the herbaceous aerial stems have died down; there is then found an upright, bulb-shaped rhizome, from which the stem has sprung and to which several cylindrical descending branches are attached. One or more of the latter, destined to produce aerial stems in the following year, will curve upwards and thicken to form bulb-shaped organs. The rhizomes so obtained are then steamed in

their own juice or boiled in water for a half to one day, by which the vitality that they otherwise obstinately retain is destroyed. They are finally dried either in the sun or in an



FIG. 216.—Long Turmeric.
(Pereira.)



FIG. 217.—Round Turmeric.
(Pereira.)

oven, and (sometimes) sorted into 'fingers' and 'bulbs,' the former being the cylindrical descending branches, the latter the erect, stem-producing ones.

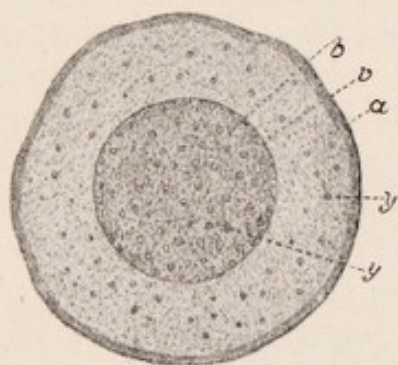


FIG. 218.—Turmeric rhizome. Transverse section. *a*, cortex; *v*, endodermis; *b*, stele; *y*, vascular bundles. Magnified 3 diam. (Berg.)

Description. — Finger or long turmeric occurs in curved or nearly straight cylindrical pieces bluntly tapering at each end. The outer surface is of a deep yellowish brown colour, longitudinally wrinkled, and marked with transverse rings (leaf-scars). Occasionally they bear short knob-like branches, or show large circular scars where these have been broken off. They are hard and heavy, and break with a short fracture;

internally they have a uniform dull brownish yellow, waxy appearance and tough horny consistence. The transverse section exhibits little of its structure beyond a paler (or

sometimes darker) ring separating the stele from the cortex. This remarkable appearance of the interior of the rhizomes is due to the prolonged boiling they undergo, by which not only is the starch gelatinised and a horny consistence imparted to the drug, but the colouring matter, previously restricted to certain scattered cells, becomes uniformly diffused throughout the rhizome.

Bulb or round turmeric resembles the finger variety, but is, as its name indicates, shorter and thicker.

The drug has a characteristic aromatic odour and taste, and when chewed colours the saliva yellow.

The student should observe

- (a) The *difference in shape* between 'bulbs' and 'fingers,'
- (b) The *yellowish brown colour*,
- (c) The *horny consistence and waxy appearance of the interior*.

Constituents.—Turmeric contains about 5 per cent. of volatile oil, and a crystalline yellow body, curcumin. These are confined, in the fresh rhizome, to the particular secreting cells in which they have been produced, but pass during the scalding into the surrounding tissue, the parenchymatous cells of which are filled with amorphous masses of gelatinised starch.

Curcumin, $C_{21}H_{20}O_6$, forms reddish yellow prisms melting at $183^{\circ}C$. and readily dissolving in alcohol, forming a deep yellow solution, the colour of which is changed to reddish brown by alkalies. Evaporated after the addition of boric acid the colour is reddish brown, which alkalies then change to blue. A mixture of alcohol and sulphuric acid dissolves it with production of a brilliant crimson red colour and forms an excellent means of detecting powdered turmeric in the presence of many other substances.

Uses.—Turmeric is used as a condiment and colouring agent.

Varieties &c.—Several commercial varieties of turmeric are known. The majority of the drug is shipped from India, that from Madras being the most esteemed. Other species of *Curcuma* (*C. angustifolia*, Roxburgh, *C. leucorrhiza*, Roxburgh) have paler coloured rhizomes; these are utilised in India for the production of starch, which is known as 'East Indian Arrowroot.'

GINGER

(Zingiber, Rhizoma Zingiberis)

Source &c.—Ginger is the dried rhizome of *Zingiber officinale*, Roscoe (N.O. *Scitamineæ*), a reed-like plant producing leafy stems a metre high, springing from branching rhizomes. It is a native of Asia, but is cultivated in many tropical countries, notably in the West Indies, in India, Africa, and Japan.

There can be little doubt that ginger was well known in India as a spice from the earliest times. The Greeks and Romans were well acquainted with it, and its use spread in the ninth and tenth centuries through Europe to England. It was introduced by the Spaniards into the West Indies and Jamaica.

In Jamaica the plant is largely cultivated. It is propagated by dividing the rhizome into 'fingers,' each of which contains a bud, and planting these about a foot apart. They grow rapidly and flower in the autumn. When the aerial stems wither the rhizomes are dug up, freed from the roots, and washed. They are then peeled with a narrow-bladed knife, by which the layer of cork and part of the parenchyma of the cortex are removed, after which they are again washed, and dried in the sun. The product is known as unbleached Jamaica ginger. Although the use of a revolving drum for removing much of the peel and of a drying machine for rapidly drying the rhizomes has been suggested, this machinery does not appear to have been successfully introduced.

Much ginger is found in commerce from which the cork layer has not been removed, or which has been deprived of it on the flatter sides only. Such ginger is known as 'coated' or 'unscraped,' whilst that which has been completely peeled is called 'scraped.' Sometimes, too, the rhizomes are treated with sulphurous acid or chlorine, or they are dusted over with calcium sulphate or carbonate which imparts to them a whitish appearance; ginger that has been treated so is termed 'bleached' or 'limed' ginger. In addition therefore to being obtained from different countries, ginger may vary in appearance according to the way in which it has been prepared for the market. As with nutmegs, limed ginger is undoubtedly less

susceptible to the attacks of insect pests. Ginger is commonly washed and limed abroad, but is also usually rewashed and heavily limed in London.

Description.—Unbleached Jamaica ginger, which is the official variety and the one that is most esteemed, occurs in flattened branched pieces technically termed 'races' or 'hands.' These vary in length, but average about 7 to 10 cm. From the upper surface of the main rhizome, which is usually straight, numerous branches about 3 cm. in length appear to arise and take an upward course; they are often slightly compressed laterally, enlarged near the rhizome, and, tapering abruptly, terminate in the remains of an undeveloped bud or a small depressed scar indicating the point of attachment of an aerial stem. The branches themselves also produce lateral branchlets.

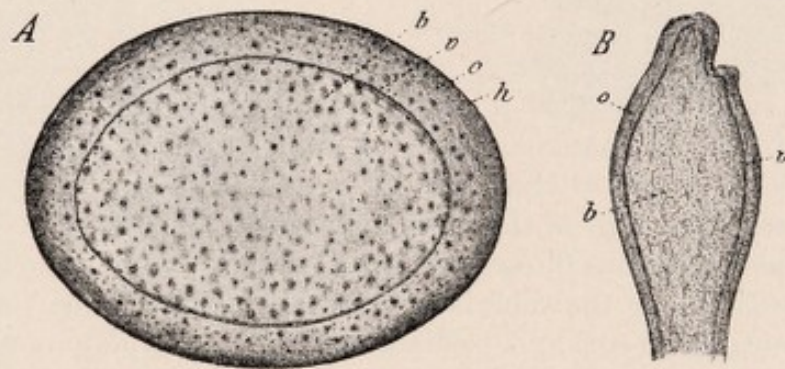


FIG. 219.—Ginger. *A*, transverse section through the rhizome, magnified 3 diam. *B*, longitudinal section through a branch, natural size. *o*, cortex; *v*, endodermis; *b*, stele. (Berg.)

All these branches and branchlets arise from buds on the under surface of the rhizome in the axils of cataphyllary leaves. When the growth of the main axis is terminated by the production of an aerial shoot, one of these buds develops, curves upwards, and itself in due time produces an aerial shoot and develops a lateral branch. Each piece of the drug or 'hand' is therefore a sympodial branch system.

The colour of the drug is usually pale yellowish buff; the surface is strongly striated or even fibrous, the fibres being the leaf-traces passing through the cortex to the leaves, and laid bare by the peeling of the rhizome. It breaks with a short, mealy or sometimes resinous fracture, short scattered fibres usually protruding from the fractured surface; these are the fibro-vascular bundles in the stele and cortex.

The smoothed transverse section exhibits a large stele which is sharply delimited by a fine yellow line from a narrow cortex, both stele and cortex containing numerous yellow oil-cells. No cork layer is to be discerned. Ginger has an agreeable aromatic odour and a strong pungent taste.

The student should observe

- (a) The *fibrous surface*,
- (b) The *short fracture with protruding fibres and yellow oil-cells*.

Microscopical Characters.—The transverse section exhibits a large stele and a wide cortex free from cork. The parenchymatous cells, which are very abundant, have very thin walls; some contain yellow oleo-resin, but most are filled with starch. The fibro-vascular bundles in the stele contain a few reticulated vessels supported by sclerenchymatous fibres, which have rather thin walls and large cavities; abutting on the vessels are small cells filled with a dark brown secretion. The starch grains are typically Scitamineous; they are simple, 12 to 30 μ long, ovoid or sack-shaped and flat, the hilum being at the extreme, pointed end.

Powdered ginger is characterised by the abundant typical starch, by the very thin walls of the parenchymatous cells, by the characteristic sclerenchymatous fibres, and by the oleo-resin cells; the latter are mostly broken, but the suberised walls are always to be found. It should contain no cork, no isodiametric sclerenchymatous cells, and no hairs. It should yield about 7 per cent. of extract to 90 per cent. alcohol, from 12 to 15 per cent. to cold water, and not less than 1.5 per cent. of ash soluble in hot water. The last two data are specially useful in detecting adulteration with exhausted ginger.

Constituents.—Ginger contains from 0.25 to 3 per cent. of a volatile oil possessing the aroma but not the pungency of the drug. The latter property is due to a yellowish oily body, gingerol, which is odourless, but has an intensely pungent taste. The drug contains in addition resin and abundance of starch. It yields from 3 to 5 per cent. of ash.

Gingerol apparently possesses phenolic properties, but it is doubtful whether it has yet been obtained pure. Warmed with solution of sodium hydroxide its pungency is destroyed, which is not the case with capsaicin, hence this test may be used to detect the fortification of preparations of ginger with those of chillies.

Uses.—Ginger is largely used as a condiment, and medicinally as a carminative and aromatic stimulant.

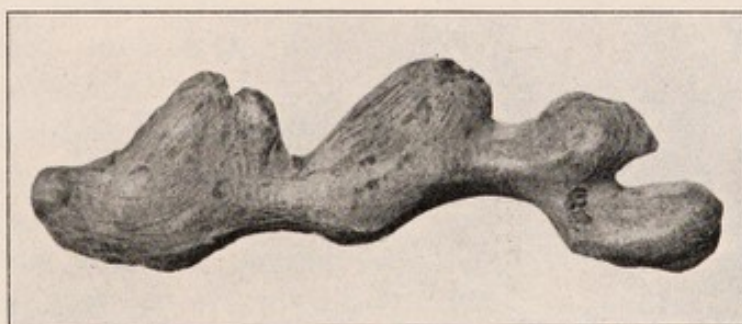
Varieties.—The chief commercial varieties of ginger are Jamaica, Cochin, and African. Japanese ginger is also imported to a limited extent, and an inferior grade of Jamaica ginger, obtained by allowing a part of the 'hand' to remain in the ground after the first crop has been collected and grow without further attention, is known as 'ratoon' ginger.



A



B



C

FIG. 220.—Ginger. A, Jamaica ; B, African ; C, Cochin. All slightly reduced.

Cochin ginger occurs in both the scraped and coated varieties ; the latter bears on its ventral and dorsal surfaces, but not on the lateral, portions of a reddish grey cork, coarsely wrinkled both longitudinally and transversely. The lateral surfaces, that have been freed from the cork, are striated and of a rather paler colour. The drug is usually in smaller 'hands' than the Jamaica, the

branches ('fingers') are commonly shorter and thicker, and the aroma less agreeable.

African ginger is a coated ginger, the ventral and dorsal surfaces bearing patches of wrinkled cork of an earthy-brown colour. The cortical tissue that is exposed on the lateral surfaces is sometimes of a dingy grey colour and lighter than the cork, sometimes nearly black and then much darker. The drug in bulk is darker than Cochin ginger and appears discoloured from want of care in the preparation of it for the market. Although deficient in aroma, it is an exceedingly pungent ginger, in this respect excelling the Jamaica drug. It yields about 10 per cent. of alcoholic extract.

Japanese ginger usually occurs in small flattened unscraped pieces; it is not produced by *Z. officinale*, as many of the starch grains are compound, and the volatile oil differs in physical properties from the genuine.

Ratoon ginger is seen in the branched hands with slender fingers characteristic of Jamaica ginger. It is, however, of a dull dingy greyish brown colour, darker than Cochin, and bears evidence of having been imperfectly peeled and carelessly cured. It is of inferior aroma and pungency.

Of all the commercial varieties of ginger, Jamaica is the most aromatic and African the most pungent.

GALANGAL RHIZOME

(Lesser Galangal, *Rhizoma Galangæ*)

Source &c.—Galangal root is the rhizome of *Alpinia officinarum*, Hance (N.O. *Scitamineæ*), a reedlike plant, attaining about a metre in height, a native of and cultivated on the island of Hainan and the neighbouring south-east coast of China. The rhizome is dug up in the autumn, washed, trimmed, cut into pieces, and dried; during the latter process the pale colour of the fresh rhizome turns to a reddish brown. The drug is exported in bales made of split cane, plaited, and bound round with cane.

Galangal root has been used in Europe as a spice for more than a thousand years, having probably been introduced by the Arabian physicians. It is not now much used in England,

but is still employed in some parts of Russia both as a spice and as a medicine.

Description.—The drug consists of a branched rhizome, about 12 mm. thick, that has evidently been cut whilst fresh



FIG. 221.—Galangal root. Natural size.

into pieces about 5 or 10 cm. long. These are frequently cylindrical, but sometimes tapering or enlarged, and often branched. They are of a dull reddish brown colour, longitudinally striated or shrivelled, and bear, at intervals of about 5 mm., pale encircling sinuous or frilled remains of cataphyllary leaves. Here and there the broken upper end of a root remains attached to the rhizome, but these are by no means numerous. It is hard, tough, and difficult to break.

The interior of the drug has a reddish brown colour, sometimes deeper, sometimes paler than that of the exterior. The transverse section exhibits a distinct central column (stele) surrounded by a wide cortex. In both of these

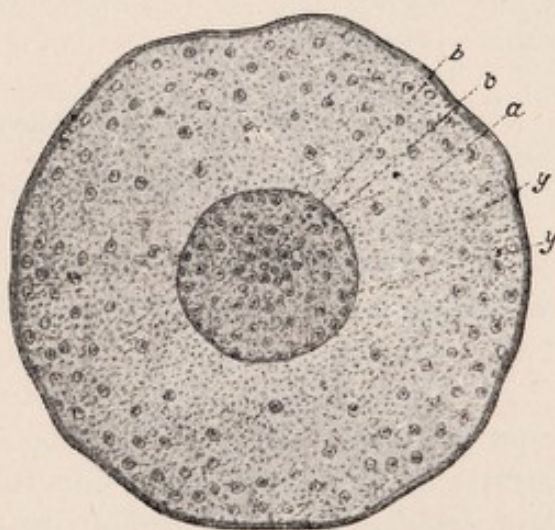


FIG. 222.—Galangal rhizome. Transverse section, magnified 3 diam. *a*, cortex; *v*, endodermis; *b*, stele; *y*, vascular bundles. (Berg.)

portions paler fibro-vascular bundles and numerous deep red resin-cells may be distinguished under the lens. The drug has an agreeable spicy odour and a strongly pungent spicy taste.

The student should observe

- (a) The *reddish brown colour*,
- (b) The *remains of the cataphyllary leaves*,
- (c) The *pungent taste*,
- (d) The *structure exhibited by the transverse section*.

Constituents.—Galangal rhizome contains a little volatile oil and a pungent oily body, galangol. It also contains three tasteless, yellow crystalline substances, viz. k  mferid, galangin, and the monomethyl ether of galangin. Alpinin, which was formerly considered to be a constituent of the drug, appears to be a mixture of k  mferid and galangin. Galangin is dioxyflavanol and has been obtained synthetically.

Uses.—Galangal rhizome has stimulant and carminative properties and is used for flatulent dyspepsia.

Varieties &c.—Greater galangal, the rhizome of *A. Galanga*, Willdenow, which is occasionally imported from Java, is much larger, orange-brown externally and pale buff internally; it has similar properties.

ORRIS RHIZOME

(Orris Root, Rhizoma Iridis)

Source &c.—Orris rhizome, or root as the drug is commonly termed, is derived from three species of *Iris* (N.O. *Irid  e*), all of which are cultivated for that purpose.

Iris germanica, Linn  , is a handsome plant with dark blue or purplish blue flowers, distributed over Central and Southern Europe, extending to Africa and India, and is a common garden plant in England. It is cultivated in Italy, especially in the neighbourhood of Florence and Verona, and also in Morocco.

Iris pallida, Lamarck, has pale bluish flowers and is a native of the eastern Mediterranean countries; it is also cultivated in Italy, and yields with *I. germanica* the bulk of the drug.

Iris florentina, Linn  , with large white flowers, is also a native of the eastern Mediterranean region, and is cultivated in Italy, but not so abundantly as the other two.

The rhizomes of all three species so closely resemble one another that there are no definite means of distinguishing them. They are dug up in the late summer when two or three years old, trimmed, and peeled; they are then allowed to dry slowly in the sun. During the slow drying the rhizomes, which in the fresh state are almost inodorous and have an acrid taste, acquire an agreeable fragrance and lose their acidity.

Description. — Orris rhizome occurs usually in pieces from 5 to 10 cm. long and 2 to 3 cm. thick, of a dull white colour. They are often dorsi-ventrally flattened and contracted at intervals or bear one or two short lateral branches at the apex. Each of the enlargements corresponds to a year's growth of the rhizome; the branches are developed from buds after the rhizome has flowered, which may not occur for three or four years.

The under surface is marked with the small dark circular scars of roots, and on the upper surface traces of the leaves, or at least of the fibro-vascular bundles that passed into them, can be discerned, the drug showing

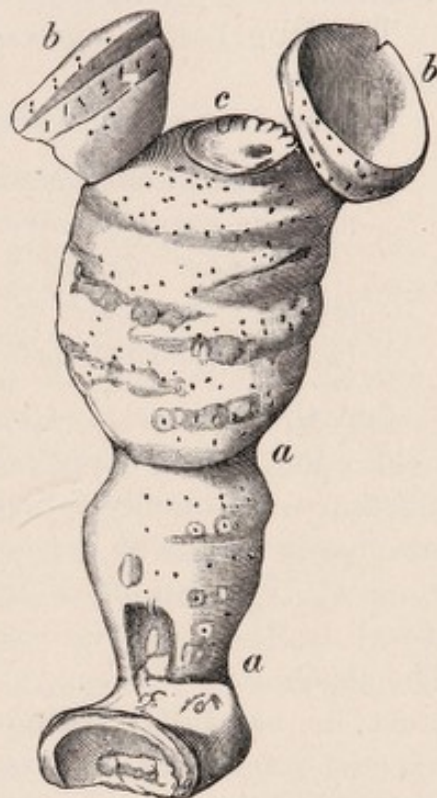


FIG. 223.—Orris rhizome. Rhizome of *Iris germanica*. *a*, constrictions indicating winter growth; *b*, *b*, young branches; *c*, scar left by previous year's flowering shoot. (Tschirch, after Hartwich.)



FIG. 224.—Orris rhizome. Transverse sections. *o*, cortex; *v*, endodermis; *b*, stele. Natural size. (Berg.)

distinct evidence of having been peeled. It is hard, heavy, and compact, and breaks with a short fracture, the interior

being yellowish and horny. The transverse section exhibits a large stele containing scattered darker bundles and a comparatively narrow cortex.

The drug has an agreeable aromatic odour and a slightly bitter taste.

The student should particularly observe

- (a) The *contractions* of the rhizome,
- (b) The *scars of leaves upon the upper* and of *roots on the under surface*,
- (c) The characters of the *transverse section*,
- (d) The *characteristic odour*.

Constituents.—By distillation with steam, orris rhizome yields about 0·1 or 0·2 per cent. of a yellowish, buttery, aromatic substance, commonly called oil or butter of orris; this consists principally (about 85 per cent.) of myristic acid together with irone, $C_{13}H_{20}O$, an oily liquid with a powerful odour of violets. Irone is the only aromatic constituent of the rhizome. The drug also contains a crystalline glucoside, iridin, which must be carefully distinguished from the brown, resinous, eclectic remedy of the same name; the latter is obtained from the rhizome of *Iris versicolor*, Linné.

Uses.—Orris rhizome is used as a perfume, dentifrice, &c., although formerly medicinal qualities were attributed to it.

Varieties.—The chief commercial varieties of orris root are the Florentine, Veronese, and Mogadore. A very inferior quality, of small size, dark colour, and little fragrance, is occasionally imported from Bombay.

Florentine orris root is usually nearly white in colour, carefully peeled, plump, and very fragrant.

Veronese orris root closely resembles the Florentine, but generally has a yellower colour, is rather less carefully peeled, often more wrinkled and more elongated; most of the pieces are pierced with a small hole at one end by which they were strung during the drying.

Mogadore orris root is altogether inferior to both the foregoing varieties. It is in smaller, flatter, and more shrunken pieces, which often bear at their apices the shrivelled remains of numerous concentrically arranged leaves. Patches of reddish cork are left attached to the drug, which is of darker colour and inferior fragrance.

Iris versicolor, Linné. The rhizome is narrow, dark brown, longitudinally wrinkled, and purplish internally; the taste is pungent and acrid. It is the source of the 'iridin' of commerce.

SARSAPARILLA

(*Radix Sarsæ*, *Radix Sarsaparillæ*)

Source &c.—Several varieties of sarsaparilla are imported more or less regularly into this country, but only one, that known as Jamaica sarsaparilla, is official in the British Pharmacopœia. This drug is obtained from *Smilax ornata*, Hooker filius (N.O. *Smilacæ*), a climbing plant with woody stems ascending lofty trees and springing from a stout, knotty rhizome. From the rhizome slender cylindrical roots are thrown off horizontally and creep for many feet a few inches below the surface of the earth. In collecting the roots they are first laid bare and then cut off near the rhizome. After they have been dried they are made into bundles; a number of these are placed upright and bound with wire into a disc-shaped bale.

The plant is a native of Central America (Costa Rica), not, as would appear from the name of the drug, of Jamaica. The root was formerly exported via Jamaica, hence the designation 'Jamaica' sarsaparilla, but it is now sent chiefly to New York, and thence to England.

Description.—Jamaica sarsaparilla occurs in bundles about half a metre long and 12 cm. in diameter, weighing about a kilogramme. Each bundle consists of numerous long, slender roots about 3 mm. in thickness, doubled up and bound loosely with one of the same roots. These usually have a dark reddish brown colour, are much shrunken and furrowed longitudinally, and bear tolerably numerous branching rootlets. They are tough and flexible, not breaking easily even when bent double. The transverse section exhibits a narrow, dark reddish brown cortex surrounding a central stele, which consists of a ring of yellowish wood with large radially arranged vessels and a white starchy pith.

The characters of the root are, however, somewhat variable, and it is not difficult to find roots that are paler in colour, less shrunken and more starchy than those described; even the same root may vary at different points. But the dark reddish

brown colour, the shrunken cortex, the presence of fibrous rootlets (technically known as 'beard') are regarded as important characters of good Jamaica sarsaparilla. The bundles are always free from the rhizome ('chump').

The drug has no odour, and only a slightly bitter taste.

The student should observe

- (a) The *dark red shrunken cortex, which does not exhibit transverse cracks,*
- (b) The *numerous wiry rootlets,*
- (c) The *transverse section ;*

and should compare the drug with Indian sarsaparilla (compare p. 395), which is marked with transverse cracks, is rigid and tortuous, and has a distinctive aroma.



FIG. 225.—Bundles of Jamaica Sarsaparilla. Reduced.

Constituents.—Three substances, all belonging to the sapotoxin group, have been isolated from sarsaparilla, viz. parillin (formerly called smilacin), smilasaponin (recently also called smilacin), and sarsasaponin. Of these three parillin and sarsasaponin have been obtained in a pure crystalline form, smilasaponin being amorphous. They are all glucosidal and all produce salivation, vomiting, and diarrhoea, but sarsasaponin is the most active (Schulz, 1896). They all have a bitter, acrid taste and their aqueous solutions froth when shaken. They differ in their solubility in water, sarsasaponin being very soluble

and parillin almost insoluble. The drug contains also varying quantities of starch; it yields from 10 to 20 per cent. of aqueous extract, and about 7 per cent. of ash.

Uses.—Sarsaparilla has been administered as an alterative in syphilis, chronic skin diseases, and rheumatism, but great diversity of opinion exists as to its therapeutic value.

Varieties.—Several other varieties of sarsaparilla are imported into the English market; the following are the most important:—

1. *Honduras Sarsaparilla*, the botanical origin of which is unknown. The drug is imported from British Honduras in bundles about 75 cm. long and 5 or 6 cm. wide, much longer and narrower therefore than the bundles of the Jamaica variety; they are sometimes closely whipped round or sometimes loosely bound with a long root. The roots are distinguished from those of the Jamaica variety by their pale yellowish or brownish colour, and by their less shrunken, more



FIG. 226.—Bundle of Honduras Sarsaparilla. Reduced. (Pereira.)

plump and starchy appearance; they have generally fewer rootlets attached and are always free from rhizome. The section exhibits a pale, starchy cortex, usually thicker than that of Jamaica sarsaparilla, but a similar stele.

This variety is largely used on the Continent, where it is generally preferred.

2. *Lima Sarsaparilla* is imported from Panama in bundles about 60 cm. long and about 7 cm. in diameter, loosely folded, bound with a root, and made into bales similar to those of Jamaica sarsaparilla, each containing about 300 bundles and weighing nearly 100 kilogrammes. This drug shows a close resemblance to Jamaica sarsaparilla, and indeed can only be distinguished with certainty by the different packing and by the anatomical characters of the cells of the endodermis and exodermis, which in certain cases constitute a most valuable means of identifying and distinguishing these drugs.

3. *Guayaquil Sarsaparilla* is imported in rectangular pressed bales containing a number of flattish bundles about 50 cm. long

and 15 cm. wide, containing the knotty rhizome and portions of the stout, round aerial stems. Sometimes the root is imported loose in bales.

Guayaquil sarsaparilla has a mahogany brown colour, and is usually larger than the Jamaica; it is not so much furrowed nor has it such numerous rootlets.

4. *Vera Cruz* or *Mexican Sarsaparilla* is obtained from *S. medica*, Schlechtendal et Chamisso. Both rhizome and roots are collected and dried, the drug not being made up into bales. It consists of a number of rhizomes, to each of which are attached numerous straight roots laid together. The latter



FIG. 227.—Bundle of Vera Cruz Sarsaparilla. (Pereira.)

have a dull greyish brown colour and are much shrunken. Like Lima sarsaparilla the variety is well characterised by the form of the cells of the endodermis and exodermis.

5. *Native Jamaica Sarsaparilla* is obtained from plants presumably of *S. officinalis*, Humboldt, Bonpland et Kunth, cultivated on the island of Jamaica. This truly Jamaican sarsaparilla, commercially known as 'native' Jamaica, must be carefully distinguished from the ordinary Jamaica (or, better, Costa Rica) sarsaparilla. It arrives packed loose in bales, and is of a pale reddish or greyish brown colour. The root bears scattered, rather stout rootlets, and exhibits in transverse section a pale cortex separated by a distinct line from a rather darker stele. These characters sufficiently distinguish 'native' Jamaica sarsaparilla from the Costa Rica drug.

There is at present no evidence to show which of these numerous varieties is the most active, and the determination, even if only approximate, of the relative amounts of sarsaponin (the most active constituent) contained in each would afford a much needed indication of the variety that should be medicinally preferred.

SQUILL

(Scilla, Bulbus Scillæ, Radix Scillæ)

Source &c.—The squill, *Urginæa Scilla*, Steinheil (N.O. *Liliaceæ*), is a bulbous plant indigenous to the countries bordering on the Mediterranean, and frequently appearing in great abundance. It is one of the most ancient of medicinal plants, having been well known to the Greeks and Romans; the drug was introduced into European medicine by the Arabian physicians of the early ages.



FIG. 228.—Squill bulb, reduced. (Bentley and Trimen.)

The plant produces a large tunicated bulb, often weighing several pounds, which lies partially imbedded in the ground. Two varieties are known, the white and the red; the former is collected largely in Sicily and Malta and is preferred in England, the latter is collected in Algeria and is the variety used in France. The scales of the white squill are whitish or yellowish, whilst those of the red variety are of a dull red colour, but many intermediate forms are known.

The outer coats, which are reddish brown in colour, dry and scarious, are removed and the inner ones cut into transverse

slices and dried. The innermost scales, which are very juicy and scarcely bitter in taste, are rejected.

Description.—The commercial drug usually consists of narrow, flattish, curved strips from 2 to 5 cm. in length and about 3 mm. thick. They frequently taper towards both ends, are of a yellowish white colour and more or less translucent. When quite dry they are brittle and can easily be powdered, but they rapidly absorb moisture from the air, becoming tough and flexible. They have only a slight odour, but a disagreeable bitter and acrid taste. Occasionally the entire bulbs are imported, but they are difficult to keep in the fresh state, as they preserve their vitality for a long time, and if allowed to remain in a warm place rapidly develop an aerial shoot.

Constituents.—The constituents of squill are imperfectly known. Merck (1879) separated scillitoxin, scillipicrin, and scillin, all of which exhibit glucosidal properties. Scillitoxin and scillipicrin are both amorphous and act upon the heart, the former being the more active of the two; scillin is crystalline, but is inactive.

The bulbs also contain mucilage, sinistrin (a carbohydrate soluble in water but insoluble in alcohol, probably identical with tritacin and irisin), and calcium oxalate in bundles of long acicular crystals; the latter easily penetrate the skin when the bulbs are handled, and give rise to excessive irritation.

Uses.—Squill closely resembles digitalis in increasing the vigour and diminishing the frequency of cardiac action; it is also a powerful expectorant, and is much used in chronic bronchitis and for coughs generally. In large doses it produces emesis.

COLCHICUM CORM

(Colchicum Root, Radix Colchici)

Source &c.—Colchicum corm is the contracted subterranean stem of the meadow saffron, *Colchicum autumnale*, Linné (N.O. *Liliaceæ*), a plant widely distributed over Europe and abundant in some parts of England in moist meadows and pastures.

The meadow saffron produces in the autumn a conspicuous reddish purple flower springing from the side of a contracted and enlarged stem (corm) situated several inches below the

surface of the ground (fig. 109, p. 217). This corm has supplied the flower with the necessary materials for its growth, and has thereby been deprived of part of the reserve material which the leaves that die down in the summer have stored up in it. The proper time for collecting the corm is therefore after the early summer leaves have filled it with reserve material, but before the production of the flower in the autumn has partially exhausted it. But at this time the plant is difficult to find, and the corms are probably collected when the plant is in flower. This possible variation in the time of collection has been presumed to cause notable variations in the activity of the corm, and has led to a preference being given to the seeds. As a matter of fact, commercial corms have been shown to vary but little in proportion of active constituent contained in them.

Description.—The fresh corms are about 4 cm. long and 3 cm. broad, bluntly conical in shape, flattened on one side, and enveloped in an outer brown and inner reddish yellow membranous coat derived from the leaves of the previous summer. Internally the corm is firm, white, and fleshy; it has a disagreeable odour, and exudes, when cut, a bitter juice that is white and milky from the presence in it of numerous starch grains.

The corms are also cut into thin transverse slices, which are dried at a gentle heat (under 65.5°C.) to avoid gelatinisation of the starch, and freed from the remains of the membranes by winnowing. They then form whitish slices about 3 cm. wide, yellowish on their outer surface and reniform in outline, the depression corresponding to the position of the flower. They break readily with a short starchy fracture. The transverse surface exhibits, when smoothed, numerous scattered darker points (fibro-vascular bundles). The drug is inodorous, but has a bitter taste.

The student should observe

- (a) The *reniform* outline of the sliced drug,
- (b) The *starchy* fracture,
- (c) The *bitter* taste.

Constituents.—Colchicum corm contains from 0.5 to 0.6 per cent. of the poisonous alkaloid colchicine (compare p. 218). The drug also contains abundance of starch.

Uses.—Colchicum is chiefly used to relieve the pain and inflammation and shorten the duration of acute gout and certain gouty affections, but is liable to cause intestinal pain accompanied by vomiting and purging.

WHITE HELLEBORE RHIZOME

(Rhizoma Veratri Albi)

Source &c.—White hellebore, *Veratrum album*, Linné (N.O. *Liliaceæ*), is an herbaceous plant with erect perennial rhizome, common in the mountains of Central and Southern Europe. It produces large, ovate, ribbed leaves and a flowering stem that attains a height of a metre or more. The rhizome appears to have been known and used medicinally for many years, but owing to its powerful and uncertain action it has been employed chiefly as an external application, though to a limited extent only.

The rhizome is dug up in the autumn, and the leaves, which are all radical until a flowering stem is produced, are cut off close to it. It is then usually dried entire, but is sometimes cut longitudinally into halves or quarters to facilitate drying, sometimes deprived of its roots, and occasionally sliced transversely. The separation of the roots is to be deprecated, as they appear to be more active than the rhizome. When fresh the rhizome has an alliaceous odour, but this is lost by drying. Our supplies are imported chiefly from Germany.

Description.—White hellebore rhizome (when freed from the roots) averages about 5 cm. in length and 2 cm. in thickness, and is of a dull black colour externally. The upper part is nearly cylindrical, but the lower extremity, where the rhizome gradually perishes and rots away as growth progresses, is usually bluntly conical or truncate. It is crowned with a dense leafy mass consisting of the thin, dry remains of numerous concentrically arranged leaf-bases which have been cut off level close to the rhizome; the outer of these are coarsely fibrous, the parenchymatous tissue having perished, leaving the veins persistent. The surface of the rhizome is rough and wrinkled and shows encircling scars of leaves that have perished. The roots leave circular scars, in the centre of which the slender wood is distinctly visible. In the untrimmed rhizome the

roots are very numerous and stout: they completely envelop the rhizome, so that the untrimmed drug is much more bulky than the rhizome alone. They are usually dull grey or yellowish in colour, and commonly show a disposition to shrivel longitudinally rather than transversely.

The rhizome frequently branches, two or even three branches springing from the same rhizome. This is caused by the production of a flowering stem; the main axis being thus terminated, the growth of the rhizome is continued by the

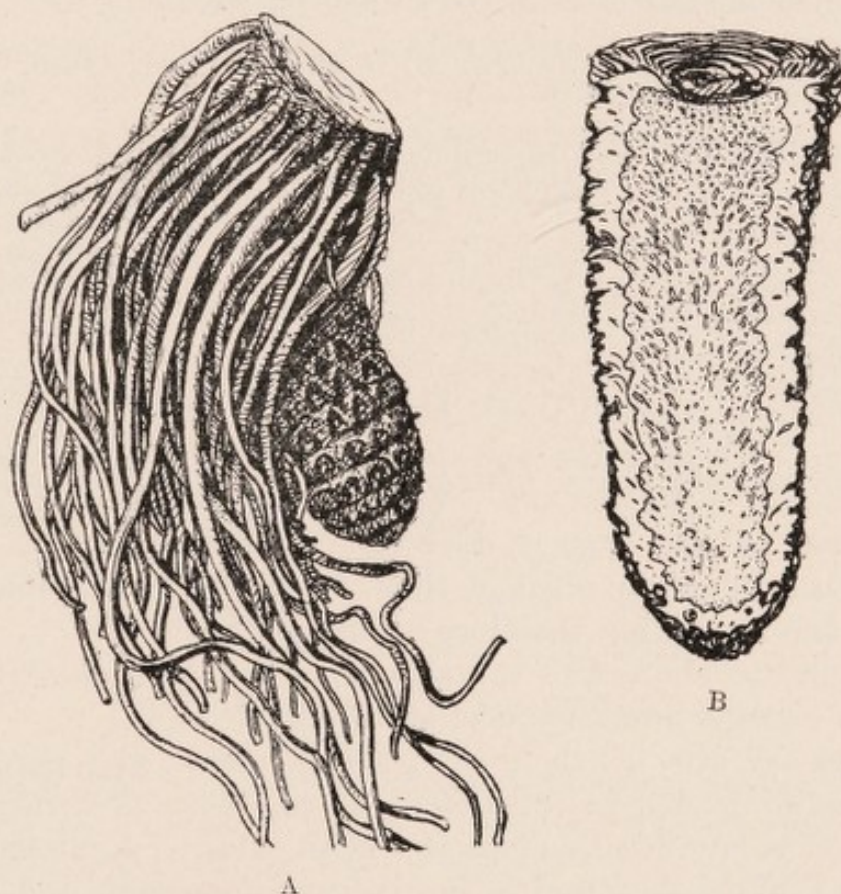


FIG. 229.—White Hellebore rhizome. A, rhizome with roots; B, longitudinal section of rhizome. Natural size. (*Pharmaceutical Journal*.)

development of one or more of the buds that are situated in the axils of the inner radical leaves. Such a branch may grow for several years before it flowers.

The drug breaks with a short fracture, the interior being whitish, firm, compact, and starchy. The cortex is about 3 cm. thick, and separated by a wavy, brownish line (endodermis) from the stele, the latter being irregularly traversed in a characteristic manner by yellowish fibro-vascular bundles. The cortex

also exhibits occasional bundles (leaf-traces), and gives off here and there a root.

The drug can easily be powdered, and the powder excites, when inhaled, violent sneezing. It has little odour, but a bitterish, acrid taste.

The student should observe

- (a) That the rhizome is *usually entire*,
- (b) That the roots are *greyish* in colour, and *not often much shrivelled transversely*,
- (c) The characters of the *transverse section*;

and should compare the drug with American veratrum. (See below.)

Constituents.—White hellebore contains several alkaloids, amounting in all to 0·5 to 1·0 per cent. The most important and the most toxic of these is protoveratrine, $C_{32}H_{51}NO_{11}$, (0·03 per cent.), which is obtainable in small crystals melting at 245° to 250° C. It closely resembles aconitine in its action and is in addition a powerful sternutatory. Jervine, $C_{26}H_{37}NO_3 \cdot 2H_2O$, is also crystalline and toxic, but it is less active than protoveratrine. Rubijervine and pseudojervine are also present, but are said to be inactive. Whether protoveratridine occurs preformed in the drug is doubtful. The roots appear to be somewhat richer in alkaloid than the rhizome (Bredemann, 1906), and should not therefore be discarded.

White hellebore also contains resin (as much as 25·8 per cent., Flückiger and Hanbury) and starch.

Uses.—White hellebore is a powerful emetic and purgative when administered in full doses. It has been prescribed for gout, but is now usually employed as an external application in certain skin diseases, for the destruction of pediculi and other noxious vermin, and as a moth-powder.

AMERICAN VERATRUM

(Green Hellebore, *Rhizoma Veratri Viridis*)

Source &c.—*Veratrum viride*, Aiton (N.O. *Liliaceæ*), is a plant so closely resembling *V. album* that its claim to be considered a distinct species is very doubtful. It is common in the eastern United States, growing in rich woods. The

plant is dug up in the autumn, the leaves are cut off close to the crown, and the rhizome is then usually halved or quartered to facilitate drying; occasionally the roots are cut off ('trimmed' rhizomes), but more frequently they are left attached to the rhizome ('with fibre').

The drug is commonly termed 'green hellebore,' but this name is better restricted to the rhizome of *Helleborus viridis*, Linné.; American veratrum is a more suitable designation.

Description.—The rhizome closely resembles that of *V. album*, the chief difference being the fact that American veratrum is usually cut longitudinally, whilst white veratrum is commonly entire; other characters are the brighter, yellowish brown colour and the more shrivelled appearance of the roots. These are, however, variable characters, and there is no definite means of distinguishing the two drugs.

Constituents.—The constituents of *Veratrum viride* are apparently identical with those of *Veratrum album*, with the (doubtful) exception that the former contains an alkaloid—cevadine—that is not found in the latter; they are present in about the same proportion.

Uses.—American veratrum has been recommended as a sedative, but is seldom prescribed.

SWEET FLAG RHIZOME

(*Rhizoma Acori Calami*)

Source &c.—The sweet flag or sweet sedge, *Acorus Calāmus*, Linné (N.O. *Aroidæ*), is a native of Eastern Europe and Central Asia, but has become widely diffused by cultivation. It has established itself in England as a wild plant on the edges of lakes and streams. In dry summers large quantities are collected in the ditches in Germany, and much is also sent from East Prussia and Galicia.

The rhizome has long been esteemed as a most valuable medicine in India, whence probably its use spread to Europe.

The long, creeping, horizontal rhizome is collected in the autumn, trimmed, cut into pieces 10 cm. or more in length, and dried. Sometimes it is partially deprived of the outer cork layer by peeling or scraping; but this is inadvisable, as the peeled rhizomes yield less oil than the unpeeled.

Description.—The rhizome commonly occurs in pieces varying from 5 to 15 cm. or more in length and from 1 to 2 cm. in thickness. They are covered with a thin brownish cork and are much shrunken, bearing deep longitudinal wrinkles. They are marked on the upper surface with large triangular leaf-scars that encircle the rhizome, springing from each side

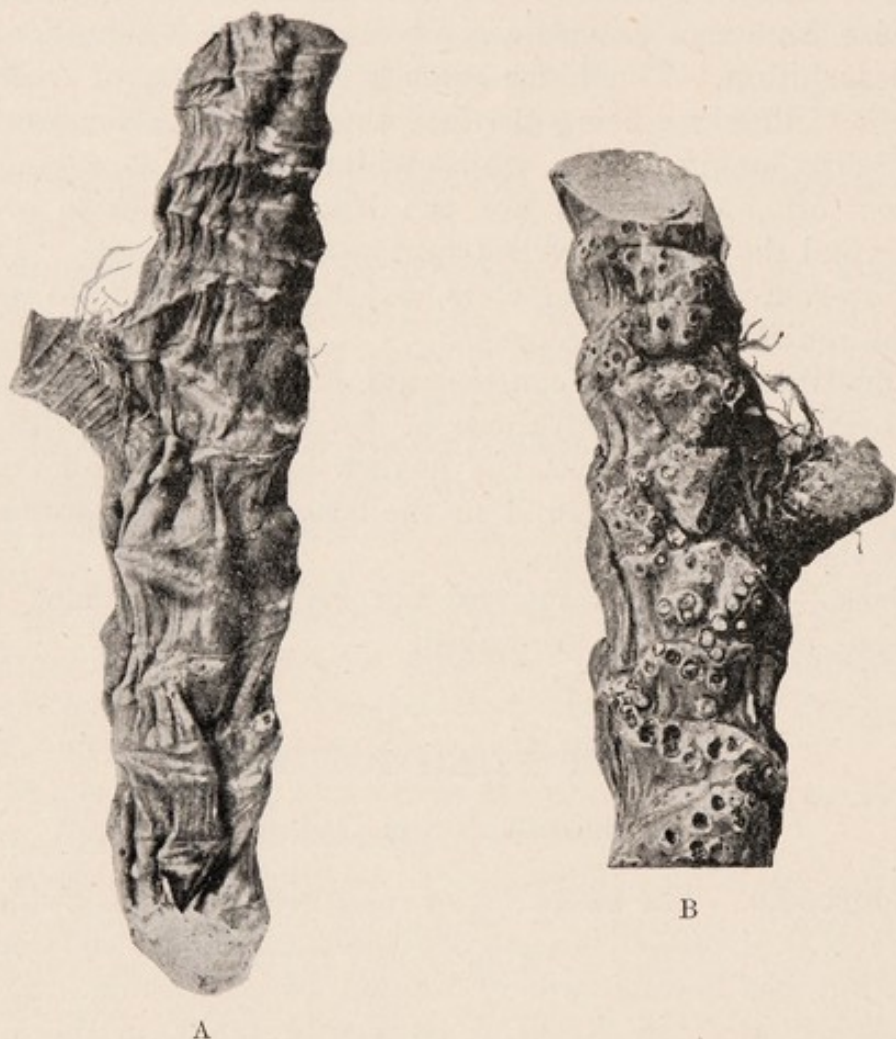


FIG. 230.—Sweet Flag rhizome. A, upper surface, showing leaf-scars. B, under surface, showing root-scars. Natural size.

alternately. To these scars the fibrous leaf-traces are sometimes attached. The under surface bears an irregular zigzag line of small raised root-scars that are circular and exhibit a central stele surrounded by a narrow cortex. The rhizome produces an occasional slender lateral branch which is distinctly marked with the scars of leaves and roots.

The scraped rhizome is of a pale brownish buff colour, has a

roughish surface, and bears less conspicuous scars of leaves and roots.

The drug breaks with a short corky fracture, and is pale brown, or nearly white, and spongy internally. The section exhibits a large stele separated by a yellowish line from a thick cortex of similar appearance. Both stele and cortex are traversed by numerous small, oval, scattered, fibro-vascular bundles.

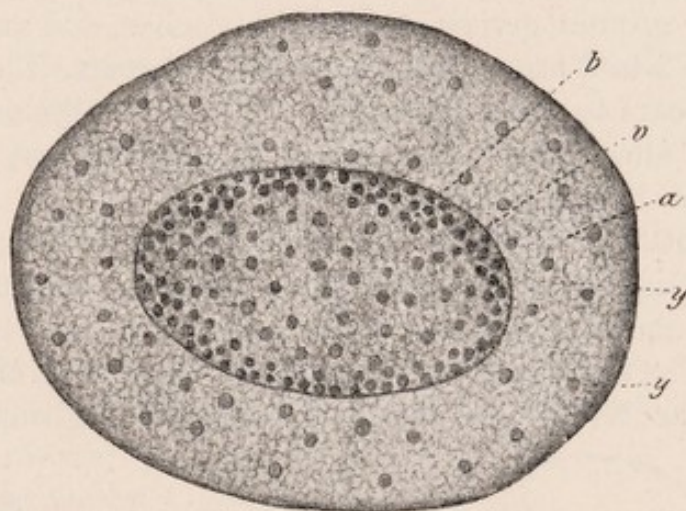


FIG. 231.—Sweet Flag rhizome. Transverse section, magnified 3 diam.
a, cortex; v, endodermis; b, stele; y, vascular bundles. (Berg.)

The freshly fractured surface has an agreeable aromatic odour. The taste is disagreeably bitter and pungent.

The student should observe

- (a) The *large triangular leaf-scars*,
- (b) The *zigzag line of root-scars*,
- (c) The *spongy texture*,
- (d) The *bitter, pungent taste*.

Constituents.—Sweet flag rhizome contains from 1.5 to 3.5 per cent. of an aromatic volatile oil, the chief aromatic constituent of which is asaryl aldehyde. It contains also an amorphous bitter principle, acorin, yielding by oxidation acoretin and by treatment with acids or alkalis volatile oil and sugar. Certain alkaloidal substances (choline, trimethylamine) appear also to be present, but they require further investigation. The drug contains an abundance of starch and a little tannin.

Uses.—The drug has stimulant and tonic properties; it has been used for ague and for atonic dyspepsia.

COUCH GRASS RHIZOME

(Rhizoma Tritici, Radix Graminis)

Source &c.—The couch grass, *Agropyron repens*, Beauvais (*Triticum repens*, Linné, N.O. *Graminææ*), is abundant in this country, being often a troublesome weed. It produces a slender rhizome, running for a considerable distance just below the surface of the ground, giving off lateral branches, and at the nodes, which are 2 to 3 cm. apart, small fibrous roots. The rhizome, which appears to have been used by the Greeks and Romans for certain affections of the bladder, is collected, cut into pieces about 1 cm. long, and dried.

Description.—Couch grass is generally met with in commerce cut into short pieces. The rhizome is very slender, averaging about 2 mm. in diameter, and of a dark straw-yellow colour. The surface is quite glabrous, hard and shining, and usually bears five or six rather prominent longitudinal ridges.



FIG. 232. — Couch Grass rhizome and transverse section; the latter magnified 3 diam. (Maisch.)

Some of the pieces bear the nodes, at which there may be found the persistent fibrous remains of a sheathing leaf-basis, and either a few threadlike paler roots or the scars left by them. The transverse section exhibits, under a lens, a narrow pale inner ring (the stele), hollow in the centre, surrounded by a darker translucent cortex.

The drug has but little odour, and a sweetish, mucilaginous taste.

The student should observe

- (a) The slender hollow rhizome,
- (b) The translucent (not starchy) cortex.

Constituents.—Couch grass contains a carbohydrate, triticin, which is not very soluble in water, and yields by

hydrolysis levulose; it appears to occur in the rhizomes of other Gramineous plants, and possibly is widely diffused in the vegetable kingdom. Mucilage, inosite, and mannite are also constituents of the rhizome, but it is impossible to say to what substance or substances the action of the drug is to be ascribed. Starch is *not* present, a character that should be noted, as certain rhizomes containing starch (notably those of *Cynodon Dactylon*, Persoon) have been mistaken for couch grass rhizome.

Use.—Couch grass has been employed as a diuretic in certain affections of the bladder.

MALE FERN RHIZOME

(Rhizoma Filicis Maris, Filix Mas)

Source &c.—The male fern, *Aspidium Filix-mas*, Swartz (N.O. *Filicinæ*), is abundant in Great Britain, and one of the commonest of our indigenous ferns. It produces a circular tuft of fronds attaining a metre in height and arising from a stout rhizome. The lamina is divided pinnately, and bears on its under surface, when in fruit, kidney-shaped or sometimes nearly peltate sori. The petiole bears numerous brown, scarious scales, especially in the lower part.

The rhizome is collected in the autumn; the fronds are cut off, leaving the lower swollen portion, about 3 cm. in length, attached to the rhizome, the roots are removed, and the drug is then dried. Sometimes the rhizome is cut longitudinally to facilitate the drying. Much is imported from Germany, large quantities being collected in the Harz and Thuringian Mountains.

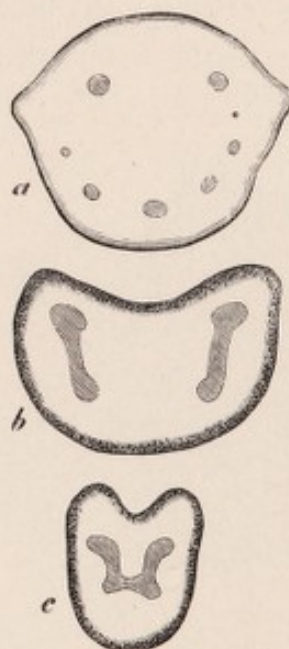


FIG. 233.—*a*, transverse section of base of petiole of *Aspidium Filix-mas*. *b*, transverse section of petiole of *A. Filix-femina*; *c*, the same just below the lamina. Slightly magnified. (Luerssen.)

Description.—The drug occurs in pieces up to about 12 or 15 cm. in length, but usually shorter, and 4 cm. in thickness; only about one-half of this is due to the rhizome itself, the rest being formed by the bases of the petioles that have been left attached to it. These, which constitute the



FIG. 234.—A, margin of scale from petiole of *A. Filix-mas*;
B, from that of *A. spinulosum*. Magnified. (Lauren.)

major part of the drug, are usually from 2 to 3 cm. in length, from 5 to 15 mm. in thickness, and enlarged near the middle. They are curved bluntly angular or longitudinally furrowed, and of a dark brown or nearly black colour externally. They are more or less densely covered with dry, brown,

membranous scales. Examined under the microscope the marginal cells of these scales will be seen to be prolonged at intervals into simple hairlike processes, each consisting of two parallel and contiguous cells, but the scale does not bear any glandular hairs, excepting sometimes two at its base; this is an important diagnostic character of the drug (Lauren, 1896). When broken the petioles should be (if recently dried) green internally, and the smoothed

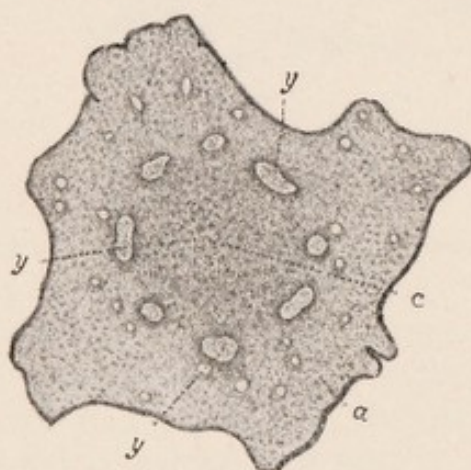


FIG. 235.—Male Fern rhizome. Transverse section, magnified 3 diam.
y, steles. (Berg.)

section should exhibit about eight (usually seven, eight, or nine) steles arranged in a diffuse circle.

The rhizome itself should also be green internally, and exhibit in section about as many principal steles as the petiole. The drug has a disagreeable, nauseous, bitter taste.

Constituents.—The chief constituent of male fern rhizome is about 5 per cent. of a yellow, amorphous substance of acid nature termed filmarone, to which the vermifuge properties of the drug are apparently to be attributed. Filicic acid, aspidinol, flavaspidic acid, and albaspidin are also contained in it, as well as fixed oil (6 per cent.), filicitannic acid (7.8 per cent.), and starch. The drug yields about 4 per cent. of ash.

Filmarone, which is said to be anthelmintic but not toxic, is insoluble in water, sparingly soluble in alcohol and petroleum spirit, but readily soluble in acetone, chloroform, and ether. Dissolved in acetone or alcohol it slowly decomposes into the comparatively inert filicic acid and aspidinol, both of which substances are also present in the drug. This decomposition also takes place in the liquid extract, causing the formation of a crystalline deposit of filicic acid and deterioration of the preparation. Filicic acid crystallises in pale yellow plates insoluble in alcohol, and sparingly soluble in ether; aspidinol in colourless needles (m.pt. 143° C.). Heated with zinc dust and sodium hydroxide methyl-phloroglucin

is produced, a reaction which indicates an analogy with rottlerin and kosin (compare pp. 469, 76). Filicin is the name given to an amorphous modification of filicic acid said to be its anhydride. Although a number of substances have been isolated from male fern rhizome our knowledge of its vermifuge constituent is still far from complete.

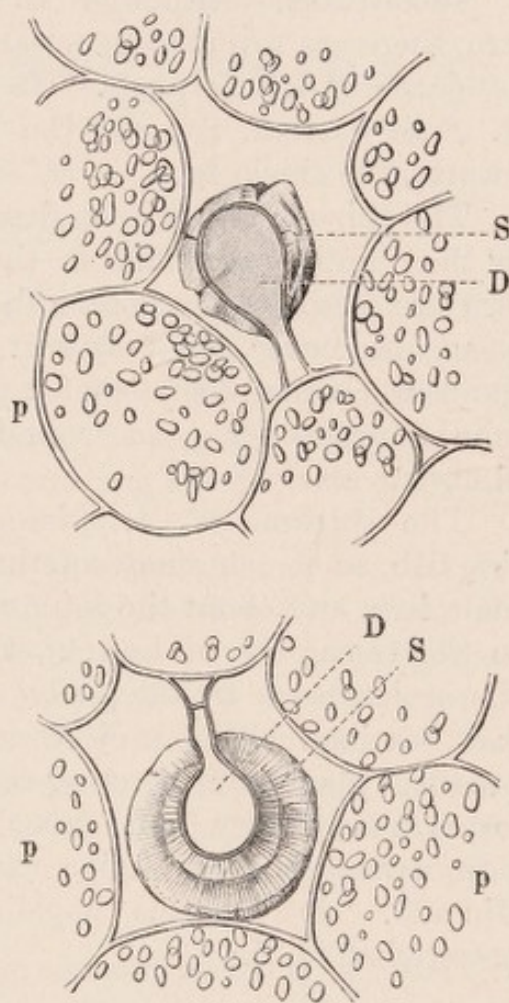


FIG. 236.—Intercellular spaces in the rhizome of Male Fern, showing the secreting glands, D, and secretion, S. P, cortical parenchyma containing starch-grains. Magnified 240 diam. (Vogl.)

Some of these constituents are formed by the peculiar secreting cells produced by the rhizome and the petioles in intercellular spaces in the parenchymatous tissue.

Use.—Male fern rhizome has a powerful tonic action on tapeworms, which it kills and expels. In large doses it is an irritant poison.

Substitutes.—Although the male fern is a common British fern, there are several others that closely resemble it and might be gathered in its place. Of these the most important are *A. Filix-fœmina*, Swartz, the lady fern, and *A. spinulosum*, Swartz, the shield fern.

The rhizome of *A. Filix-fœmina* may easily be distinguished by the number of bundles in the leaf-base, for whilst the male fern has from seven to nine the lady fern has only two large ones. Moreover, the lady fern produces no secreting cells in the parenchyma of rhizome or petiole. It has decided anthelmintic properties, and contains filicic acid and possibly filmarone also.

The rhizome of *A. spinulosum* is more difficult to distinguish, as it contains secreting cells similar to those of the male fern, and about the same number of bundles. According to the researches of Lauren, the character of the margin of the scales borne by the petiole is distinctive, that of *A. Filix-mas* bearing hairlike projections, whilst that of *A. spinulosum* produces glandular secreting cells. The rhizome of *A. spinulosum* is frequently found mixed with the male fern in German commerce. It is an active vermifuge, and is largely used in Finland. It contains aspidin (polystichin), polystichinin, polystichalbin, &c.

SECTION IX

STARCHES, GLANDS, HAIRS &c.

STARCH

(Amylum)

Source &c.—The official varieties of starch (Amylum, B.P.) are those obtained from wheat, *Triticum sativum*, Lamarck, from maize, *Zea Mays*, Linné, and from rice, *Orýza satíva*, Linné (N.O. *Graminææ*). Wheat is largely cultivated in temperate climates, whilst maize and rice are grown chiefly in warmer or subtropical countries.

In preparing the starch from the fruits, it is essential in the first place that the cells containing it should be ruptured in order to liberate the starch-grains, and in the second place that the starch-grains thus liberated should be separated from other matters, both soluble and insoluble, that accompany them, especially from the nitrogenous gluten which often clings to them pertinaciously. The cells are ruptured by grinding the softened grain to a pulp, and the gluten is removed by one of the following processes, viz. :

- (a) A mixture of crushed grain and water is allowed to undergo putrefactive decomposition; the gluten is decomposed, lactic, acetic, and other acids being produced and removed by washing.
- (b) The crushed grain is mixed with a dilute solution of caustic soda by which the gluten is dissolved.
- (c) The grain is crushed and mixed with water to a dough from which the starch-grains are washed by kneading it in a stream of water, leaving a mass of gluten behind.

The starch is purified by washing, straining, and allowing the milky liquid containing starch-grains in suspension to clear,

by which a more or less complete separation into pure starch and starch mixed with varying amounts of cell-débris is effected. It is finally dried, during which the moist mass gradually splits up into angular fragments. These are then ground to form starch powder.

Description.—From whatever source starch is obtained it forms either a fine white powder, or angular or columnar masses easily reducible to powder. It is inodorous and quite insoluble in water, to which it should impart neither acid nor alkaline reaction; usually, however, wheat and potato starches are faintly acid, while maize and rice are faintly alkaline, as these are made by the soda process. It leaves, when incinerated, only traces of ash. Boiled with water and cooled it



FIG. 237.—Wheat Starch. Magnified 300 diam. (Tschirch.)

gives a cloudy, more or less gelatinous mixture, which is coloured deep blue by solution of iodine.

Although the different varieties of starch show certain differences in the temperature at which they gelatinise, the chief means of distinguishing them and ascertaining their freedom from admixture lies in the examination with the microscope.

Wheat Starch consists of large and small grains mixed together, with few intermediate in size; the former are lenticular in shape and sometimes marked with faint concentric rings. The hilum is central but not conspicuous. The larger of the large grains average about 30 to 38 microns¹ (μ) in diameter, the smaller of the large grains 15 to 25, whilst the small grains average 6 to 7.

¹ A micron is the one-thousandth part of a millimetre.

Maize Starch consists of grains that are nearly uniform in size and rather smaller than the large grains of wheat starch (10 to 25 μ); they are polygonal with blunt angles, or more or less rounded. In the centre there is often a small cleft, or two or three radiating from a centre (the hilum).

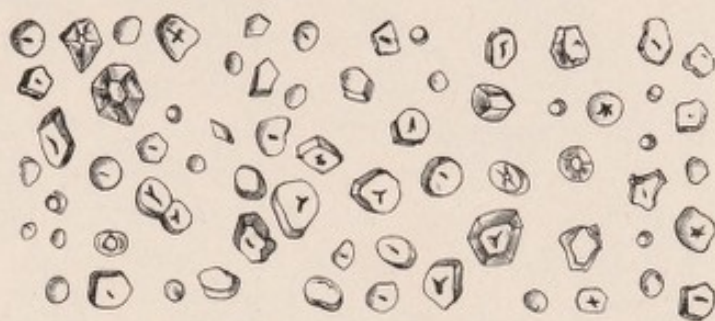


FIG. 238.—Maize Starch. Magnified 300 diam. (Tschirch.)

Rice Starch consists of extremely minute grains, averaging about 4 to 6 μ in diameter. They are polygonal, with sharp angles, and without evident concentric striæ, hilum, or cleft.

Varieties.—The following varieties of starch, although not official, are sufficiently important to call for remark:—

Potato Starch, obtained from the tubers of *Solanum tuberosum*, Linné (N.O. *Solanaceæ*), is extensively employed for various technical purposes and has been frequently used to adulterate maranta starch and certain drugs.

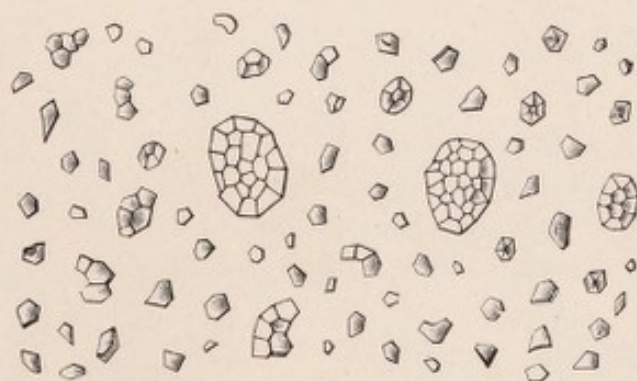


FIG. 239.—Rice Starch. Magnified 300 diam. (Tschirch.)

The grains are much larger than those of any of the official starches, varying mostly from 45 to 75 μ in length and from 45 to 60 μ in breadth; larger grains may occasionally be found and smaller ones are by no means uncommon. They have usually a flattened ovoid shape and possess a small hilum that is often situated near the *narrow* extremity of the

grain, whilst the broad end frequently exhibits a sinuate outline; the concentric striæ are well marked.

Maranta Starch, obtained from the rhizomes of *Maranta arundinacea*, Linné (N.O. *Marantaceæ*), is known in commerce

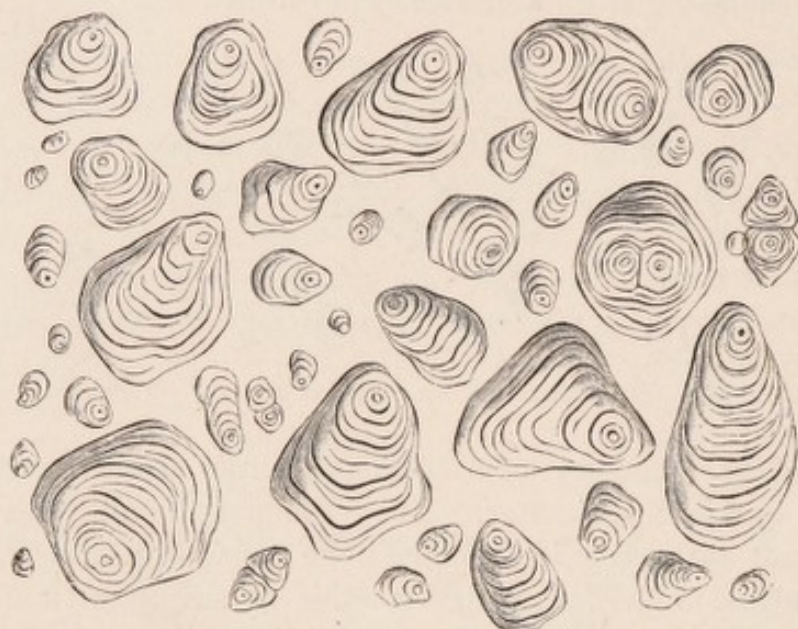


FIG. 240.—Potato Starch. Magnified 300 diam. (Tschirch.)

as St. Vincent, Bermuda, and Natal arrowroot, or simply as arrowroot, but as the latter term is applied to a number of other starches it is desirable that this, the arrowroot of English



FIG. 241.—Maranta Starch. Magnified 300 diam. (Tschirch.)

commerce, should be specified as maranta starch. Thus the starch of *Curcūma angustifolia*, Roxburgh, and *C. leucorhiza* Roxburgh (N.O. *Scitamineæ*), is known as East Indian arrowroot; that of *Manihot utilissima*, Pohl (N.O. *Euphorbiaceæ*),

and that of *Ipomœa Batatas*, Choisy (N.O. *Convolvulaceæ*), as Brazilian arrowroot; that of *Canna edulis*, Edwards, and other species of *Canna* (N.O. *Scitamineæ*) as Queensland arrowroot, &c.

The grains of maranta starch resemble in general appearance those of potato starch, but they are as a rule decidedly smaller, measuring only 30 to 45 μ in length and 24 to 30 μ in breadth. They are rather irregularly ovoid in shape and exhibit distinct concentric striæ. The position of the hilum is usually indicated by a cleft or by three or four radiating fissures, and in the majority of grains is near the broad end. The size of the grain, the character and position of the hilum sufficiently distinguish this starch from potato starch, which it otherwise resembles.



FIG. 242.—Curcuma Starch. Magnified 300 diam. (Tschirch.)

Curcuma starch, from the rhizomes of *C. angustifolia*, Roxburgh, and *C. leucorrhiza*, Roxburgh (N.O. *Scitamineæ*), is known as East Indian arrowroot and is largely used in India, although it does not find its way, to any great extent, to this country.

The grains average about 36 to 60 μ in length, although both larger and smaller ones may be found. They vary considerably in shape, but typical ones are of an elongated ovate outline. The hilum is situated in a little projection from the narrow end of the grain, and is therefore remarkably eccentric; it is often indistinct, but its position can be found by following the concentric striæ which are usually discernible. The grains are nearly flat, appearing as rods when viewed from the edge.

LYCOPODIUM

(Lycopodium)

Source &c.—Lycopodium consists of the spores of the common clubmoss, *Lycopodium clavatum*, Linné (N.O. *Lycopodiaceæ*), and probably other species. The clubmoss, with its long creeping stems and ascending branches covered with narrow moss-like leaves, is distributed over Great Britain and Europe generally. It produces fruiting branches covered with small scaly leaves and resembling a slender elongated cone. On the upper surface of these leaves (sporophylls) near the base are small receptacles (sporangia) filled with minute spores. These spores form the drug; they are collected by shaking the fruiting branches over a cloth in which the lycopodium collects as a fine yellow powder which is freed from extraneous matter by passing it through a fine sieve and packed in sacks, which are usually covered with matting. It is collected chiefly in Russia.

Description.—Lycopodium appears as a pale yellow, fine, very mobile powder that floats when thrown on to the surface of water. Blown into a flame it burns instantly with a brilliant flash, but when incinerated in a crucible it is slowly consumed, leaving only about 4 per cent. of ash.

Examined under a microscope lycopodium is seen to be composed entirely of minute spores, each of which is about $25\ \mu$ in diameter and has the shape of a triangular pyramid with a convex base. The entire surface of the spore is covered by a delicate network of projecting ridges. When crushed the spores burst and a drop of yellowish oil exudes from each. These characters are so well marked that sophistication is readily detected.

Constituents.—The spores contain about half their weight of fixed oil, which, however, does not make itself evident until the cellular membrane in which it is enclosed is either broken or destroyed. The oil consists principally of lycopodium-oleic acid (80 per cent.) and myristic acid (about 2 per cent.) combined with glycerin. Lycopodium-oleic acid resembles ordinary oleic acid but is not identical with it. Phytosterin, sugar, and traces of an alkaloid are also present in the drug.

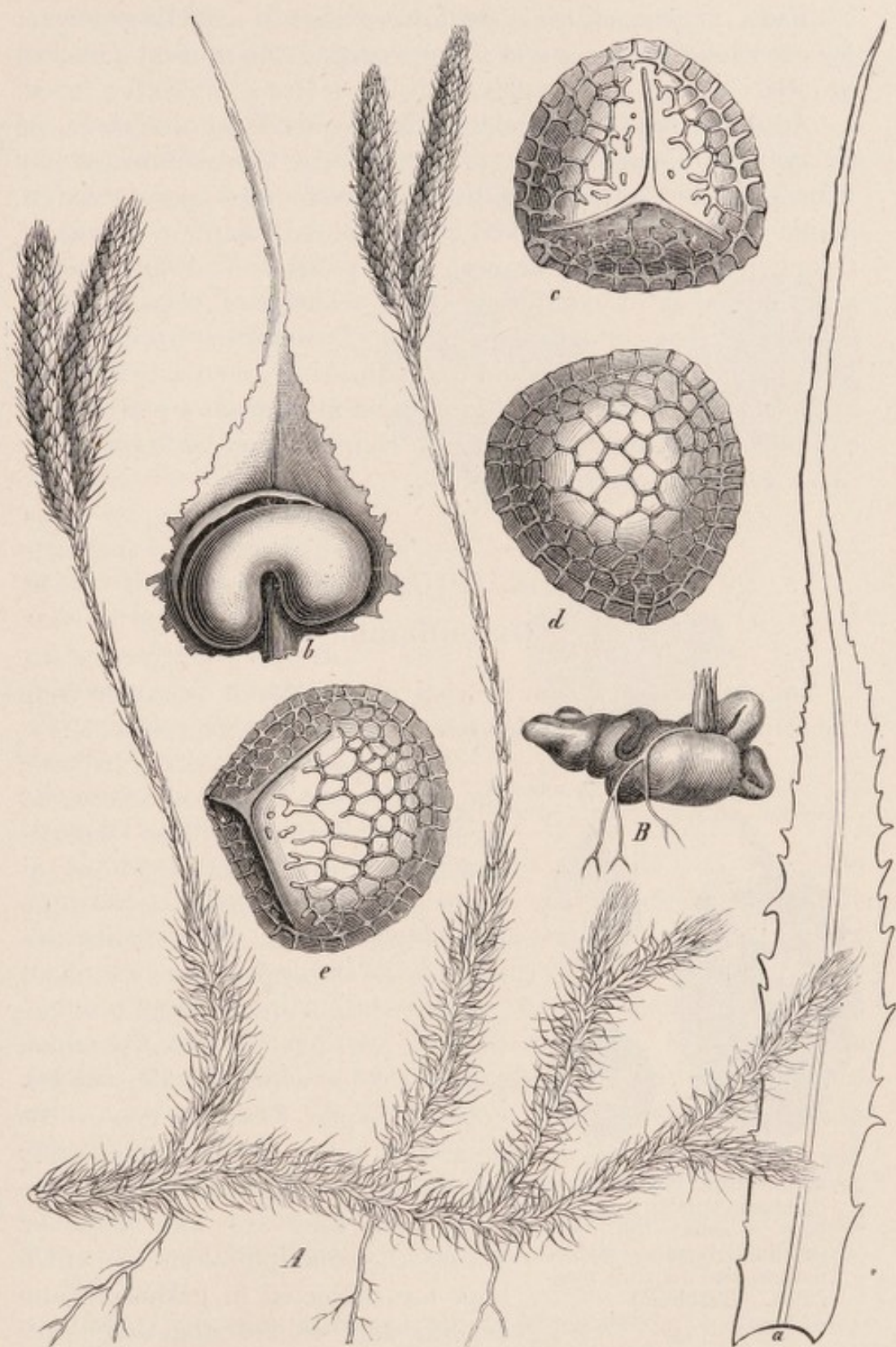


FIG. 243.—*Lycopodium*. *A*, portion of *Lycopodium clavatum*, natural size: *a*, foliage leaf; *b*, sporophyll with sporangium, magnified; *c*, *d*, *e*, spores, highly magnified. *B*, Prothallium of an allied species. (Luerssen.)

Uses.—Lycopodium is sometimes used as a dusting powder for excoriated surfaces and for preventing the mutual adhesion of pills.

Adulteration.—Lycopodium is frequently adulterated, the following substances, all of which are easily detected by microscopical examination, having been found:—potato starch, maize starch slightly roasted and coloured, sulphur, powdered colophony, powdered amber, and pollen of various kinds, especially that of coniferous trees, which has been actually sold (in Austria) under the name of *Lycopodium hungaricum*. Pine pollen consists of ovoid grains bearing an enlargement on each side. The drug should not yield more than 4 per cent. of ash (absence of mineral matter). Sulphur may be detected by its solubility in carbon disulphide.

LUPULIN

(Lupulinum)

Source &c.—Lupulin consists of the glands obtained from the strobiles of *Humulus Lupulus*, Linné (N.O. *Urticaceæ*).



FIG. 244.—Hop. *a*, strobile of the Hop, natural size; *b*, bract enfolding at its base a small fruit, and showing lupulin glands, natural size; *c*, fruit magnified. (Tschirch.)

The cone-like, collective fruits of the hop (see p. 152) are known as strobiles, and consist of leafy stipules and bracts, the latter enfolding at their base minute fruits. Both the bases of the bracts and the fruits (to a less degree the stipules) are sprinkled over with bright shining glands which when fresh have a pale greenish yellow colour, which darkens as the hops are kept. These glands can be separated more or less completely by shaking and beating the ripe hops, and they are also detached during the manipulations to which hops are subjected in gathering and drying, and collect together with

sand, debris, and other extraneous matter, on the floors of the hop-kilns. By sweeping the floors and sifting the sweepings, much, if not all, commercial lupulin is obtained.

Description.—Commercial lupulin is a granular, brownish yellow powder with a strong, hop-like odour and bitter, aromatic taste. Examined under the microscope it is seen to be composed of a number of glands, each of which consists of a hemispherical layer of cells, the cuticle of the concave surface of which has been raised, dome-like, by the secretion of oil or oleo-resin between it and the cell-wall. When burst by pressure, which is very easily effected, the gland discharges a granular oily liquid.

Lupulin is generally very impure, as indeed it must be if it represents simply the sifted sweepings of the hop-floors, but the glands themselves are easily recognised under the microscope, and as easily distinguished from accidental (sand, débris of the strobiles, &c.) or intentional impurities.

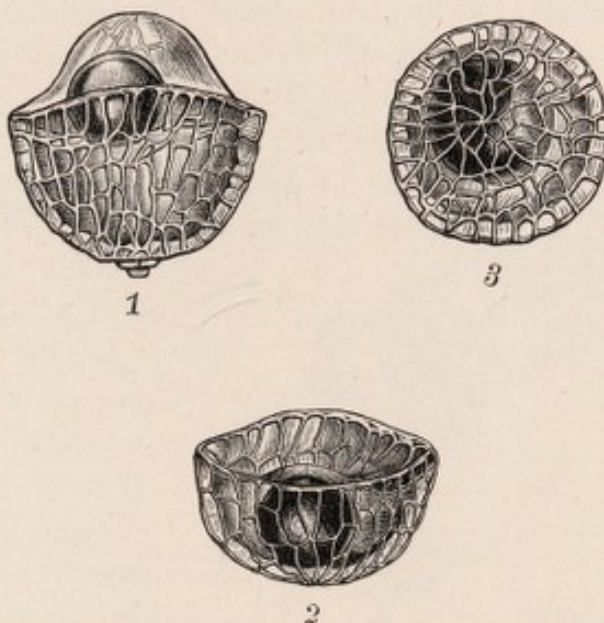


FIG. 245.—Lupulin. 1 and 2, side views; 3, seen from below. Magnified 100 diam. (Vogl.)

Constituents.—Lupulin contains volatile oil, α - and β -lupamaric acids, resin, wax, and traces of alkaloids, volatile acids, &c. Pure lupulin yields to ether about 80 per cent. of its weight, and affords about 2.5 per cent. of ash. Commercial lupulin, however, often gives from 10 to 25 per cent. or even more ash, and yields from 40 to 70 per cent. to ether. The British Pharmacopœia fixes a maximum of 12 per cent. of ash and a minimum of 40 per cent. of substances insoluble in ether.

By keeping, lupulin gradually darkens in colour and acquires an unpleasant odour, said to be due to valerianic acid produced from the resin by oxidation (compare the constituents of hops, p. 153).

Uses.—Lupulin is occasionally employed as a stomachic tonic, and also as an hypnotic to promote sleep.

KAMALA

(Kamala)

Source &c.—Kamala consists of the glands and hairs that cover the fruits of *Mallotus philippinensis*, Müller Argoviensis (N.O. *Euphorbiaceæ*), a small tree widely distributed throughout India, Ceylon, the Malay Archipelago, Australia, &c.

The drug, which has probably been used in India for many centuries as a dye-stuff, was known to the Arabian physicians of the tenth century, and at the present time still retains in the Indian bazaars its Arabic name, *wars*. It was introduced into European medicine as a vermifuge about 1858. It is collected

chiefly in Orissa (south-west of Calcutta), Bengal, and Bombay.

The tree produces three-celled capsular fruits about the size of a large pea, and more or less completely covered with a red powder. These fruits are gathered, dried, and thrown into a basket, where they are shaken and rubbed with the hands; the red powder covering them is detached, and, falling through the basket, is caught on a cloth placed beneath it. This powder, which consists of the



FIG. 246.—Fruits of *Mallotus philippinensis*. Natural size. (Vogl.)

stalked glands and stellate hairs from the surface of the fruits, constitutes the drug.

Description.—Kamala is a fine, granular, mobile powder of a dull red or madder colour, without odour and almost tasteless, floating when thrown on to the surface of water. Alcohol, ether, chloroform, and caustic alkalies are coloured deep red by it, but water has little action on it. That it is not a homogeneous powder can easily be seen by gently shaking it, when a greyish portion (hairs) will aggregate on the surface.

Examined with a microscope, after the removal of most of the colouring matter by solution of potash, kamala will be seen to consist of glands and hairs. The former, which are much smaller than lupulin glands, are of a depressed globular shape; they are filled with a deep red resin, and contain a number of

club-shaped secreting cells radiating from a common centre. The hairs are thick-walled, curved, and usually arranged in small groups.

Constituents.—The most important constituent of kamala is rottlerin (from *Rottlera*, a former generic name of the tree),

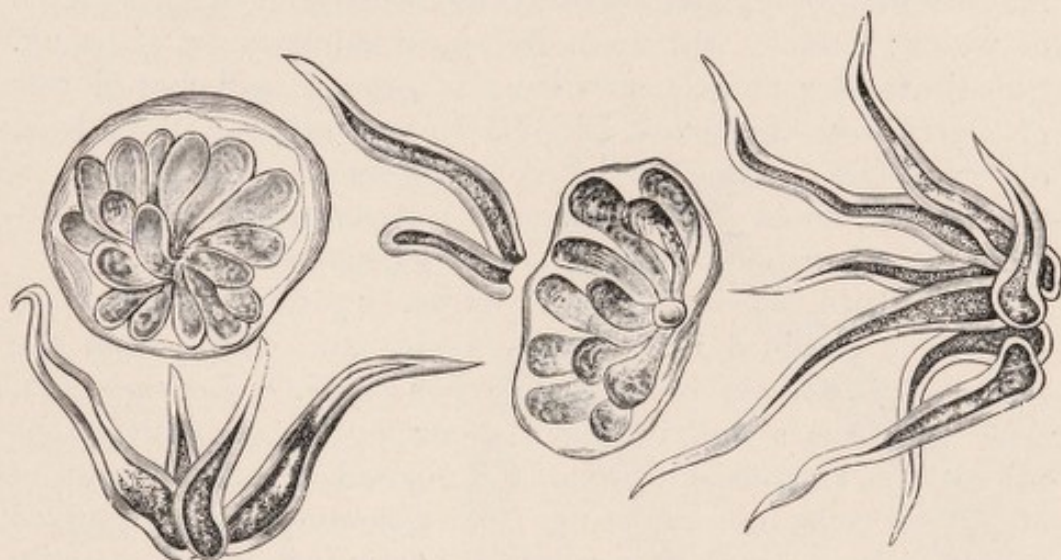


FIG. 247.—Kamala, showing glands with their secreting cells and grouped hairs. Magnified. (Moeller.)

$C_{11}H_{10}O_3$, which crystallises in thin salmon-coloured plates. By treatment with hot caustic alkalis rottlerin yields methylphloroglucin; by reduction with caustic soda and zinc dust dimethylphloroglucin is produced. The same substances may be obtained from koso-toxin and also from filmarone by similar means, thus showing a remarkable analogy between these three vermifuge substances, all of them being derivatives of phloroglucin. The drug also contains a yellow crystalline substance, a red and a yellow resin, and wax. Isorottlerin (Perkin) appears to be impure rottlerin.

If quite pure, kamala yields about 1.5 per cent. of ash, but this amount is usually exceeded by the commercial drug, even

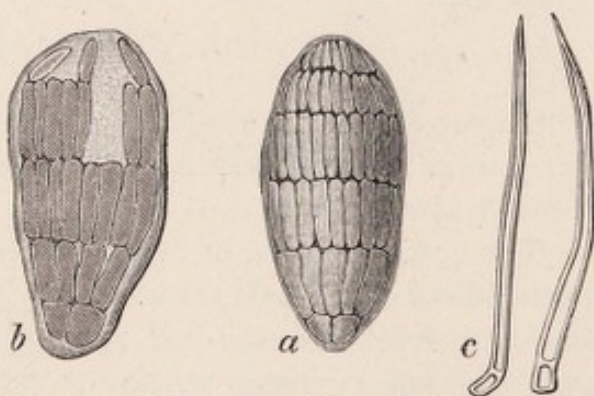


FIG. 248.—Glands (a and b) and hairs (c) of a species of *Flemingia*. Magnified 140 diam. (Vogl.)

when of good quality, from which from 3 to 5 or even 10 per cent. may be obtained.

Adulteration &c.—Kamala is often grossly adulterated with ferric oxide or with a ferruginous sand, inferior qualities of the drug yielding 50 per cent. or even more ash. Its quality may be roughly judged by throwing a little on to the surface of water; kamala will float, but most adulterants will sink. Substitutes for kamala consisting of ground safflower (florets of *Carthāmus tinctorius*, Linné), dyed starch, &c., have been observed, but are easily detected by the microscope.

Use.—Kamala is an efficacious remedy for tapeworm, expelling the worm and producing free purgation.

Substitute.—*True wars* or *wurus*, a drug analogous to kamala, is obtained in Southern Arabia and Africa from the fruits of *Flemingia congesta*, Roxburgh (N.O. *Leguminosæ*). The drug has a dull purplish colour, and is seen under the microscope to consist of glands composed of several tiers of elongated cells (not radiating from a common centre), mixed with which are single (not grouped) hairs; it is therefore easily distinguished from kamala. It contains flemingin, which is analogous to but not identical with rottlerin; red and orange brown resins and homoflemingin are also present in it.

COTTON

(Cotton Wool, *Gossypium*)

Source &c.—Cotton wool consists of the hairs of the seed of *Gossypium barbadense*, Linné (N.O. *Malvaceæ*), and other species of *Gossypium*.

The cotton plants, of which many varieties exist, are either herbs, shrubs, or small trees. They produce three-to-five-celled capsular fruits containing numerous seeds covered with a woolly mass of long white or yellowish hairs. These are separated from the seeds and freed from impurities by machinery specially designed for that purpose.

Each of the hairs thus separated is covered with a thin cuticle by which certain waxy and fatty substances are secreted; the presence of these is objectionable, as they repel moisture, and consequently the wool will only slowly absorb watery fluids. To remove them, the cotton wool is usually boiled

under pressure with a dilute caustic alkali, after which it is washed, bleached by chlorinated lime and hydrochloric acid, again washed and then dried; finally the fibres are loosened by machinery, and separated by a current of air, from which they are collected as a fleecy wool. The wool thus freed from the wax and fat naturally present in it possesses much better absorbent properties and is in most cases more suitable as a surgical dressing (absorbent wool).

Description.—Each of the soft white filaments of which cotton wool consists is a single hair from the surface of the seed. They attain as much as 5 cm. in length, and appear, when examined under the microscope, as flattened, twisted bands with slightly thickened rounded edges. Cotton wool should readily sink in water, showing that the waxy coating with which it is naturally provided has been removed, as directed by the Pharmacopœia; it should not, however, communicate to water either an acid or an alkaline reaction, as

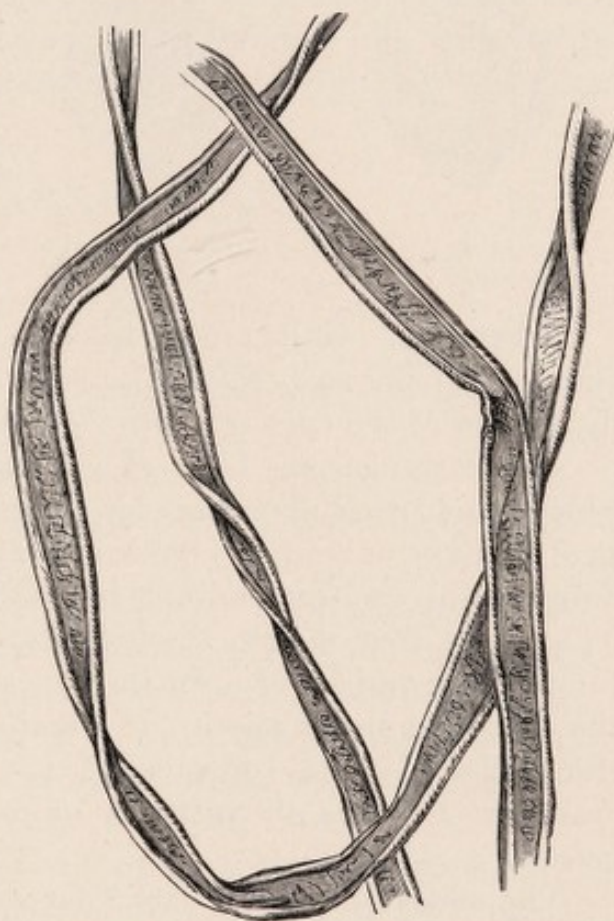


FIG. 249.—Cotton. Magnified. (Tschirch.)

might be the case if it had not been completely freed from the acids and alkalies commonly used to remove the wax. Cotton wool is inodorous, tasteless, and insoluble in water but almost completely soluble in an ammoniacal solution of cupric oxide, the cuticle remaining undissolved. Solutions of iodine colour cotton wool yellow, which is changed to deep blue by sulphuric acid. It burns easily, leaving less than 1 per cent. of ash.

Constituents.—Cotton wool consists principally of cellulose ($C_6H_{10}O_5$)_n, associated with traces of inorganic matter, albu-

minoids &c. The fatty matter is partly a wax soluble in alcohol and ether, and melting at 86° C., partly a mixture (apparently) of stearic and palmitic acids.

Cotton wool is best identified by microscopic examination. It may be distinguished from animal fibres by being insoluble in hot 8 per cent. solution of potassium hydroxide, by not being stained permanently yellow by a solution of picric acid, and by containing only traces of nitrogenous substances. It differs from many other vegetable fibres by the blue colour it yields with iodine and sulphuric acid, but its ultimate identification can be effected only by the microscope.

GALLS

(Galla)

Source &c.—Galls are excrescences on the twigs of *Quercus infectoria*, Olivier (N.O. *Cupulifera*), resulting from the deposition of the eggs of *Cynips gallæ tinctoriæ*, Olivier.

Under the generic term of galls a large variety of excrescences and other abnormal formations are included, that are produced not only upon plants, but also in a few instances upon animals, the exciting cause being either a plant or an animal. The plants that induce the formation of galls are exclusively fungi, but a variety of animals are capable of producing them, the principal being species of *Cynips* and *Aphis*. Thus the true oak-apple, the bedeguar of the rose, the oak gall, oak spangles, &c., are all varieties of galls produced by various insects.

The official drug is a particular variety of gall produced by a particular insect upon a particular plant. This variety of gall is known commercially as 'Aleppo' galls or 'Turkey' galls; they are collected in Asiatic Turkey, especially in the province of Aleppo.

The wasp that produces these galls is *Cynips gallæ tinctoriæ*, Olivier. Of this insect the female only is known, reproduction taking place parthenogenetically. By means of her ovipositor the wasp deposits an egg between the rudimentary leaves near the growing-point of young shoots of the oak. The larva emerges from the egg and wounds the delicate tissue with its mandibles, simultaneously introducing into the

tissue a secretion that stimulates a rapid development of tissue. The new tissue thus formed assumes a concentric arrangement and within this the larva lives, feeding upon starch produced by the cells. Arrived at maturity the larva passes into the pupa stage, from which the wasp emerges and, boring through the gall with its mandibles, escapes. The gall is therefore probably to be regarded as a metamorphosed shoot. Very remarkable is the fact that no development of tissue takes place until a glandular secretion passes from the mandibles of the larva into the surrounding tissue, which is always merismatic in nature; this formation of tissue continues as long as the exciting substance is supplied, but should the larva perish it at once ceases and the growth of the gall is arrested.

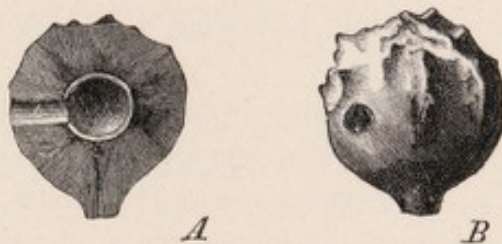


FIG. 250.—Galls. *A*, showing interior; *B*, exterior, both with hole bored by the insect. (Vogl.)

Galls should be collected preferably before the insect escapes; after that has happened they become lighter in weight and are less esteemed.

Description.—Aleppo galls are nearly spherical in shape and vary from 12 to 20 mm. in diameter. They are hard and heavy, and bear, especially in the upper portion, short, bluntly pointed projections. They are of a bluish green or olive green colour externally, yellowish or brownish white within. There is usually a small cavity in the centre, in which the remains of the larva or of the gall-wasp may be found. They have no odour, but an intensely astringent taste followed by a slight sweetness.

Constituents.—Galls contain as principal constituent from 50 to 70 per cent. of tannic acid, which, to distinguish it from other varieties of tannic acid, is termed gallotannic acid. They contain also a little gallic acid (2 to 4 per cent.), ellagic acid, cyclogallipharic acid, sugar, and starch.

Gallotannic acid, the 'tannic acid' of the British Pharmacopœia, $C_{13}H_9O_7 \cdot COOH$, is a pale yellow amorphous substance yielding bluish black precipitates with solutions of ferric salts. Its aqueous solution darkens when exposed to the air with simultaneous formation of gallic acid, $C_7H_6O_5 \cdot H_2O$, and sometimes also of ellagic acid, $C_{14}H_6O_8 \cdot 2H_2O$.

Uses.—Galls are used medicinally as a local astringent chiefly in the form of suppository or ointment. They find an extensive application technically in tanning and dyeing, in the manufacture of ink, &c.

Varieties.—*White galls* are the galls collected after the escape of the gall-wasp; they are rather larger than the 'blue' galls, rather lighter in weight, and yellowish in colour. They are less esteemed, and are considered to contain less gallotannic acid, which, however, does not from analyses appear always to be the case.

Chinese and Japanese galls are produced by *Aphis chinensis*, Bell., on *Rhus semialata*, Murray (N.O. *Anacardiaceæ*); they are of a very irregularly lobed shape, reddish brown in colour, hollow, and covered with a thick, grey, velvety down. They are largely used in the manufacture of gallotannic acid, of which they contain about 70 per cent.

COWHAGE

(*Mucuna*).

Source, &c.—Cowhage consists of the hairs attached to the fruit of *Mucuna pruriens*, de Candolle (N.O. *Leguminosæ*), a climbing plant indigenous to India, Africa, and South America.

The fruit, a small, curved, nearly black legume, is densely covered with stiff yellowish brown hairs which form the commercial drug.

Description.—Cowhage appears in commerce as a yellowish brown, loosely felted mass of hairs with occasional small black portions of the pericarp. Examined under the microscope it is seen to consist of one-celled, thin-walled, sharply pointed hairs which are 2 or 3 mm. long and bear numerous short, often recurved prominences.

Constituents and Use.—The hairs contain a little tannin, but their action as a vermifuge is purely mechanical.

SECTION X

DRIED LATEX

Latex is the name given to the milky liquid contained in laticiferous tissue. This tissue may take the form of elongated, branching cells (Apocynaceæ, Asclepideæ, Urticaceæ, most Euphorbiaceæ) or of superposed cells with intact transverse walls (many Convolvulaceæ) or of superposed cells the transverse walls of which have been perforated, thus forming laticiferous 'vessels' (Papaveraceæ, many Compositæ, Campanulaceæ, Sapotaceæ, some Convolvulaceæ and Euphorbiaceæ, &c.). In addition to water, salts, proteids, pectin, gum, fat, wax, enzymes, &c., the latex frequently contains substances of medicinal or technical value, as, for instance, alkaloids (*Papaver*), caoutchouc (*Hevea*, *Ficus*, &c.), guttapercha (*Palaquium*, *Mimusops*), resin (*Euphorbia*), &c. It is readily exuded by the plant on incision and may thus be collected and dried (opium, lactucarium, euphorbium) or further treated for the isolation of one or more of its constituents (caoutchouc, guttapercha).

OPIUM

Source &c.—Opium consists of the dried latex of the opium poppy, *Papaver somniferum*, Linné (N.O. *Papaveraceæ*). The drug was apparently known in very remote times, as both the Greeks and Romans were well acquainted with it, and with the manner in which it was collected then, as it is now, from the unripe capsule of the opium poppy. The physicians of the Arabian school probably introduced the drug into India as well as into Europe. It was originally used as a medicine, the practice of opium-eating having originated probably in Persia.

Opium is collected principally in European and Asiatic Turkey, in Persia, India, China, and in small quantities in

Australia. The cultivation of the opium poppy has been experimentally carried on in France, Germany, and other countries, where, however, the expense of the necessary labour and land has been so great as to render it unprofitable, although opium of very high quality has been obtained. Indeed, the highest percentage of morphine ever observed in the drug (22.88) was found in a sample collected near Amiens, in France.

All parts of the plant yield on incision a white latex, but the unripe capsule is especially rich, and from it alone opium is obtained. The wall of the capsule contains an elaborate

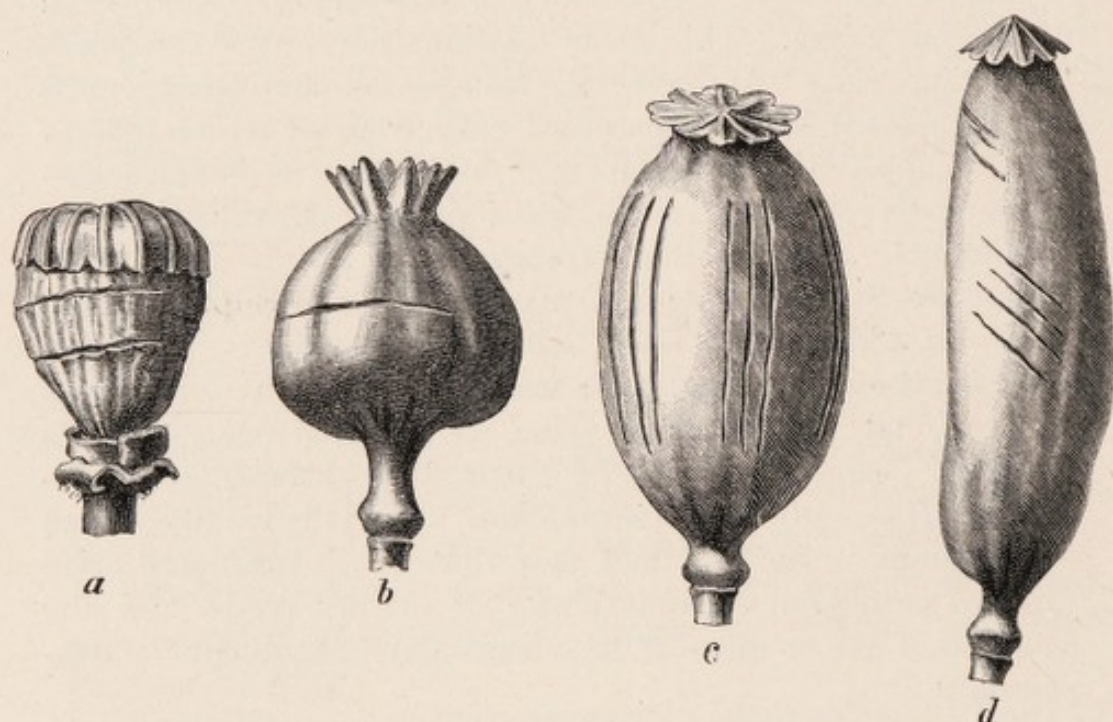


FIG. 251.—Opium. Poppy capsules, showing the different methods of incising. (Vogl, from specimens in the Museum of the Pharmacological Institute, Vienna.)

branching and anastomosing system of laticiferous vessels that accompany generally the fibrovascular bundles; these vessels are filled with a white milky secretion, and, as they are in open communication with one another, a considerable area of the system is drained of its latex when the vessels are incised at any particular point.

Although the methods adopted in the different countries for collecting the opium vary in their minor details, the principal features remain the same; in India alone a particular method of treating the opium is adopted. Soon after the petals have

fallen, and whilst the capsule is still unripe, being about 4 cm. in diameter, incisions are made in the wall, great care being taken that they do not penetrate to the interior of the fruit, for then both opium would be lost and the seeds prevented from ripening; the latter have a commercial value, for they contain a fixed oil which they yield when submitted to pressure.

The incisions are sometimes limited to a single transverse one extending round the capsule (Asia Minor); sometimes they are oblique or vertical and two or three together (India), or the method adopted varies in different districts of the same country.

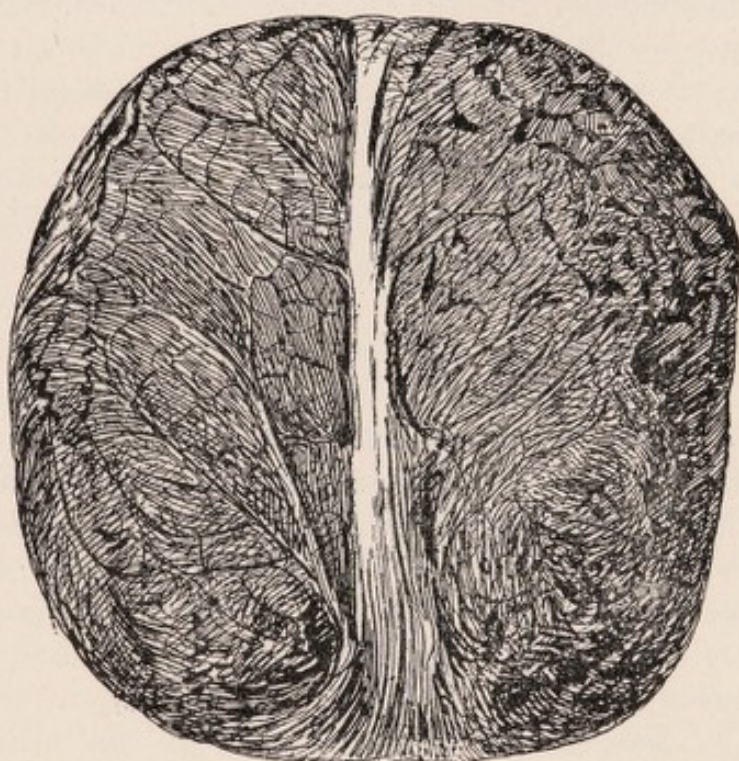


FIG. 252.—Turkey Opium. Slightly reduced. (*Pharmaceutical Journal*.)

Sometimes the capsules are cut once only, sometimes they are subjected after a short lapse of time to a second and third cutting. This is usually done in the afternoon, and on the following morning the latex that has exuded and partially dried is scraped off with a knife. The scrapings are united, and as soon as sufficient has been collected it is formed into a cake which is partially dried by exposure to the sun.

These cakes are wrapped in poppy leaves (Asia Minor) or paper (Persia, India), and are then ready for exportation.

Varieties of Opium.—1. *Turkey*.—This variety of opium is obtained in both European and Asiatic Turkey. In the

former, Macedonia produces increasing quantities of opium which are exported from Salonica, and the cultivation is being pushed forward in Bulgaria; in Asiatic Turkey, the central and north-western districts yield the bulk of the drug, which is sent chiefly from Constantinople and Smyrna.

Turkey opium occurs in flattened cakes varying commonly from $\frac{1}{4}$ to 1 kilogramme in weight, although they may be larger as well as smaller. They are covered with a greyish green leaf of the poppy plant, the broad midrib of which is usually conspicuous, and are sprinkled over with the brown, triangular, winged fruits of a species of *Rumex*. These are thrown amongst the cakes by the opium merchants to prevent them from sticking together when packed in cases (' chests ') for shipment.

When fresh the drug is plastic; internally, it has a rich reddish brown colour of varying depth, and is coarsely granular. It has a strong characteristic and not unpleasant odour and a bitter taste.

Several subvarieties of Turkey opium are recognised on the market. The most important of these are the Karahissar, Ghiveh, and Boghaditz opiums, which are largely used by pharmacists. Salonica, Tokat, and Malatia opiums are known as ' soft shipping ' opiums; as the name indicates, the paste is soft; they are chiefly exported to the United States, the West Indies, Central and South America. Yerli opium is also soft; it is largely used for the manufacture of morphine.

2. *Persian Opium* is produced most largely in the neighbourhood of Ispahan and Shiraz in the west and near Meshed in the north-east. After collection the opium is kneaded into a homogeneous mass, which is then divided into short, bluntly conical masses weighing from 200 to 400 grammes each, wrapped in paper stamped with the name of the merchant or into brickshaped masses about 20 cm. long, which are wrapped in red paper and tied round with red string. Occasionally it is formed into short sticks or flat cakes, but these are seldom seen. It is usually of a dark brown colour internally and quite homogeneous, not exhibiting the granular appearance that characterises Turkey opium; this is doubtless due to the method of preparation.

The bulk of the opium imported into England consists of the Turkey and Persian drugs; the latter is largely exported to

South America and elsewhere for smoking, but when sufficiently cheap is used for the manufacture of morphine.

3. *Indian Opium*.—The chief opium-producing districts in India are the central districts of the Ganges, including Behar, Benares, and Patna, and the tablelands of Malwa which lie to the north-east of Bombay, most of the drug being produced by licensed cultivators and purchased by the Government. That which is destined for use in India is dried in the sun until the moisture in it is reduced to 10 per cent., and then made into flat cakes (Bengal abkari opium) or round balls (Malwa opium) and wrapped in oiled paper. But for the Chinese market, which takes nearly all the opium produced in India, it is formed into round balls which are enveloped in cases made of dried poppy petals, opium, and water, each cake with its shell resembling a Dutch cheese in size and shape.¹

4. *Chinese Opium*.—China produces large and increasing quantities of opium, which, however, are entirely consumed in the country and not exported.

Constituents.—Amongst the numerous constituents of opium the most important are the alkaloids it contains. Of these no fewer than twenty-one have been reported, but the existence of some of these in the drug is open to considerable doubt. Chief of them, both in its medicinal importance and in the quantity in which it exists, is morphine; narcotine and codeine are of secondary importance, and next to these come thebaine, narceine, and papaverine.²

Morphine, $C_{17}H_{19}NO_3 \cdot H_2O$ (or $C_{17}H_{17}NO_2 \begin{smallmatrix} OH \\ \diagup \\ OH \end{smallmatrix} + H_2O$), forms colourless crystals, very slightly soluble in cold water but readily in solutions of caustic alkalies or alkaline earths; it is almost insoluble in cold ether, chloroform, or benzene. Heated with hydrochloric acid in a sealed tube to 140° – 150° C., it is partly converted into apomorphine ($C_{17}H_{17}NO_2$). Morphine is a powerful hypnotic, but apomorphine in addition to a hypnotic action produces a powerful emetic effect.

Codeine, $C_{18}H_{21}NO_3$, or methyl morphine ($C_{17}H_{17}NO_2 \begin{smallmatrix} OH \\ \diagup \\ OCH_3 \end{smallmatrix}$) is usually obtained from the mother liquors from which morphine

¹ Details of the process will be found in the *Pharmacographia Indica*.

² For a complete list and a table of the reactions by which they may be distinguished, Allen's *Commercial Organic Analysis*, vol. iii. part ii., may be consulted.

has been crystallised, but can also be prepared by heating morphine with sodium hydroxide and methyl iodide. It forms large rhombic crystals soluble in 80 parts of water and readily soluble in chloroform. It is a strong base, and is liberated from its salts by fixed alkalies but not by ammonia. It has only a mild hypnotic action.

Narcotine, $C_{22}H_{23}NO_7$ or $C_{19}H_{14}(OCH_3)_3NO_4$, crystallises readily in rhombic prisms or needles, and may be extracted from the residue left after treating opium with water; it is a weak base and has little or no narcotic action, hence it has also been called 'anarcotine.'

All these are well-defined, crystalline alkaloids, and together constitute in good dry opium about one-fifth of the weight of the drug.

Amongst the other constituents attention must be directed to meconic acid, $HC_7H_3O_7 \cdot 3H_2O$, a crystalline organic acid that exists to the extent of about 5 per cent. combined with morphine; this well characterised and easily identified acid is important in toxicological investigations as corroborative of the presence of opium.

Meconin and meconoiosin are two indifferent substances and exist in small quantity only.

Mucilage, sugar, wax, caoutchouc, and salts of calcium and magnesium are also contained in opium, but starch, tannin, oxalic acid, and fat, all of which are common constituents of plants, are not found in it, and their presence therefore indicates adulteration of the drug.

The proportion of water contained in opium varies from 7 to 24 per cent., freshly imported Turkey opium often containing about 20 per cent. Good Turkey opium yields from 4 to 8 per cent. of ash and from 55 to 65 (usually over 60) per cent. of dry aqueous extract (calculated in each case upon the dry opium).

The quality of opium is, however, determined almost exclusively by the proportion of morphine it contains. Good Turkey opium yields from about 12 to 18 per cent. of morphine (calculated upon the dry drug), but is subject, of course, to considerable variation. Persian opium is less rich in morphine, and contains, when of good quality, from 8 to 12 per cent.; in exceptional cases 16 and even 19 per cent. has been recorded. Indian opium is invariably poorer, and has not been found to exceed 8.5 per cent., varying usually from 4 to 7 per cent. Chinese opium has been shown to contain from 4.3 to 11.2

per cent. The alkaloid certainly exists in combination with acids (probably partly with meconic, partly with sulphuric acid), and is easily and completely extracted by water.

Narcotine varies usually from about 2 to 8 per cent., although the latter figure is occasionally exceeded. It appears to occur in larger proportion in Indian and Persian opium than it does in Turkey, and to exist chiefly in the free state, it being a weak base. Codeine exists in proportions ranging from 0·3 to 1·9 per cent. in combination with acids. Thebaine varies from 0·2 to 0·5 per cent., narceine 0·1 to 0·4 per cent. The remaining alkaloids constitute together about 1 per cent. of the drug.

For the preparation of tincture and extract of opium which are standardised to contain 0·70 to 0·80 and 20 per cent. of morphine respectively any suitable variety of opium may be used provided it contains, when dry, not less than 7·5 per cent. of morphine, but for other official uses opium must contain between 9·5 and 10·5 per cent. of morphine, and opium containing more than 10 per cent. may be diluted with opium containing between 7·5 and 10 per cent. or with milk sugar. Hence any opium containing over 7·5 per cent. of morphine may be officially used, the strength being adjusted by suitable blending. This permission was apparently given with the view of favouring the importation of the best varieties of Indian opium, but the result has been inappreciable. Turkey opium, on the other hand, is frequently diluted to contain about 10 per cent. of morphine before exportation.

The necessarily high price of the drug and its nature invite adulteration, which is accordingly frequently practised. Stones, small shot, pieces of lead, and such substances are frequently found in opium. Gum, grape must, sugary fruits, &c., are said to be frequently added to it. The percentage of morphine, the ash, moisture, and residue insoluble in water all give valuable indications, the last-named excluding the sugary pulp of apricots and other fruits. The insoluble residue will contain portions of the outer epidermis of the poppy capsule, but not of the inner (absence of powdered capsules); such fragments are more frequent in Turkey than in Indian opium, the former, obtained usually from a horizontal incision, requiring more scraping than the latter, in which the opium collects at the bottom of a vertical incision. Starch should not be present in

appreciable quantity ; it is, however, regularly found in Persian opium (Mjoen, 1895), and traces are said to be frequently present in Turkey opium (Cæsar and Loretz, 1898) but not in quantity sufficient to constitute an adulteration.

Assay.—Opium may be assayed by the official process.

Uses.—Opium is one of the most valuable of drugs. It is unexcelled as an hypnotic and sedative, and is frequently administered to relieve pain and calm excitement. It is also used as an astringent in diarrhœa and dysentery, and as a sedative in certain forms of cough, dyspnœa, &c.

LACTUCARIUM

Source &c.—Lactucarium consists of the dried latex of *Lactuca virosa*, Linné (N.O. *Compositæ*), and other species of *Lactuca*. *Lactuca virosa* is a native of Central and Southern Europe, but is cultivated in England.

All the plants belonging to the sub-order *Ligulifloræ*, in which the genus *Lactuca* is included, contain a system of latiferous vessels forming an anastomosing network penetrating to all parts of the plant (compare fig. 193). They are especially numerous in the bast of the stem, but are present also in the pith. Hence when the stem of *L. virosa* is wounded a free exudation of latex takes place, in the form of white milky fluid of intensely bitter taste. This latex when dried constitutes the drug. It is collected in Germany near Zell on the Mosel, where most of the commercial drug is produced, by cutting the stem off about a foot below the summit ; the latex which exudes is taken off by the finger and transferred to a china cup. It soon coagulates and is then removed from the cup by warming and gently tapping, when it falls out in the shape of a blunt cone which is cut into four pieces and dried. Every morning a thin slice is taken off the stem and the collection of lactucarium thus proceeds during the summer.

Description.—German lactucarium occurs in hard, opaque, irregular, angular pieces, sometimes flat or curved on one or two of their sides, of a dingy brown or reddish brown colour. In the interior they are paler, if quite fresh creamy white and of the consistence of wax ; but the colour changes by exposure to a dull brown, the drug becoming at the same time hard. They

possess a strong characteristic odour, different from but recalling that of opium, and a bitter taste.

Lactucarium is tough and difficult to powder. Boiled in water it softens to a plastic mass, but only very little of it is soluble. The cooled and filtered liquid should not be coloured blue by iodine, indicating the absence of starch, which has been found in factitious lactucarium, but, as Composite plants contain no starch, this should not be present in the genuine drug. Lactucarium is only partially soluble in alcohol and ether.

Constituents.—It appears doubtful whether lactucarium possesses any particular therapeutic action, although it has been used as a sedative. Lactucin, lactucic acid (crystalline), and lactucopierin (amorphous) are three bitter principles, the re-examination of which is to be desired. Lactucerin (lactucone), constituting about one-half of the drug, and extracted from it by boiling alcohol, is a crystalline, tasteless, inert, waxy substance, yielding by saponification acetic acid and lactucol (or, according to Hesse, α - and β -lactucerol).

In addition to these constituents, that are apparently peculiar to lactucarium, various other substances commonly found in the latex of plants have been detected, such as caoutchouc, albumen, mannite, certain inorganic substances, &c.

The alkaloid hyoscyamine, which Dymond detected in both wild and cultivated lettuce, especially when the flowering stage is reached, and to which possibly any sedative action of the fresh plant might be due, could not be found in lactucarium.

Use.—Lactucarium has been used as a sedative, but is now not much employed.

GUTTAPERCHA

Source &c.—Guttapercha is obtained from the latex of several species of *Palauquium* and *Payena* (N.O. *Sapotaceæ*), the principal being *P. oblongifolium*, Burck, *P. borneense*, Burck, *P. Leerii*, Burck, and *P. Treubii*, Burck, all of which are stately trees indigenous to the Malay Archipelago. They contain in the bast, as well as in the cortical parenchyma of the stem, extending into the mesophyll of the leaves, numerous superposed, elongated, laticiferous cells which are filled with

a granular latex. It is this latex that forms, when properly prepared, guttapercha. To that end the trees with a trunk about 30 cm. in diameter are felled, the branches stripped off, and transverse or oblique channels cut in the bark. Into these the latex is discharged, and in them it coagulates. This coagulation is apparently due to the coagulation of an albumin in the latex by which the separate particles of guttapercha are entangled and retained. The coagulated latex is then scraped from the incision, kneaded under hot water to free it from accidental impurities, beaten with mallets, and finally made into cakes which are bought up by Chinese merchants.

At present Sumatra yields the bulk of commercial guttapercha, but the destructive and wasteful method of collection has led to numerous endeavours to cultivate the trees and obtain from them the guttapercha by a more rational method. These endeavours have met with some success. Burck has shown that by making V-shaped incisions in the living tree large quantities of guttapercha can be obtained, and that the tapping can be continued for three or four years without apparent injury to the tree. It has also been found that the leaves contain more guttapercha than the stem-bark, and that it can be extracted by boiling the dried and crushed leaves with a suitable solvent, such as toluene or petroleum spirit; from the latter solution the pure guttapercha is deposited on cooling (Obach's process). Not only could the trees be preserved by this means, but the stools of trees that have already been felled send up shoots, the leaves of which could be utilised, although the stems are too young to fell. The guttapercha obtained by this means is, however, not equal to that produced by incision, and the process has not yet established itself.

The yield by felling has been variously computed at about 300 to 600 gm. from each tree, whereas by tapping 1,400 gm. has been obtained annually; the leaves are said to yield 10 per cent. of their weight.

Description.—Crude guttapercha occurs in commerce in lumps or blocks of very variable, often large size, of a brown or greyish brown colour externally, reddish yellow or reddish grey internally, and of laminated or fibrous nature. It has an odour that is not disagreeable (especially when rubbed), and it is flexible though scarcely elastic. It often contains mechanical impurities, from which it is freed by slicing and washing it and pressing

it whilst plastic through wire gauze, or by softening in hot water and rolling into strips; these are then torn by machinery into shreds and the shreds kneaded into dark-brown lumps (purified guttapercha).

White guttapercha is prepared by dissolving purified guttapercha in chloroform, decolorising the solution with charcoal, filtering, and precipitating with alcohol.

Purified guttapercha is firm, tough, and flexible, but scarcely elastic; it can be cut easily with a knife, and at a temperature of 45°–60° C. it softens and can be rolled or drawn. It is soluble in chloroform and carbon disulphide in the cold; turpentine and benzol dissolve it when warmed, alcohol and ether only partially, whilst caustic alkalies and dilute acids have no action upon it. It is a very bad conductor of heat and electricity, and upon the latter fact depends its extensive use as an insulator.

Constituents.—The principal constituent of guttapercha is a hydrocarbon, gutta, $C_{30}H_{48}$; with this are associated several crystalline substances which have been grouped into three series, viz. albans, fluavils, and albanans. Guttapercha also contains tannin, salts, substances resembling sugar, and an unstable substance, guttan.

Gutta is white when pure, and has been obtained in minute crystals; on exposure to the air it gradually assumes a reddish colour.

The albans are soluble in boiling alcohol, but not in cold; they are crystalline, and are distinguished by the prefixes α , β , γ , &c.; they yield by hydrolysis with alcoholic potash the corresponding alcohol, albaresinol, together with cinnamic acid.

The fluavils are soluble in cold alcohol; they are also crystalline, are similarly distinguished, and yield an alcohol and cinnamic acid when saponified.

The albanans are insoluble both in cold and hot alcohol.

As the albans &c. from different varieties of guttapercha are not identical these substances are further distinguished by a prefix indicating their source; thus those obtained from commercial (Sumatra) guttapercha are termed 'sumalbans,' 'sumafluavils,' &c.

The quality of commercial guttapercha is judged by exhausting with ether or petroleum spirit and determining the resins (albans, fluavils, &c.) which dissolve, then removing the gutta with chloroform, and weighing the insoluble residue.

Uses.—Apart from the varied technical uses of guttapercha a solution of that substance in chloroform is used to form a protective covering on the skin or as a means of applying various remedies.

CAOUTCHOUC

Source &c.—Caoutchouc is a substance contained in the latex of a large number of plants, especially of those belonging to the natural orders *Euphorbiaceæ*, *Urticaceæ*, and *Apocynaceæ*, but it is by no means confined to these. Indeed, it is so widely distributed that in all cases the latex of plants appears to contain caoutchouc or some similar substance as a constant constituent. Many secrete it in such quantity as to form suitable sources for its commercial extraction. Commercial caoutchouc, however, always consists of caoutchouc associated with fat, resin, &c., and is best termed 'rubber.'

Pará rubber, which variety is alone official, is obtained from *Hevëa brasiliensis*, Müller Argoviensis, and probably other species (N.O. *Euphorbiaceæ*), a large tree widely distributed in the basin of the Amazon and the low ground flanking its tributaries, the Madeira, Purus, Jurna, &c. The tree is also largely cultivated in Ceylon, the Straits Settlements, &c.

In the collection of the latex, spiral, herring-bone or isolated incisions are made in the bark of the trunk and the latex collected. This latex consists of globules of caoutchouc with small quantities of other bodies held in suspension by proteid substances; it is treated in various ways for the production of rubber.

In Brazil the small tin cups in which the latex has been collected are emptied into calabashes which the collector carries to his hut. Here he has a pole, about the length of a broomstick and thickened for a few decimetres at a little distance from one end, supported horizontally on a cross-bar. Under the thickened portion a clay dome, or sheet iron cone, is placed in which a fire is kindled on to which palm nuts are thrown. The latex is emptied into a large basin and a little is poured by means of a dipper on to the thickened part of the pole. This is now rotated in the dense smoke of the burning nuts. The latex is rapidly coagulated by the acetic acid in the smoke to a layer about 1 mm. thick, the creosote and

other tarry substances from the smoke acting as preservatives. The coating and coagulation is repeated again and again until a short, thick, cylindrical mass weighing usually from 3 to 30 kilogrammes, but sometimes much more, has been obtained. The pole is then removed and the ball hung up to dry. In this way 'ball' Pará rubber is obtained. Sometimes a paddle, which may be dipped into the latex, is used instead of a pole and the rubber removed by slitting it along one side; this gives 'spade,' 'paddle,' or 'biscuit' Pará rubber. Pará rubber,



FIG. 253.—Sampling Pará rubber; in the centre balls of Pará rubber cut transversely, showing the central hole.

therefore, consists of the latex dried after coagulation, and contains in addition to caoutchouc all the other constituents of the latex (except water). The coagulation is probably due to precipitation of part of the albumin by the acetic acid of the smoke. The latex contains about 40 per cent. of caoutchouc, 2·8 per cent. of proteids, and 55 per cent. of water.

Description.—Pará rubber occurs in commerce in elastic, rounded, cylindrical, or flattened masses of varying size and shape, and of characteristic odour. Externally they are of a uniform brownish black colour, but internally they exhibit under

a lens a large number of very thin yellowish layers separated by dark lines, each layer representing a coat of coagulated latex. The drug is insoluble in water, alkalies, or dilute acid, but chloroform, oil of turpentine, carbon bisulphide, and benzol make it swell and become soft and gelatinous, the caoutchouc dissolving and leaving a gelatinous substance undissolved. Digestion with alcohol removes from Pará rubber about 1.5 per cent. of resin, but inferior rubbers may yield much more.

Constituents.—Pará rubber contains from 40 to 60 per cent. of the hydrocarbon caoutchouc (caoutchouc-gutta) which when quite pure is white and corresponds in composition to the empirical formula $(C_{10}H_{16})_n$; it is a very unstable body and rapidly oxidises. In Pará rubber it is associated with 30 to 50 per cent. of the gelatinous substance which probably protects the caoutchouc from change; small quantities of resin, fat, colouring and mineral matter are also present. Good rubber always contains a considerable amount of the gelatinous substance and only small quantities of resin &c.; in poor rubbers the reverse is the case.

Varieties.—*Ceylon or Plantation Rubber.*—This now forms a very important commercial article, the production of which is rapidly increasing. The latex is coagulated by allowing it to stand for a few hours, with or without the addition of a little acid, and the coagulum is put into a washing-machine consisting of a pair of very heavy corrugated cylinders over which water is poured. The rubber globules are united by this treatment and come from the machine in the form of thin, crinkled sheets (crêpe rubber) which are hung up to dry. Sometimes the coagulum is passed through a machine which presses the rubber into small vermiform pieces; these are afterwards submitted to heavy pressure which converts them into 'block' rubber. Such rubber is of course free from the proteids and other substances present in the Pará rubber. It usually occurs in large thin sheets of a pale yellow or brownish black colour or in translucent dark brown or golden brown blocks about 4 cm. thick.

The description of the numerous other commercial varieties of rubber would be far beyond the scope of this work, but the following may be briefly noticed as illustrating the various methods of preparation and the varying appearance of this important and interesting substance:—

Assam Rubber from *Ficus elastica*, Roxburgh (N.O. *Urticaceæ*); the latex is coagulated by boiling and formed into dark red lumps which are compacted into larger masses.

Mangabeira Rubber from *Hancornia speciosa*, Müller Argoviensis (N.O. *Apocynaceæ*); collected in Eastern Brazil, the latex being coagulated with alum or salt water. It occurs in large, flat, pinkish white pieces often very wet from presence of salt water.

Central American Rubber from *Castilloa elastica*, Cervantes (N.O. *Urticaceæ*); the latex is coagulated with salt or sodium bicarbonate or with an infusion of various plants; the masses of coagulum are pressed together into slabs composed of black, wavy sheets.

West African Rubber. The latex of *Funtumia* (*Kickxia*) *elastica*, Stapf (N.O. *Apocynaceæ*), is coagulated by boiling or by pouring it into cavities in the trunk of the tree. That of *Landolphia florida*, Bentham (N.O. *Apocynaceæ*), is smeared by the natives over their bodies, and after drying rolled into balls.

Mozambique Rubber from *Landolphia Kirkii*, Dyer (N.O. *Apocynaceæ*), occurs in balls or in sausage-shaped masses consisting of strings of rubber wound round a little wooden spindle.

Ceara Rubber from *Manihot Glaziovii*, Müller Argoviensis (N.O. *Euphorbiaceæ*). The bark is shaved off until the latex trickles down the trunk; it is allowed to dry, peeled off in strings and rolled into balls.

SECTION XI

DRIED JUICES

A number of plants exude on incision liquids that have been contained in certain specialised cells. These liquids differ in their composition from the latex contained in laticiferous tissue and also from the oil, oleo-resin, or oleo-resinous emulsions secreted in cells, glands, or ducts. Some of them contain substances of medicinal value, as, for instance, various species of *Aloë*, *Eucalyptus*, &c.; these yield when dried drugs that, for want of a better term, have been designated dried juices. In many cases tannin forms the chief constituent as it does in the various kinos; in others, particular substances not produced in other natural orders or even genera are found, such as aloin.

ALOES

(*Aloë*)

Source &c.—Aloes is officially described as the juice that flows from the transversely cut leaves of certain species of *Aloë* (N.O. *Liliaceæ*) evaporated to dryness.

The aloe plants are indigenous to Eastern and Southern Africa, but have been introduced into other tropical countries, as for instance the West Indies, and will flourish even in Southern Europe. They produce spikes of yellow or red flowers and large fleshy leaves resembling those of the American agave, an ornamental plant commonly grown in this country and often erroneously called an aloe.

The leaf which is fleshy and mucilaginous in its interior, contains near the epidermis a row of isolated, fibrovascular bundles each of which is surrounded by an endodermis. The cells of the pericycle and sometimes of the neighbouring parenchyma are unusually large, and filled with a yellow

liquid, the aloetic juice. When the leaves are cut from the plant this juice drains from the cells containing it. Probably the transverse walls of the elongated and axially arranged cells give way under the pressure exerted upon them by the surrounding tissue, and thus the aloetic juice is drained from cells situated at a considerable distance from the incision.

Little or nothing flows from the mucilaginous tissue in the centre of the leaf, and as it contains no aloetic juice no effort is or should be made to obtain it; in fact, its presence would lower the quality of the aloes.

The drug is obtained chiefly from Eastern and Southern Africa and from the West Indies. The means by which it is prepared are probably practically identical in all three countries. The leaves are cut from the plant and placed so that the juice that drains from the aloetic cells may be received in any convenient vessel. This juice is then concentrated, either (probably) by allowing it to evaporate spontaneously (Socotrine aloes) or by boiling it until it has reached the desired consistence, when it is poured into boxes or gourds (West Indian aloes) or skins (Zanzibar aloes) and allowed to solidify.

The manner in which this operation is performed has a remarkable influence on the physical characters of the aloes. If the juice is rapidly concentrated, the concentration carried

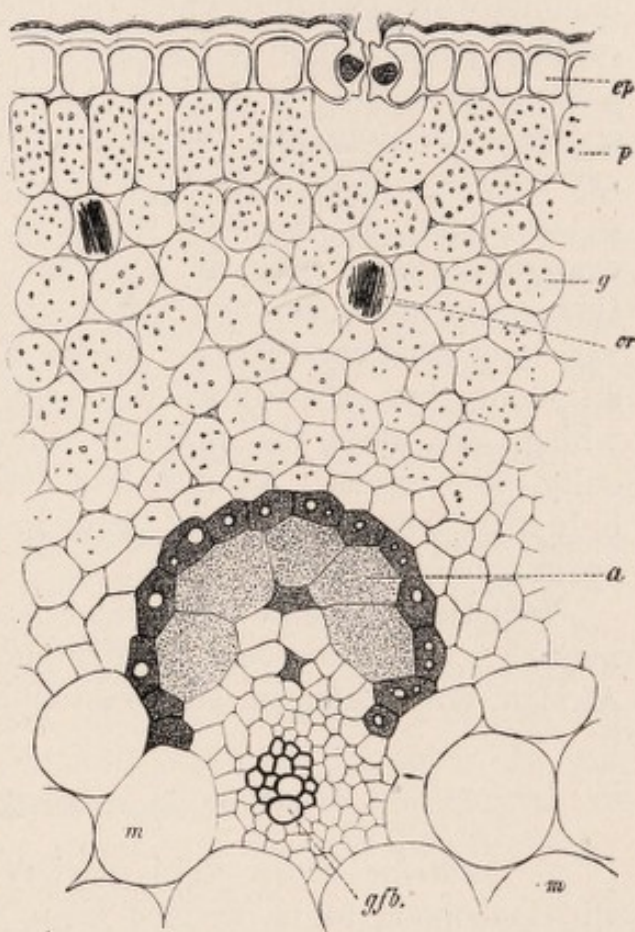


FIG. 254.—Transverse section near the margin of an Aloe leaf. *ep*, epidermis; *gfb*, vascular bundle, the pericyclic cells, *a*, of which are much enlarged and contain a yellow secretion (aloes); *cr*, calcium oxalate crystals; *m*, mucilaginous parenchyma. (Magnified.) (Tschirch.)

as far as practicable, and the resulting aloes quickly cooled, a drug is obtained that breaks with a vitreous or glassy fracture, and in small splinters is quite homogeneous and transparent even when examined under the microscope. Such an aloes is termed a 'vitreous,' 'lucid,' or 'glassy' aloes. But if the evaporation is carried on slowly and not quite so far as in the preceding case, a drug is obtained that is opaque and exhibits when examined under the microscope minute prismatic crystals embedded in a transparent resinous mass. Such an aloes is termed 'hepatic' or 'livery.' The crystals that it contains are aloin, and the reason why in this case the aloin crystallises, whilst in the vitreous aloes it does not, is probably to be found in the fact that the conditions under which evaporation takes place are more favourable to crystallisation, this is also influenced by the facility with which the particular variety of aloin crystallises. Hence Natal aloes, which contains an aloin that crystallises with extreme facility, is opaque, whilst Cape aloes, the aloin in which crystallises with difficulty, is vitreous. Nevertheless every variety of aloes not only may, but actually does, occur in both the vitreous and the opaque modification.

Varieties of Aloes.—The chief commercial varieties of aloes may be conveniently considered under three heads, viz.: East African, South African, and West Indian.

EAST AFRICAN ALOES

1. *Socotrine Aloes*.—This variety is stated in the British Pharmacopœia to be derived from *Aloë Perryi*, Baker, and probably other species. It is brought by Arab traders from the east coast of Africa, the island of Socotra (600 miles west of Aden), and possibly also from the coast of Arabia, to Bombay, whence it is exported to Europe. It arrives usually in kegs or tins, or occasionally in large barrels, and commonly has a pasty, semi-liquid, or even treacly consistence. It is then of a brownish yellow colour and quite opaque, but if not too viscid it separates on standing into a clear, dark brown, supernatant liquid and a dark yellow sediment which under the microscope is seen to consist of minute prismatic crystals (aloin). The odour of the fresh aloes is usually remarkably unpleasant, but this may change when the aloes is kept under certain (not at

present precisely known) conditions to a rather agreeable fragrance that has been compared to myrrh and saffron.

As this variety of aloes contains a varying amount of water, and is not, as imported, in a suitable condition for use in pharmacy, it must be dried at a gentle heat, best by exposing it in wooden trays in a warm room. It then forms hard, dark brown or sometimes, if dried at too high a temperature, nearly black masses, breaking with a dull, waxy, uneven, often porous fracture, and possessing a strong, characteristic unpleasant odour and an extremely bitter, nauseous taste. It should be almost entirely soluble in alcohol, and yield about half its weight to cold water. Small splinters are opaque, but mounted in a drop of almond oil and examined under the microscope they exhibit numerous minute prismatic crystals (of aloin) embedded in a transparent, dark yellowish brown mass. This aloes therefore belongs to the class of aloes known as livery or hepatic aloes. From other aloes it may be distinguished by moistening a little of the powder with nitric acid, when a reddish or yellowish brown colour is produced.

2. *Zanzibar Aloes*, which is sometimes regarded as a variety of Socotrine, is commonly poured into goat (so-called 'monkey') skins which are then packed in cases. It is usually hard, but is sometimes soft, and then the contents of the case become compacted into a solid mass. It has a liver-brown colour, and a dull waxy, but nearly smooth and even fracture. In this respect it differs from the foregoing, which breaks with an uneven fracture, as it does also in its odour, which is characteristic and strong but not disagreeable.

Both the foregoing varieties of aloes are usually hepatic, a fact that points to a slow concentration of the aloe juice, possibly by spontaneous evaporation. Both occur also in the vitreous variety, but East African aloes is seldom imported in this condition.

SOUTH AFRICAN ALOES

3. *Cape Aloes*.—Large quantities of aloes of excellent quality are exported from Mossel Bay and Cape Town in Cape Colony. It is obtained from *Aloë ferox*, Miller, a species widely distributed in South Africa and often occurring in considerable quantity. The aloe juice is collected in goat-skins covering a

hollow in the ground around which the cut leaves are piled ; from these it is transferred to tins, and finally boiled down over a naked fire in iron pans. This variety of aloes, which is preferred in Austria and Germany, occurs in masses of a dark reddish brown or nearly black colour, often with a greenish tinge, and breaking with a clean, glassy fracture. Thin splinters are perfectly transparent, of a reddish brown or amber-yellow colour, and exhibit no trace of crystals when examined under the microscope. It belongs therefore to the class of glassy, lucid, or vitreous aloes, and may be easily distinguished from all other glassy aloes by its very distinctive sour odour and by the pale yellow colour of its powder.

Recently the aloe juice has been allowed to undergo slight fermentation and then dried in shallow troughs exposed to the sun's heat. This aloes is known as Crown and also as 'Uganda' aloes, the latter being a very misleading fancy name ; it occurs in bricks or fragments of a yellowish brown colour and bronze-gold fracture ; it has the odour of Cape aloes but is distinctly an hepatic aloes.

4. *Natal Aloes*.—The botanical source of this variety of aloes, which is seldom imported, has not yet been definitely ascertained.

Natal aloes is almost always opaque, and has a characteristic dull greenish black or dull brown colour. In odour it closely resembles Cape aloes, and it may therefore be easily distinguished from all other opaque aloes by this character alone. It yields when scraped a pale greyish green or sometimes pale yellowish powder, and when this is mixed with a little sulphuric acid and the vapour of nitric acid blown over it, a deep blue colouration is produced.

These last three characters are so distinctive that Natal aloes is one of the easiest to identify.

WEST INDIAN ALOES

5. *Barbados Aloes*.—But very little aloes is now produced in the island of Barbados, and that which bears this name is in reality prepared in the Dutch islands of Curaçao, Aruba, and Bonaire ; it is therefore, often and more appropriately, termed Curaçao aloes. The plant which yields it appears to be *Aloë vera*, Linné, or possibly *A. chinensis*, Baker.

Curaçao or Barbados aloes arrives usually in boxes, sometimes in gourds. It occurs in the glassy as well as in the livery variety; the former, commercially known as 'Capey' Barbados, may become opaque on keeping, a change to be ascribed to the slow crystallisation of the aloin. It is also by no means uncommon to find packages that are partly filled with glassy, partly with opaque, aloes; such differences in the appearance are probably due to slight differences in the mode of evaporating the juice.

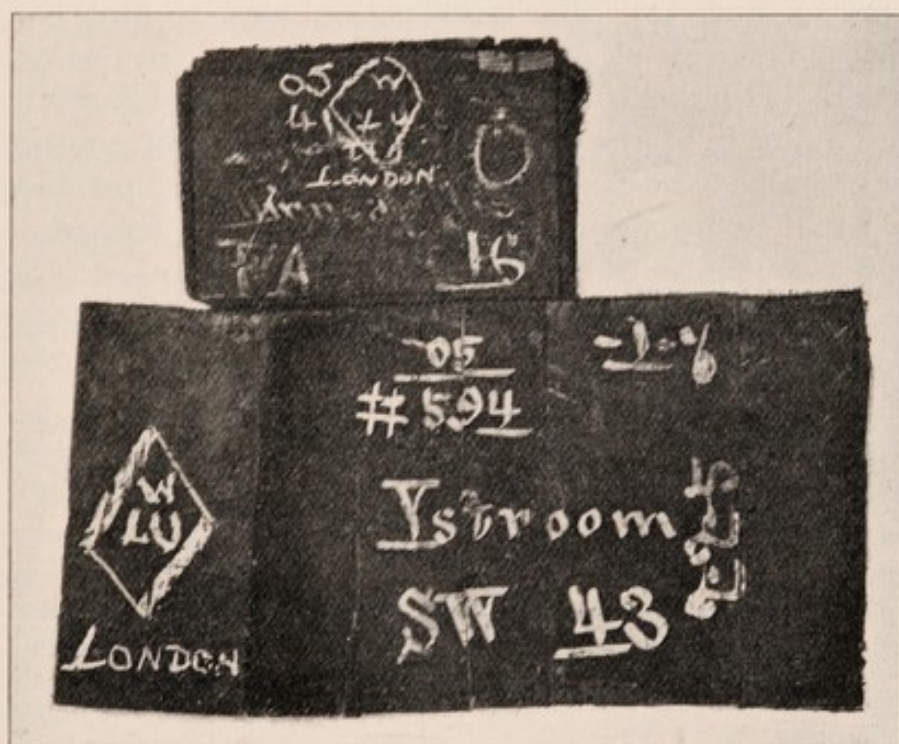


FIG. 255.—Boxes of Curaçao aloes.

Livery Curaçao aloes of good quality varies in colour from yellowish or reddish brown to chocolate-brown, lower grades being black and occasionally burnt. It breaks with a dull, waxy, even fracture, small splinters exhibiting under the microscope numerous minute crystals of aloin. It closely resembles Zanzibar aloes, and, in fact, can be distinguished (apart from chemical tests) only by its distinctive odour.

Vitreous Curaçao aloes, which is not a highly esteemed variety, is distinguished from the livery by its transparency. It has usually, in small fragments, a garnet-red colour; in other respects it resembles the foregoing.

The following chemical tests may be of service to the student in distinguishing the varieties of aloes (Bainbridge and Morrow).

	Nitric acid	Sulphuric acid and vapour of nitric acid
Socotrine aloes . . .	reddish brown	—
Zanzibar „ . . .	„ „	—
Cape „ . . .	permanent green after standing a few minutes	—
Natal „ . . .	permanent crimson	deep blue
Curaçao „ . . .	evanescent crimson	--

Curaçao (and true Barbados) aloes may readily be distinguished from all others by Klunge's cupraloin test which consists in adding to 10 c.c. of a freshly prepared 0·1 per cent. aqueous solution of the aloes, 1 c.c. of a 5 per cent. solution of copper sulphate, 0·5 c.c. of a saturated solution of sodium chloride, and a little hydrocyanic acid (or alcohol); a fine wine-red colour permanent for 24 hours is produced; of the other varieties of aloes only Cape aloes may give a pale colour which, however, rapidly fades. This distinctive reaction is due to the presence of isobarbaloin in the aloes.

The student should have little difficulty in identifying the five foregoing varieties of aloes. Two only (Cape and Curaçao) are commonly met with in the vitreous form, and they are easily distinguished both by their colour and by their very different odour. Five (Socotrine, Zanzibar, Natal, Curaçao, and Uganda) are hepatic. Of these the odour of Natal distinctly recalls that of Cape, whilst the greyish green or pale yellowish brown powder is characteristic. Uganda aloes is readily identified by its bronze-gold colour. Socotrine aloes is remarkable for its unpleasant odour and uneven, porous fracture. Zanzibar and hepatic Curaçao are very similar in appearance, but differ in odour; these are the only two likely to be confused, and if necessary a chemical test must be applied.

Constituents.—The principal constituent of all the foregoing varieties of aloes (with the exception of Natal aloes) is the pale yellow, crystalline glucoside, barbaloin (formerly called socaloin, zanaloin, capaloin, &c., according to its origin). In Curaçao and in true Barbados aloes the barbaloin is accompanied by about an equal quantity of isobarbaloin which is crystalline and isomeric with barbaloin, but easily distinguished from barbaloin, as it yields the cupraloin test (see above).

Socotrine and Zanzibar aloes contain no isobarbaloin, and Cape aloes traces only.

The crystalline aloin is accompanied by an amorphous aloin, β -barbaloin, which may be produced by heating barbaloin for about three hours to 160° – 165° C.; it is isomeric with barbaloin, and constitutes part at least of the water-soluble substances other than barbaloin and isobarbaloin. β -barbaloin is particularly abundant in Cape and Uganda aloes.

Other constituents of aloes are resin and aloë-emodin, in addition to water-soluble substances (other than the aloins) of which nothing definite is known. The resin of Curaçao aloes consists of barbaloresinotannol combined with cinnamic acid; that of Cape, Uganda, and probably Zanzibar and Socotrine aloes consists of capaloresinotannol combined with paracumaric acid.

Aloë-emodin is a decomposition product of barbaloin and occurs in small proportion only. Its presence is interesting, as it furnishes an explanation of Bornträger's reaction for aloes. This consists in shaking a solution of aloes with benzene, which extracts from it a yellow substance. The benzene solution is separated and shaken with ammonia, by which the yellow colour is changed to reddish violet and taken up by the ammonia.

Various formulæ have been proposed for barbaloin of which that of Léger, $C_{21}H_{20}O_9$, is probably the most correct. It is sparingly soluble in water, more readily in alcohol and acetone. Its aqueous solution slowly acquires a green fluorescence when saturated with borax, a reaction also exhibited by aloes. It is a glucosidal methyl-anthraquinone derivative, yielding by prolonged standing of an alcoholic solution, or by treatment with sodium peroxide (but not with mineral acids), aloë-emodin (methylisoxychrysin, m.pt. 144° C.) and an uncrystallisable levorotatory sugar, aloinose. It is isomeric with frangulin (compare p. 284), but the latter is hydrolysed by mineral acids yielding dextrorotatory, crystallisable rhamnose.

The proportion in which the aloins are present in the respective aloes is not accurately known. Tilden (1872) and Treumann (1880) obtained from 20 to 25 per cent. of aloin from Curaçao aloes. Carr and Reynolds (1907) found in a number of specimens from 12.6 to 27.9 per cent. As no exact assay process is known, and as there appears to be considerable loss in its extraction, it may be assumed that good Curaçao aloes

may contain upwards of 30 per cent. of crystallisable aloins. Socotrine and Zanzibar aloes appear to contain less. Cape aloes has yielded over 9 per cent.

Pedersen (1898) ascribes the following composition to Barbados aloes :

Resin	12·65
Barbaloin	12·25
Emodin	0·15
Ash	1·75
Water	10·50
Amorphous substances soluble in water	62·70
	<hr/> 100·00

Natal aloes differs materially from other aloes in its composition. It contains nataloin, homonataloin, and a resin consisting of nataloresinotannol (probably identical with capaloresinotannol) combined with paracumaric acid. Nataloin does not yield a fluorescent solution when dissolved in a solution of borax.

Uses.—All the varieties of aloes have more or less powerful purgative action, Cape aloes being the strongest and Natal aloes the weakest, all of them acting with remarkable slowness. Aloes is one of the most valuable purgatives in certain forms of constipation, as it improves the digestion and does not lose in activity by repetition.

Varieties.—In addition to the above-described varieties Mocha aloes is occasionally imported from Bombay in tin-lined cases; it is a black, brittle, glassy aloes of very strong odour. Jafferabad aloes, which is sent from that port to Bombay, is also nearly black; it does not enter into English commerce.

KINO

(Malabar Kino, Cochin Kino)

Source &c.—The term kino or kano was first applied to a red astringent substance imported from West Africa about the middle of the eighteenth century. This was obtained from *Pterocarpus erinaceus*, Poiret. It was, however, soon replaced by other similar astringent drugs, and the term kino became a generic one. The official drug, although often spoken of as 'kino,' is better termed Malabar or Cochin kino. Malabar kino

is the juice obtained from incisions in the trunk of *Pterocarpus Marsupium*, Roxburgh (N.O. *Leguminosæ*), evaporated to dryness. The bast of the tree, which grows in Southern India and Ceylon, contains, according to v. Höhnelt, numerous comparatively wide and short tubular cells arranged in axial rows; these cells are filled with a red astringent liquid, which flows from them when they are wounded. Vertical incisions, with oblique lateral ones running into them, are accordingly made in the bark; the juice that flows is collected in small cups made of leaves, or in other convenient receptacles, and soon dries in the sun to a dark mass that readily breaks up into small angular grains. It is sometimes boiled before it is evaporated, an operation that modifies the subsequent behaviour of the drug. Kino is occasionally imported as a treacly liquid which can easily be dried.

Description.—Kino occurs in small, glistening, angular grains that appear quite black and are remarkably free from dust. When thin laminae or the edges of the grains are examined they are seen to be transparent and of a dark ruby-red colour. They are hard and brittle, breaking with a vitreous fracture and yielding a brownish red powder. The drug is odourless, but has, when chewed, an astringent taste, and adheres to the teeth, colouring the saliva red.

In cold water kino is only partially (from 80 to 90 per cent.) soluble; it dissolves to a greater extent in hot water, and is almost entirely soluble in alcohol. The aqueous solution turns green on the addition of a ferrous salt, violet with an alkali, and throws down a precipitate (kinotannic acid) when acidified with a mineral acid.

The student should particularly observe

- (a) *The brilliant, apparently black, colour,*
- (b) *The absence of any dust;*

and should compare the drug with red gum.

Constituents.—The principal constituent of kino is kinotannic acid, of which it contains from 70 to 82 per cent. The published assays vary from 50 to 96 per. cent., but this variation is probably due partly to variation in the drug, partly to variation in the process adopted for the assay, and partly to the gradual production of oxidation products intermediate between the soluble kinotannic acid and the insoluble kino-red. This

change from kinotannic acid to kino-red commences immediately the juice is exposed to the air, as evinced by a darkening in colour; it is continued slowly in the dry drug which becomes duller and less soluble, and proceeds rapidly in solutions of the drug, which gelatinise owing to the formation of insoluble kino-red. It is caused by the presence of an oxydase enzyme, and may be prevented by destroying the activity of the enzyme by boiling the juice or the solution of the drug. Hence the boiling of the juice before evaporation is a rational procedure.

In addition to kinotannic acid and kino-red the drug contains about 10 to 15 per cent. of moisture, and small quantities of pyrocatechin (catechol), gallic acid, and mineral constituents (ash 1.5 per cent.)

Uses.—Kino is a powerful astringent; it is given internally for diarrhoea and dysentery and is also used externally.

Varieties.—Kinos have been obtained from numerous plants belonging to various natural orders, including Leguminosæ, Myrtaceæ, Polygonaceæ, Myristicaceæ, and Saxifragaceæ. Of these kinos the following may be briefly mentioned:—

1. *Red gum* (see below).
2. *Butea gum* from the stem of *Butēa frondosa*, Roxburgh (N.O. *Leguminosæ*), in India. To the small grains, which are bright and brittle when fresh, but become dull and tough, small buff coloured fragments of cork and cortex adhere. The kinotannic acid varies from 15 to 62 per cent. The drug is official for use in India.
3. *Eucalyptus* or *Botany Bay kino* from various species of *Eucalyptus* in Australia, the most suitable being *E. calophylla*, R. Brown, the tannin of which does not gelatinise. The drug occurs in irregular dark red pieces.
4. *African kino* from *Pterocarpus erinaceus*, Poiret, in West Africa. It closely resembles the official drug.

RED GUM

(*Eucalyptus Kino*, *Gummi Eucalypti*)

Source &c.—*Eucalyptus Kino*, or as it is commonly termed 'red gum,' is a variety of Australian kino obtained from *Eucalyptus rostrata*, Schlechtendal (N.O. *Myrtaceæ*), and other species (*E. marginata*, Smith, *E. amygdalina*, Labillardier

&c.). They are all Australian trees, *E. rostrata* forming large forests on the banks of the Murray River in New South Wales and yielding a valuable timber. This species is usually preferred as the source of red gum for medicinal use, because the tree is gregarious, cannot easily be mistaken for others, and yields freely a drug of good quality. The gum, which is secreted in cavities in the wood, or sometimes between the bark and the trunk of the tree, forming carbuncles, is obtained by making an incision and inserting a trough-shaped piece of tin by which the treacly liquid as it drains from the cut is carried into buckets or tins. In a few days it dries into a solid mass which soon becomes friable, breaking up into very dark fragments; or it may be evaporated by boiling, and the official drug is probably prepared by this method. The yield of each tree is very variable, the average being about a litre, some yielding none, others as much as 18 litres (Maiden, 1897).

Description.—Red gum is seen in commerce in small pieces, about the size of a pea or less. They are of a dark reddish brown colour, opaque, and more or less dusty, but thin laminae are transparent and ruby-red, the powder being pale reddish in colour. It is somewhat tough, and has when chewed an astringent taste, colouring the saliva red and adhering to the teeth. Cold water should dissolve from 80 to 90 per cent. According to Brownscombe (1899) good qualities should yield not less than the latter percentage.

The student should observe

- (a) The *reddish colour*,
- (b) The *dusty appearance*

of the drug.

Constituents.—Red gum contains about 47 per cent. of kinotannic acid (Maiden, 1897), which is undoubtedly its principal constituent. There is also present kino-red, a gelatinisable tannin glucoside, catechin, pyrocatechin, and about 15 per cent. of moisture, the remainder consisting of substances not at present exactly known. According to Smith (1904), eucalyptus kinos contain two tannins giving with ferric chloride a violet and a green reaction; the former gelatinises readily but the latter does not.

Uses.—Red gum is not so powerful an astringent as kino, but its action is said to be slower and more prolonged.

ELATERIUM

Source &c.—Elaterium is the feculence that is deposited, on standing, by the juice of the nearly ripe fruit of the Squirting Cucumber, collected and dried. This plant, *Ecballium Elaterium*, Richard (N.O. *Cucurbitaceæ*), is a rough, prostrate, trailing plant common in Southern Europe, particularly in the countries bordering on the Mediterranean. It is cultivated to a limited extent in England (Hitchin, Ampthill), the majority of the commercial drug being imported from Malta. The plant and the drug under notice have long been known, the process described by Dioscorides for making elaterium being almost identical with the method now adopted.

If the fruits, which resemble small hairy gherkins about 3 to 5 cm. long, are allowed to ripen, they are forcibly separated from the peduncles, the seeds and juice being simultaneously ejected. They are therefore collected before they are quite ripe, sliced, and pressed; the slightly turbid juice is allowed to stand, during which it becomes more turbid, and throws down a deposit which is collected, drained, and dried. This forms the elaterium of commerce.

Description.—Elaterium occurs in thin, opaque, curved pieces about 2 mm. thick, pale green in colour if fresh, (presumably from the presence of a little chlorophyll) but becoming greyish green and finally yellowish grey by keeping. It is light and friable, breaking readily with a short, very finely granular fracture exhibiting minute crystals when examined with a lens. It has a slight odour, and bitter, acrid taste. It should not effervesce when moistened with dilute acid, nor should it give a blue colour when iodine is added to a cooled decoction, these tests indicating respectively the absence of chalk or other carbonates, and starch, such substances having been used to adulterate elaterium. It should not yield more than 10 per cent. of ash (indicating the absence of an undue proportion of inorganic matter).

Constituents.—The principal constituent of elaterium is a crystalline substance, elaterin, of which it contains when pure about 30 per cent. commercial elaterium of good quality yielding not less than 25 per cent. The commercial English drug has been found to yield from 19·7 to 27·1, whilst the Maltese,

which generally contains chalk and starch, yields from 13·8 to 17·2 per cent. Elaterium contains about 12 per cent. of moisture and yields about 8 per cent. of ash. Other constituents, such as Walz's prophetin, ecballin, or elateric acid, hydroelaterin and elateride, have been reported but require further investigation.

Elaterin, $C_{22}H_{30}O_6$, is an indifferent body obtainable in the form of small, colourless, scaly crystals with a bitter taste; it is sparingly soluble in alcohol and in ether, but readily in chloroform. It appears to be a naphthalin derivative and contains two lactone rings, being converted into an acid (elaterinic acid) by boiling with potassium hydroxide. Elaterin is not contained preformed in the juice of the fruit, but is produced by the action of a ferment, elaterase, on a glucoside; the latter has been isolated as a very bitter, amorphous, yellowish powder.

Uses.—Elaterin, the active constituent of elaterium, is the most powerful hydragogue cathartic known, producing in doses of even 6 to 30 mg. numerous very watery motions. Like elaterium, it is almost entirely used as a hydragogue purgative in dropsy and uræmia.

SECTION XII

EXTRACTS

Under this heading three drugs are grouped together which are prepared by evaporating aqueous decoctions of various plants.

GAMBIER

(Pale Catechu, Terra Japonica, Catechu)

Source &c.—Pale catechu is an extract prepared from the leaves and young shoots of *Uncaria Gambier*, Roxburgh (N.O. *Rubiaceæ*).

This plant is a climbing shrub indigenous to the Malay Archipelago and largely cultivated on the small islands between Singapore and Sumatra, as well as in British North Borneo, and on other islands of the Archipelago. The drug was introduced into Europe towards the end of the eighteenth century, but was probably used in India at much earlier times for chewing with betel leaf (the leaf of *Piper Betle*, Linné).

The leaves and young shoots of the shrub are collected and boiled with water; the decoction is evaporated to a syrup in copper pans (iron pans would discolour it) and cooled; during the cooling the workman works a stick up and down in an oblique direction in the liquor, by which crystallisation is induced and a mass of the consistence of soft clay is obtained. This is usually conveyed in a moist state, often dripping with the mother liquor that drains from the crystalline mass, to Singapore, where it is cut into cubes from 2 to 3 cm. in diameter and dried. Occasionally it is formed into strips, plates, or small round discs, or sometimes it is imported in large blocks, but cube gambier is the form in which it is usually employed in pharmacy.

Description.—Gambier, as observed, is usually seen in the form of tolerably regular cubes, measuring from 2 to 3 cm. each way; it is light in weight, and of a dull, dark reddish brown colour externally, which, however, varies slightly, even on different sides of the same piece. The cubes break easily, and internally are of a pale cinnamon-brown colour, porous and friable. The drug has no odour; the taste is at first bitter and astringent but afterwards sweetish.

Gambier of good quality is almost entirely soluble in boiling water, and yields not less than 80 per cent. to alcohol.

The filtrate from the alcoholic solution, made strongly alkaline with solution of potash and shaken with petroleum spirit, imparts to the latter a brilliant green fluorescence, a reaction which is characteristic of gambier.

A little of the powdered drug mounted in water and examined under the microscope exhibits numerous minute acicular crystals (of catechin), but should be free from starch. The residue left after extraction with alcohol may also be tested for starch. The ash should not exceed 5 per cent.

Constituents.—Gambier consists principally of catechin and catechutannic acid, these two substances in varying proportions constituting together in good specimens over 60 per cent. of the drug; the percentage of catechin varies from 7 to 33 per cent., that of catechutannic acid from 22 to 50. These figures, however, vary with the care with which the drug has been prepared.

Catechin, $C_{15}H_{14}O_6 \cdot 4H_2O$, forms white, silky, acicular crystals with an astringent taste; it is sparingly soluble in cold but freely in boiling water, the solution giving an intense green colour with ferric salts. In the presence of caustic alkalies and water, catechin readily absorbs oxygen and yields a black dye; with carbonated alkalies the colour is red. Upon this reaction the extensive use of gambier and catechu for dyeing depends. Gambier also contains small quantities of a second catechin, $C_{15}H_{14}O_6$, differing from the foregoing in its melting point and crystalline form.

Catechutannic acid has been obtained as a reddish, amorphous substance easily soluble in cold water and in alcohol, the former being used to extract it from the drug. It is apparently produced from catechin by loss of a molecule of water, and itself yields an insoluble red substance, catechu-red, when boiled with water or with dilute mineral acids. These three substances, catechin, catechutannic acid, and catechu-red, appear therefore to stand in close relation to

one another, and the relative proportion in which they occur in the drug depends largely upon the care with which it is manufactured, well prepared gambier containing most catechin. Hence commercial gambier may contain as much as 50 per cent. of catechutannic acid, and as little as 7 per cent. of catechin.

Trimble (1888) found in three samples of gambier the following composition :

Catechin	7 to 19 per cent.
Catechutannic acid	33 to 47 „ „
Gum	10 to 16 „ „
Ash	3 to 4 „ „
Moisture	9 to 11 „ „
Colouring matter &c.	4 to 28 „ „

Other investigators have obtained larger proportions both of catechin (up to 33 per cent.) and catechutannic acid (up to 50 per cent.).

Other constituents of the drug are catechu-red, quercetin, and gambier-fluorescin, a fluorescent substance which can be removed from an alkaline solution of gambier by agitation with petroleum spirit. This fluorescent substance is absent from black catechu and many similar extracts, and forms therefore a valuable means of identifying gambier (Dieterich, 1897).

Uses.—Gambier is employed medicinally as a local astringent in the form of a lozenge or as a general astringent in diarrhoea; its use for these purposes is, however, insignificant compared with the quantities consumed in the dyeing and tanning industries; for the former, a mixture of catechin and catechutannic acid is said to give the best results.

CUTCH

(Catechu, Black Catechu, Catechu nigrum)

Source &c.—Cutch is an extract prepared from the heart-wood of *Acacia Catechu*, Willdenow (N.O. *Leguminosæ*), a tree of medium size common in India and Burmah. It yields a valued timber, and also an astringent bark that is used for tanning.

This drug must be carefully distinguished from the foregoing (gambier), which is official under the name of catechu.

The two substances are quite distinct, and that obtained from *Acacia Catechu* is to be regarded as true catechu. To avoid confusion it would be well to adhere to the terms gambier and cutch for the two drugs, thus avoiding the use of the term catechu, which has been applied to both.

Cutch has long been used in India as a masticatory, but it was not introduced into Europe till the latter half of the seventeenth century.

To obtain the drug the tree is felled, the bark and sapwood stripped from the trunk, the dark red heartwood cut into chips and boiled in water in earthen pots. The decoction is then strained and boiled down in iron pots with continual stirring until it attains the consistency of syrup. When sufficiently cool to handle, the extract is spread upon leaves arranged within a wooden frame or mould and left for the night. In the morning the cutch is dry, and forms brick-like masses weighing about 20 kilogrammes, which are broken up for the market.

Description.—Cutch occurs in nearly black masses, the outer portions of which are hard and brittle, but the interior often still soft. It breaks easily, the fractured surface having a dull gloss, and containing a number of small cavities. It yields a dull brown powder and has no odour, but an astringent and subsequently sweetish taste.

When macerated with cold water it forms a brown magma, which exhibits under the microscope numerous minute crystals similar to those found in gambier. Boiling water dissolves it almost entirely, but on cooling deposits a crystalline sediment.

Constituents.—Cutch closely resembles gambier in chemical composition. It contains as principal constituents catechutannic acid and acacatechin, but the former is usually present in much larger quantity than the latter. Acacatechin differs from the catechin of gambier in its formula, $C_{15}H_{14}O_6 \cdot 3H_2O$, and melting point. The drug contains in addition catechu-red and small quantities of quercetin, but is free from the fluorescent substance that is present in gambier. Although the two drugs, gambier and cutch, as usually found on the market have little resemblance to one another, this is due solely to the manner of preparation, the syrupy liquor being in the case of gambier allowed to crystallise. This method is sometimes pursued in India with cutch, and the resulting drug, 'katha,' then closely

resembles gambier, but can always be distinguished from it by the absence of the fluorescent substance.

Trimble (1888) found three samples of cutch to have the following composition :—

Catechin	2 to 10 per cent.
Catechutannic acid	25 to 33 „ „
Gum	20 to 29 „ „
Ash	2 to 3 „ „
Moisture	12 to 15 „ „
Colouring matter &c.	21 to 25 „ „

Good cutch contains from 10 to 12 per cent. of catechin, whereas katha contains about 50 per cent.

Uses.—Cutch is employed chiefly in the dyeing and tanning industries, especially the former, the amount of colouring matter it contains often rendering it more suitable for dyeing than gambier.

CURARE

Source &c.—Under the name of curare several (at least three) varieties of a dark, extract-like mass appear in commerce. They are all arrow poisons prepared by tribes of Indians in the valleys of the Amazon and Orinoco and their tributaries. The manner in which these extracts are prepared, or the ingredients, vegetable or animal, that enter into them is only imperfectly known. The bark of various species of *Strychnos* (*S. toxifera*, Bentham; *S. Castelnæi*, Weddel; *S. Gubleri*, G. Planchon, *S. Crevauxii*, G. Planchon, &c.) appear to be essential constituents. In the bark of these plants considerable quantities of poisonous alkaloids are present.

Description.—Curare has been imported in gourds, in small earthen pots, and in bamboo tubes, but gourd curare is now no longer a commercial article. It has the appearance of a very dark brown or nearly black extract resembling black catechu, often containing small cavities. That imported in bamboo is dark brown and granular, the broken fragments frequently exhibiting crystals sufficiently large to be visible to the naked eye. It has little or no odour, but a very bitter taste.

All these varieties of curare are poisonous when injected subcutaneously, but when administered by the mouth they are harmless, producing, it is said, the effect of a stomachic tonic.

The degree of toxicity varies not only in the different varieties but in different specimens of the same variety, and the strength, therefore, of each parcel must be determined before it can be used medicinally. Bamboo curare yields to water about 84 to 88 per cent., gourd curare 34 to 75 per cent., pot curare 50 to 87 per cent. (Böhm, 1898). These figures suffice to show the extreme variability of the drug.

Constituents.—Gourd curare contains the alkaloids curarine and curine; curarine is extremely toxic, but curine is less so. Bamboo curare contains tubocurarine and curine. Pot curare contains protocurarine, protocurine, and protocuridine.

Uses.—Curare has been employed as a remedy for hydrophobia and chorea; it has also been found useful for tetanus, but it would appear desirable to abandon the use of the crude drug in favour of that of its active alkaloids.

SECTION XIII

GUMS

Under this name a number of substances resembling in their properties acacia gum, tragacanth, or cherry gum have been grouped together. They are all insoluble in alcohol, ether, &c., but dissolve or at least swell in water, yielding either viscous adhesive solutions or gelatinous mixtures.

When submitted to carefully regulated hydrolysis with dilute mineral acids various sugars are produced, but the gum is not entirely converted into sugars, about 20 per cent. resisting such treatment. This residue has proved in each gum investigated to be an organic acid with which the various sugars separated during the hydrolysis have been combined. Hence the gums must be regarded as consisting of glucosidal acids of high molecular weight. In some gums these acids exist almost wholly in the free state, but in the majority of gums they are partly combined with potassium, magnesium, or calcium in the form of salts.

Amongst the sugars that have been obtained from gums are the pentoses arabinose, xylose, and tragacanthose and the hexose galactose. In addition to the glucosidal organic acid gums contain mineral matter (up to 5 per cent.) together with small quantities of sugars and of nitrogenous substances.

Gums are yielded by trees and shrubs belonging to a number of natural orders, but especially Leguminosæ, Rosaceæ, Rutaceæ, Anacardiaceæ, and Sterculiaceæ. They are produced by the conversion of the cell-walls of the tissues into gum (gummosis), doubtless by means of a diastasic enzyme of the origin of which nothing definite is known. They are formed as a protective coating after the infliction of injury on the tree, and are to be regarded as pathological products.

Mucilages, on the other hand, are normal products of the plant and are secreted in certain cells.

The so-called artificial gum (dextrin) produced from starch differs essentially from the gums in being entirely converted into dextrose by dilute mineral acids; it is strongly dextro-rotatory, most gums being slightly lævorotatory.

ACACIA GUM

(Gum Arabic, *Acaciæ Gummi*)

Source &c.—Acacia gum is a dried exudation from the stem and branches of various species of *Acacia* (N.O. *Leguminosæ*), especially of *Acacia Senegal*, Willdenow, a small tree attaining a height of 5 or 6 metres, and growing freely both in Western Africa (Senegambia) and in Eastern Africa (the upper Nile districts), possibly also in Central Africa, forming forests of considerable extent. The best gum is produced near Kordofan from trees specially cultivated and worked for gum. Strips of bark .5 to 1 metre long and from 2 to 8 cm. wide are removed from the trunks and large branches, care being taken not to injure the cambium. About two months afterwards the gum is collected, and the orchard is then picked over about every four days until the rains set in, when the exudation of gum ceases. Gum is also spontaneously exuded from wild trees, but this is usually rather darker in colour and not so valuable. The trees begin to yield gum when they are about three years old and continue to yield for about fifteen years.

The gum is brought to Omdurman, where part of it is sorted, bleached, and 'ripened' by exposure to the sun, but most of it is exported in the crude state in reed mats to Trieste, the centre of the commerce in gum, where it is graded and further exported. Part of the gum produced in East Africa reaches London *via* Bombay, and is termed East Indian and Bombay gum.

Description.—Kordofan gum, which is generally regarded as the best variety, occurs in rounded or ovoid tears, varying in size from a pea to a hazel nut or even larger. They are often quite white, but sometimes show a yellowish tinge, and are opaque from the presence in the outer part of the tears of small fissures. In consequence of these they easily break up into a number of small, transparent, angular fragments with glistening, vitreous surfaces. The drug is practically inodorous, and has

a bland, mucilaginous taste. Whilst the finest qualities are white, or have at most only a yellowish tinge, inferior grades have a decided yellow or reddish or brownish red colour and then contain traces of tannin.

Acacia gum is insoluble in alcohol, but dissolves freely in water, forming a translucent, viscid, but not glairy or ropy liquid, that feebly reddens litmus paper. A 10 per cent. aqueous solution of good qualities is slightly lævorotatory, and when boiled with an equal volume of Fehling's solution throws down a slight but distinct deposit of cuprous oxide. Solution of lead subacetate produces a copious white precipitate, whilst a saturated solution of borax forms with a strong solution of gum a clear, translucent jelly.

Constituents.—Acacia gum consists almost entirely of a glucosidal acid of high molecular weight, which has been termed arabic acid, combined with potassium, magnesium, and calcium; by hydrolysis each molecule yields two molecules of the sugar arabinose and four of galactose together with an organic acid to which the name of arabic acid has also been given, but which is better termed isogeddic acid, as it is isomeric with the corresponding acid, geddic acid, obtained from geddah gum. The acid of acacia, is therefore, a diarabinan-tetragalactanisogeddic acid, the termination 'an' indicating the anhydride of the corresponding sugar. This acid can be obtained from the gum by acidulating an aqueous solution with a mineral acid, dialysing it until the mineral constituents are removed, and fractionally precipitating with alcohol. Whilst moist it dissolves in water, but the dried acid only swells in water, dissolving on the addition of an alkali.

Gum acacia also contains an oxydase enzyme, and hence readily turns powdered guaiacum resin, or the tincture diluted with water, blue. It loses about 14 per cent. of moisture when dried at 100° C. and yields from 2·7 to 4·0 per cent. of ash. It contains further a small percentage of nitrogen, but this does not enter into the composition of the gum itself (distinction from gelatin &c.); it is probably due to the enzyme, from which the gum cannot be entirely freed.

Uses.—Acacia gum is used medicinally as a demulcent and as a means of suspending oils, resin, &c., in aqueous fluids.

Varieties, Impurities, &c.—Gum-yielding acacias are widely distributed over tropical and subtropical countries, and furnish

large quantities of gums which, though in most cases unsuitable for medicinal use, are extensively employed for certain technical purposes. In the deserts of Scinde the flora much resembles that of the African deserts, and large forests of *A. arabica*, Willdenow, exist, from which the Amrad gum of Bombay is obtained; *A. modesta*, Wallich, yields the gum sent from Northern India (Amritsar gum), whilst an altogether different plant, *Anogeissus latifolia*, Wallich (N.O. *Combretaceæ*), furnishes the Ghatti gum of commerce; the latter may be distinguished from acacia gum by its giving only a slight precipitate with solution of lead subacetate, whereas acacia yields a copious one. It occurs in pale yellowish white tears or vermiform pieces free from cracks but with a dull surface to which small pieces of bark occasionally adhere. It forms a viscous mucilage when used in about half the proportion of gum acacia, and is admirably adapted for many pharmaceutical preparations.

Northern Africa supplies a gum (Mogadore gum) probably obtained from *A. gummifera*, Willdenow, the finest pieces of which are indistinguishable from Kordofan gum; it is, however, nearly always darker in colour.

Senegal gum in its finest qualities (from *A. Senegal*) closely resembles Kordofan gum but is less fissured; lower grades (possibly from *A. Adansonii*, Guillemin et Perrot, and other species) have a yellowish tinge and often contain vermiform pieces.

Southern Africa also yields gum from *A. horrida*, Willdenow, and Australia from *A. dealbata*, Link, *A. pycnantha*, Benth, &c.

Many of these gums form glairy, ropy solutions with water, and when diluted throw down gelatinous deposits of gum that has swelled but not dissolved. An acacia gum suitable for pharmaceutical use should be free from both those characters, and should further give no reaction for starch (which might be present as an adulterant of powdered gum) or for tannin, which is present in certain inferior varieties of gum (such as Australian); a 10 per cent. aqueous solution should be slightly lævorotatory (absence of dextrin, from which an artificial gum has been prepared, certain sugars, &c.).

TRAGACANTH GUM

(Tragacantha)

Source &c.—Tragacanth gum is a dried gummy exudation from the stem of *Astragalus gummifer*, Labillardier (N.O. *Leguminosæ*), and other species of *Astragalus*.

These plants are small, branching, thorny shrubs, about a metre in height, and are natives of Southern and Eastern Europe and especially of Asiatic Turkey and Persia, where they form one of the most characteristic forms of vegetation. When the stem is incised a gum exudes and dries, the form that it assumes being dependent on the form of the incision, vertical slits yielding flat, ribbon-shaped pieces and punctures vermiform tears. It is produced by the transformation of the cell-walls of the medullary rays and pith into gum, which easily absorbs water, and, swelling, exerts considerable pressure on the surrounding tissue. When, therefore, the stem is wounded the gum is forcibly pressed out, a piece about 2 cm. long being exuded in half an hour; it carries with it the starch grains present in the cells in a more or less unaltered condition, and these are therefore a natural constituent of the drug.

Of the influences that induce gummosis of the cell-wall, nothing definite is known.

In some districts accidental wounds by grazing cattle appear to suffice for the production of tragacanth. In Asiatic Turkey it is collected chiefly in Anatolia and shipped from Smyrna; in Persia the Baktiari mountains, south of Ispahan, and the neighbouring districts yield much tragacanth, which is conveyed from the Persian Gulf ports to Bombay, and thence to Europe. The former variety is known as Smyrna, the latter, which alone is official, as Syrian or Persian.

Description.—*Syrian* or *Persian tragacanth* occurs in thin, flattened, curved, ribbon-shaped flakes of a translucent, horny appearance and nearly colourless or faintly yellowish. The flakes are often 3 cm. long and 1 cm. wide, and are marked with numerous concentric ridges, conveying the impression that the gum has been exuded in successive portions. The flakes break with a short fracture, are odourless and almost tasteless. Soaked in cold water they swell considerably, forming a gelatinous mass, but only about 8 or 10 per cent. dissolves.

Smyrna tragacanth occurs in similar pieces in which however, the ribbon-like character is less pronounced, and which are more opaque than the Persian, so that the two, when placed side by side, can easily be distinguished. Moreover, *Smyrna tragacanth* contains sufficient starch to give a decided reaction with the iodine test, whereas Persian responds only very faintly.

Constituents.—That portion of tragacanth that is soluble in water consists chiefly of a polyarabinan-trigalactan-geddic acid and yields by hydrolysis arabinose, galactose, and geddic acid; the insoluble part of the gum is termed bassorin; it is converted by baryta water into isomeric α - and β -tragacanthan-xylan-bassoric acids which yield by hydrolysis tragacanthose, xylose, and bassoric acid. Tragacanth contains also water, traces of starch, cellulose, and nitrogenous substances, and yields about 3 per cent. of ash.

Uses.—Tragacanth is chiefly employed medicinally as a means of temporarily suspending insoluble powders in mixtures, and to give the requisite firmness to pill-masses.

Varieties &c.—In addition to the tragacanth described (flake tragacanth), much is imported of a very inferior quality ('hog' gum, Caramania gum); such gum is usually in tears or irregular vermiform pieces, and darker in colour. Sometimes it is whitened with lead carbonate before being used to adulterate the finer qualities.

Vermicelli tragacanth is in thin vermiform pieces often of good colour; tragacanth of this nature is collected in Northern Morea from *A. cylleneus*, Boissier et Heldreich.

SECTION XIV

RESINS

Under the term resin a number of substances possessing certain properties in common are grouped together, but it is impossible to define the group as sharply as those of the fats, waxes, &c. The most important of these properties is insolubility in water, but ready solubility in alcohol, the alcoholic solution leaving on evaporation a film of transparent varnish. Resins are hard, amorphous, brittle solids (occasionally semi-solids), which soften when heated, and finally melt to a clear, adhesive fluid; they contain a large percentage of carbon, but only little oxygen, and burn with a smoky flame; they are free from nitrogen. Many are soluble in ether or in chloroform, but only a few dissolve in petroleum spirit.

Although most resins, and indeed all resins of medicinal or technical importance, are natural products, it is possible to produce resins artificially. Various volatile oils, especially those containing terpenes, yield resins by oxidation, and resinous bodies are also formed by the action of potassium hydroxide on aldehydes &c.

Natural resins are commonly produced by special cells and discharged, together with other products, into a cavity formed by the separation of the cells from one another; in this way the oleo-resins of the Coniferæ, the gum resins of the Umbelliferæ, &c., are produced. The tissue intervening between oleo-resin ducts frequently breaks down, so that branching cavities are formed; in this case the cell-walls appear to be converted into resin or oleo-resin, but the quantity thus produced is seldom large.

Guaiacum resin, on the other hand, is secreted in the vessels and cells of the heartwood, completely filling them and thus obstructing the passage of water. The resin of Indian hemp is secreted by external, stalked glands, whilst shellac is probably produced by the lac insect.

In addition to the secretion ducts normally present in the plant, others may be formed as the result of injury, and this may also take place even if the plant produces normally no such ducts. The number of the ducts thus formed may be very large and produce large quantities of oleo-resin which, discharged over the wound, forms a temporary protection for it. This flow of oleo-resin, which is termed 'secondary flow' to distinguish from the 'primary flow' from ducts normally present, is the source of most of the oleo-resins of technical importance.

None of the resins are simple bodies; all are mixtures, and most of them are mixtures of complex nature.

The following are the chief classes of substances that have been isolated from the resins:

1. *Resinotannols*: aromatic, amorphous, brownish resin-alcohols allied to the tannins; they occur partly free, but more generally combined with aromatic acids or with umbelliferone in the form of esters (tannol-resins).

2. *Resinols*: crystalline, colourless resin-alcohols, also occurring partly free, partly in the form of esters (resinol-resins).

3. *Resin-acids*: these are partly crystalline, and mostly occur free; they combine with alkalies to form soaps, and with metals to form esters that often crystallise readily.

4. *Resenes*: these are indifferent bodies, and neither esters nor acids.

5. *GlucORESINS*: which yield sugar by hydrolysis.

6. *Various acids*, more particularly belonging to the aromatic series, such as benzoic, cinnamic, paracumaric, salicylic, &c., which occur partly free and partly combined with the resin-alcohols.

The resins dealt with in this volume may be conveniently grouped according to their constituents, thus colophony, Burgundy pitch, sandarac, and amber are all of Coniferous origin, and present many points of analogy. Guaiacum contains chiefly resinols and in mastich the principal constituent is a resene. Benzoin and dragon's blood contain resinotannols together with aromatic acids. In shellac fatty resins are present, and in euphorbium euphorbone, while araroba, consisting almost entirely of crystalline substances, is not, strictly speaking, a resin, although it may conveniently be appended.

COLOPHONY

(Amber Resin, Resin, Resina)

Source &c.—Colophony is the residue left after the distillation of the oil of turpentine from the crude oleo-resin of various species of *Pinus* (N.O. *Coniferae*).

Most Coniferous trees contain in the wood a branching system of schizogenous secretion ducts filled with a viscid oleo-resin, which is exuded when the ducts are punctured. The amount thus yielded is, however, small. Very much larger quantities, practically the entire yield, are obtained by hacking the bark of the tree. In the new wood produced by the cambium immediately after such injury large numbers of oleo-resin ducts are formed, from which abundant oleo-resin is poured out over the wound; after a time this formation of ducts and discharge of oleo-resin diminishes, and eventually ceases, but may be continued by repeating the injury which caused their production. The flow may therefore be continued for some considerable time. Hence the oleo-resin is not a normal ('physiological') but an abnormal ('pathological') product.

The term 'common' turpentine is practically restricted to the oleo-resin obtained in America, as the English market is almost exclusively supplied from that source. The bulk is obtained from *Pinus palustris*, Miller, the long-leaf pine, but *P. Tæda*, Linné, the loblolly pine, *P. echinata*, Miller, the short-leaf pine, and *P. cubensis*, Grisebach, the Cuban pine, all yield a considerable quantity. These trees, especially the long-leaf pine, form extensive forests in the southern and south-eastern United States, extending from Texas to North Carolina.

The oleo-resin is collected in the following manner:

In the winter, when no oleo-resin flows, cavities are cut in the trunk of the tree near the base; they slope inwards and downwards, and are destined to receive the turpentine. In the spring triangular incisions are made above the cavity or 'box,' the bark and part of the young wood being removed. The turpentine soon rapidly exudes and collects in the box, from which it is removed by a dipper. After eight or ten days the flow diminishes, but may be increased by cutting a strip of bark

above the triangular incision; this process of hacking is repeated until the autumn, when the flow of turpentine gradually ceases. The last portions that are slowly exuded partially dry before they reach the box, and form a white incrustation on the hacked surface. This incrustation is removed and forms the drug known in America as 'scrape,' and in England as 'gum thus' or 'American' or 'common' frankincense.

The crude turpentine is removed by a dipper from the boxes to barrels for transportation to the stills. These are of copper, and set in brick furnaces. Water is added and the whole warmed, any chips of wood &c. that float to the top

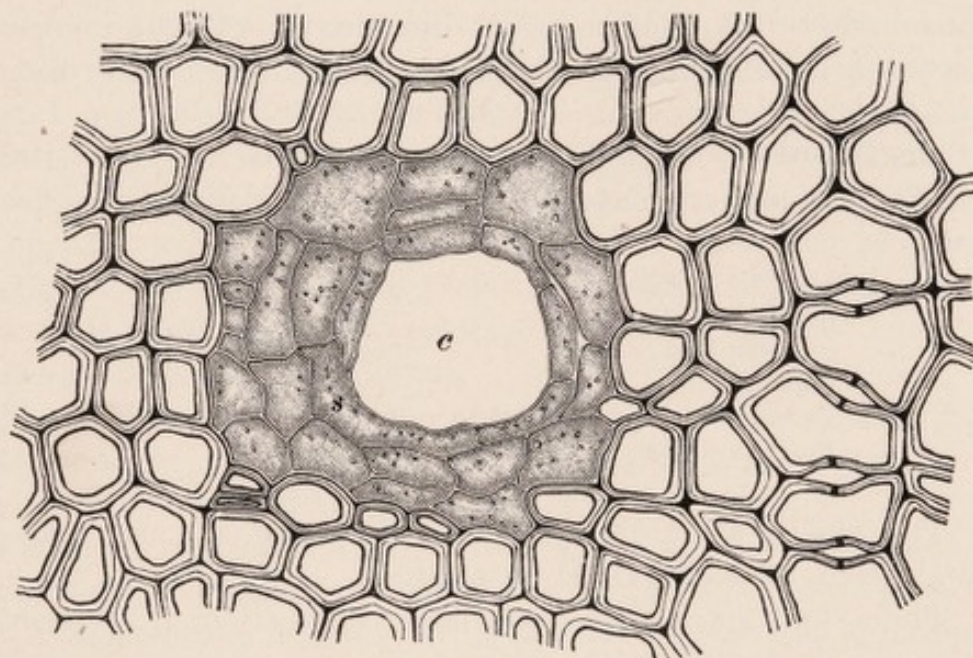


FIG. 256.—Transverse section through the wood of *Pinus maritima*, showing an oleo-resin duct, c. Magnified. (Tschirch.)

being skimmed off. The head is then luted on, and the heat increased. At first, water and oil of turpentine distil over, subsequently oil of turpentine alone. Water is occasionally added to prevent the resin from charring. After the distillation has been stopped the melted resin is run through wire strainers into barrels.

The finest resin is that obtained from the tree in the first year, when the crude turpentine yields about 80 per cent. of it. After that the proportion of oil of turpentine in the oleo-resin gradually diminishes whilst that of the resin increases, but the latter becomes darker and darker in colour.

So enormous is this industry in the United States that it is computed that at least 800,000 acres of virgin forest are newly invaded annually to supply the turpentine stills in operation.

Description.—The resin thus obtained should form pale amber-coloured, transparent, glassy masses, very brittle and easily powdered. It is rather heavier than water, the specific gravity varying from 1.070 to 1.085 (Dieterich). It has a faint terebinthinate odour and taste. At about 80° C. it softens, but it does not completely melt until the temperature exceeds 100° C. It is soluble in alcohol, ether, and chloroform, and leaves when incinerated but little ash. Freshly powdered colophony is almost entirely soluble in petroleum spirit, but becomes much less soluble by long keeping. A thin film of the resin increases in weight by exposure to the air, a change probably due to oxidation.

Constituents.—According to Tschirch and Studer (1903) American colophony has the following approximate composition :

α -Abietic acid	30 per cent.
β -Abietic acid	22 „
γ -Abietic acid	32 „
Resene	5 „
Volatile oil	0.5 „
Bitter principle	trace

The abietic acids are unstable crystalline isomeric acids to which the formula $C_{20}H_{28}O_2$ is assigned.

The α - and β -acids are removed from an ethereal solution of the resin by shaking with solution of ammonium carbonate; the γ -acid by subsequent shaking with sodium carbonate solution, the resene remaining in the ethereal liquid. The acid number¹ of colophony varies from about 136 to 180 and the

¹ The acid number is the number of milligrammes of potassium hydroxide necessary to neutralise the acids present. It is determined by dissolving a weighed quantity of the resin in alcohol and titrating with alcoholic solution of potassium hydroxide, using phenolphthalein as indicator.

The saponification number is the number of milligrammes of potassium hydroxide necessary to neutralise the acids and also to saponify the esters present. It is determined by boiling a weighed quantity of the resin with an excess of alcoholic volumetric solution of potassium hydroxide and titrating back with sulphuric acid.

The ester number is the number of milligrammes of potassium hydroxide necessary to saponify the esters present. It is obtained by deducting the acid number from the saponification number.

saponification number from 157 to 200. Although the saponification number is uniformly higher than the acid number, the resin is nevertheless free from esters.

Destructive distillation of colophony yields 'resin spirit' and 'resin oil,' both of which are largely used for technical purposes.

Uses.—Colophony has stimulant and diuretic properties. It is used chiefly as an ingredient of ointments and plasters.

Varieties &c.—Resin is obtainable in commerce in various grades ranging from 'water-white' to nearly black. Opaque resin is made by melting common resin with water.

Bordeaux turpentine is obtained chiefly from *P. maritima*, Poiret, in the south-western departments of Landes and Gironde. A vertical incision is made through the bark and about 1 cm. deep into the wood, and an earthen pot is fixed at the bottom, in which the turpentine is collected. The cut is gradually lengthened until it is about 3 metres long, then the opposite side of the tree, and finally the edges of the cicatrix of the first cut are incised, the tree remaining productive for many years. A product similar to 'scrape' is also obtained; it is termed 'galipot.'

The resin consists of pimaric, pimaric, and α - and β -pimarolic acids. The volatile oil is distinguished from American turpentine by being strongly lævorotatory.

Venice turpentine is obtained from the larch, *Larix europæa*, De Candolle, in France and Southern Tyrol, by boring into the stem in the spring, and collecting the oleo-resin that exudes. It is a yellowish, slightly turbid, viscid liquid, with bitter, aromatic taste. The resinous portion consists chiefly of α - and β -larinolic acids. A factitious mixture of resin and turpentine is commonly substituted for it.

BURGUNDY PITCH

(Pix Burgundica)

Source &c.—Burgundy pitch is a resinous exudation obtained from the stem of *Picea excelsa*, Link (N.O. *Coniferae*), melted and strained.

Burgundy pitch is collected chiefly in Finland, smaller quantities being obtained in the Black Forest and in the Jura

mountains. Incisions are made through the bark into the outer layers of wood, and the oleo-resin that slowly collects between the bark and the wood is, after the lapse of some months, scraped out of the incisions, melted under water, and strained.

Description.—True Burgundy pitch is an opaque, yellowish brown or dull reddish brown substance, hard and brittle, but gradually taking the form of the vessel in which it is kept. It is strongly adhesive, breaks with a conchoidal fracture, and has a very agreeable aromatic odour, especially when heated. The taste is sweet and aromatic without bitterness.

It is soluble in twice its weight of glacial acetic acid, and readily soluble in alcohol.

Constituents.—Burgundy pitch contains resin and a little volatile oil. The latter appears to consist chiefly of α - and β -picea-pimarolic acids, small quantities of picea-pimarinic, and picea-pimaric acid, and resene (juro-resene).

Uses.—Burgundy pitch is used in the preparation of a few plasters.

Varieties &c.—Much of the Burgundy pitch of commerce is a factitious mixture of resin, turpentine, and palm oil; it may be distinguished from the genuine by its incomplete solubility in twice its weight of glacial acetic acid (Pharmacographia).

AMBER

(Succinite, Succinum)

Source &c.—Amber is the fossil resin of certain extinct Coniferous trees, chiefly of *Pinus succinifera*, Conwentz. The term is a generic one, several varieties of amber having been distinguished, but that known as Baltic amber, or, better, succinite, is the only one of commercial importance.

The amber-yielding trees probably formed, in the early part of the period geologically known as the oligocene and belonging to the tertiary formation, extensive forests over the northern parts of Scandinavia. They contained oleo-resin ducts similar to those of Coniferous trees of the present day, and in addition frequently produced abnormal quantities of oleo-resin as the result of injuries, to which they appear to have been especially liable. The oleo-resin, hardened by exposure and liberated by

the gradual destruction of the trees, was carried, towards the latter end of the oligocene period, from the position occupied by the forest and deposited in a bed of blue earth of considerable extent near the eastern shores of the Baltic. From this bed of earth which lies below the sea-level the amber is now recovered chiefly by mining, but some little is washed by the sea from the exposed surface of the stratum and thrown up by the waves on the shore.

Succinite is also occasionally found on the east coast of England, whither it has been brought by the sea.

Description.—Succinite occurs in pieces varying much in size and shape, usually with rounded edges and covered with a dark crust. Internally it is transparent, translucent, or quite opaque (cloudy amber), and of varying shades of yellow or brown. It exhales when warmed a slight but characteristic odour, and is almost tasteless. It is hard, breaking with a bright, conchoidal fracture that is sometimes glassy, sometimes opaque. It is partially soluble (about 30 per cent.) in alcohol, ether (about 20 per cent.), and chloroform (about 20 per cent.); it melts at 280° to 290° C., at the same time decomposing and yielding water, succinic acid, and various tarry products.

Constituents.—That portion of succinite which is soluble in alcohol consists of free succino-abietic acid associated with a little bornyl succino-abietate. The part insoluble in alcohol, succinin, is a compound of succinic acid, with a resin-alcohol, succino-resinol. Succinite contains in addition traces of sulphur and of inorganic substances. By destructive distillation it yields a dark tarry oil accompanied by water; the former, separated from the watery fluid and redistilled, forms the genuine yellow oil of amber of commerce, which may be distinguished from a common substitute made from colophony by its higher specific gravity (0.926 to 0.930) and optical rotation (+23° to +26°).

GUAIAECUM RESIN

(Resina Guaiaci)

Source &c.—Guaiacum resin is the resin obtained from the stem of *Guaiacum officinale*, Linné, or *Guaiacum sanctum*, Linné (N.O. *Zygophyllæ*). Both of these are large evergreen

trees, the former a native of the West Indian Islands and the north coast of South America, the latter indigenous to Southern Florida and the Bahamas. Both occur in Cuba and Hayti, in the latter of which islands most of the resin of commerce is produced. The Spaniards became acquainted with the tree when they conquered San Domingo; the wood was soon brought to Europe, where it acquired an immense reputation in the sixteenth century as a cure for syphilis and other diseases; the resin was introduced later.

The resin may be obtained either by spontaneous exudation from the bark of the trees or exudation after incision (tear guaiacum); in the latter case deep cuts are made into the stem or branches, and the exuded resin is scraped off. But the bulk of the resin of commerce is produced in a rather crude way from the trunk of the tree, the heartwood of which, as already stated (see 'Guaiacum Wood'), contains from 20 to 25 per cent. of resin.

A log of the wood is supported in a horizontal position above the ground by two upright bars. Each end of the log is then set on fire, and, a large incision having been previously made in the middle, the melted resin runs out therefrom in considerable abundance (Pharmacographia); or one end of a log of wood is raised, and fire applied to it, when the melted resin will run out of a groove cut in the other end, and may be received in potsherds (block resin).

Description.—Guaiacum resin is usually seen in large masses of dark colour, often more or less covered with a greenish powder. The resin breaks easily with a clean, glassy fracture, thin splinters viewed by transmitted light being transparent, and varying in colour from yellowish green to reddish brown. The powder is greyish, but becomes green by exposure to light and air. It has a slightly acrid taste, and, especially when warmed, a somewhat balsamic odour. It is freely soluble in alcohol, chloroform, and solution of caustic potash, incompletely in ether, but only slightly soluble in petroleum spirit, carbon disulphide, or benzene.

The resin in tears forms rounded masses, attaining 2 to 3 cm. in diameter, usually covered with a greenish powder, and exhibiting the characters already detailed.

The commercial drug is never completely soluble in alcohol. The residue, which in the case of tear resin is about 1.5 per

cent., and in good samples of the lump averages about 7.5 per cent. (Evans, 1898), may in exceptional cases amount to as much as 25 per cent. It consists chiefly of fragments of vegetable débris, gummy matter, &c.

Guaiacum resin is easily identified by its remarkable reaction with oxidising agents. This is best seen by dissolving a little of the resin in alcohol and adding a drop of dilute solution of ferric chloride; the liquid instantly assumes a deep blue colour which is destroyed by reducing agents, but restored by oxidising agents.

The student should observe

- (a) The *varying colour* that the resin exhibits when viewed by transmitted light,
- (b) The *greenish powder* with which it is often more or less covered,
- (c) Its *characteristic*, though not powerful, *odour and taste*.

Constituents.—Guaiacum resin consists almost entirely of resin-acids and has approximately the following composition:

α -Guaiaconic acid	}	. . . . .	70.00 per cent.
β -Guaiaconic acid			
Guaiaretic acid			11.25 "
Guaiac- β -resin			15.00 "
Guaiacic acid, guaiac-yellow, vanillin, saponin, &c.			2.25 "

α -Guaiaconic acid is a colourless amorphous substance, probably a mixture, one constituent of which is changed by oxidising agents to deep blue guaiac-blue; sulphurous acid reduces this to a colourless substance, which may be again oxidised.

β -Guaiaconic acid is colourless and crystalline. Guaiaretic acid is light brown, amorphous, and insoluble in ether. Guaiac- β -resin is brown and amorphous, and appears to be chiefly a decomposition product of the guaiaconic acids; it contains the substance that yields guaiac-blue by oxidation.

Uses.—The action of guaiacum is that of a local stimulant or, in large doses, irritant. It has been employed locally in the form of the lozenge, and has also been given in chronic gout and rheumatism.

Adulterants &c.—Guaiacum resin is so cheap that it offers little inducement for adulteration. Colophony which has been mixed with it may readily be detected by agitating the freshly

powdered resin with petroleum spirit and shaking the filtrate, which should be colourless, with 0.1 per cent. solution of cupric acetate; if colophony is present the petroleum spirit will assume a vivid green colour. The acid number is about 90, but the determination is unsatisfactory, as the end-reaction is indefinite. Guaiacum resin in other resins may generally be detected by the ferric chloride reaction.

Peruvian guaiacum is brownish and aromatic, and is used in perfumery; its botanical origin is unknown.

ARARоба

(Goa Powder)

Source &c.—Araroba, or, as it is often termed, Goa powder, is a substance found in cavities in the trunk of *Andira Araroba*, Aguiar (N.O. *Leguminosae*), a large tree common in the damp forests of Bahia (Brazil).

This remarkable substance is found filling longitudinal fissures in the trunk of the tree. From careful microscopical examinations that have been made of the fragments of wood picked from the crude drug, it would appear that the walls of both parenchymatous and prosenchymatous cells, as well as those of the vessels, undergo a complete change, by which they are converted into a yellowish, powdery substance, araroba. This change is observable first in the secondary thickenings of the cell-wall, but afterwards the cell-walls themselves break down, thus forming cavities of considerable size which are filled with the araroba. The exact nature of the change, of the influences that induce it, and the manner in which it is effected, is unknown; it appears to be a pathological not a normal physiological process.

Araroba is collected by felling the tree, sawing the trunk into lengths, and splitting these longitudinally. The yellowish powder is then scraped out with the axe, by which means numerous splinters of wood and other debris are simultaneously removed. It is exported in that crude condition, and may be purified by sifting it as free as possible from fragments of wood, drying, and powdering it. The drug appears to have been long known to the natives of Brazil as a cure for certain skin diseases. In 1864 Kemp drew attention to the Goa

powder that was used in India for similar purposes, and this was proved in 1875 to be identical with the araroba of the Brazilians.

Description.—The crude drug, as imported, consists of a brownish yellow or umber-brown powder mixed with numerous small and large fragments of wood. Microscopical examination of the powder shows the presence of numerous minute prismatic crystals, and granular, amorphous matter accompanied by

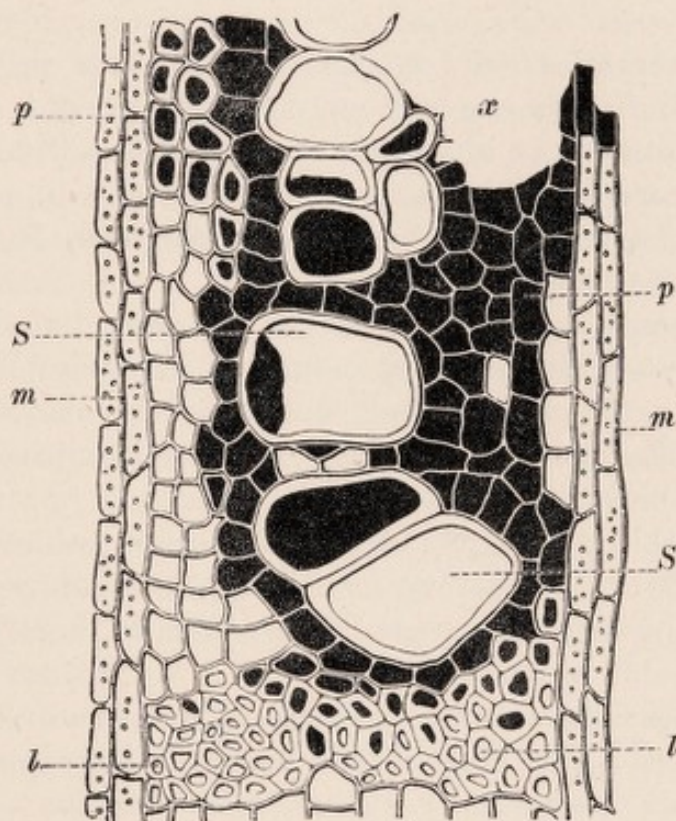


FIG. 257.—Araroba. Portion of a transverse section of the wood of *Andira Araroba*, near to a cavity filled with araroba. *S*, vessels; *l*, wood fibres; *p*, wood parenchyma; *m*, medullary rays. Nearly all the elements contain a dark substance, which in the upper part forms a dense mass, *x* (omitted from the illustration). Magnified. (Vogl.)

vegetable débris. The smoothed transverse surfaces of the larger fragments of wood show thin, yellow, medullary rays, vessels, and here and there yellow masses (of araroba). As already observed, it is sometimes purified by simply freeing it from the débris present, drying, and powdering; but the purification is more generally effected by grinding the crude drug, drying it, boiling it with benzene, and filtering; the hot benzene solution deposits on cooling a yellow, crystalline

powder which forms the chrysarobin of commerce. This is a yellow, crystalline, tasteless, and inodorous powder, soluble in hot chloroform and benzene, almost entirely soluble in hot alcohol, very sparingly and incompletely soluble in petroleum spirit, and practically insoluble in water. Hot solution of potash dissolves it almost entirely. To solution of ammonia it imparts at first a slight pink tinge; this colour, however, quickly deepens owing to oxidation of the chrysarobin (which is insoluble in ammonia) to chrysophanic acid (which is soluble).

Purified araroba melts when heated, gives off yellow fumes, and finally burns, leaving not more than 1 per cent. of ash.

Crude araroba, as imported, often contains from 15 to 30 per cent. of water, which appears to be added to prevent the irritating dust from rising; it may yield from 50 to 75 per cent. of purified araroba.

Constituents.—Purified araroba, officially but incorrectly termed chrysarobin, consists chiefly of chrysarobin and the methyl ether of dichrysarobin; with these are associated small quantities of dichrysarobin and of a fourth substance which has not yet been investigated.

Chrysarobin, $C_{15}H_{12}O_3$, occurs in small, yellow crystals melting at $204^{\circ}C$. It is insoluble in aqueous ammonia, but is converted by oxidation into chrysophanic acid, $C_{15}H_{10}O_4$, which is soluble in ammonia.

Uses.—Purified araroba has been used successfully in ring-worm, psoriasis, and other skin diseases; it acts apparently by destroying low vegetable organisms.

BENZOIN

(Benzoinum)

Source &c.—Benzoin is obtained from *Styrax Benzoin*, Dryander (N.O. *Styraceæ*), and probably other species of *Styrax*.

S. Benzoin is indigenous to Java and Sumatra and is the source of the Sumatra benzoin of commerce, but whether the Siam and Palembang varieties of the drug are produced by varieties of this tree or by distinct species is not at present definitely known. The difference in the constituents of the

resins points at least to their origin in distinct varieties (according to Tschirch 'physiological' varieties) of the tree. The drug was not known in Europe till the middle of the fifteenth century, although it had presumably long been produced in Sumatra.

It is a remarkable fact that the benzoin tree does not contain at any period of its development special secreting cells or ducts for the formation of the benzoin. The drug appears to be a purely pathological product, the formation of which may be induced by injury to the bark of the tree.

The drug is obtained by hacking the bark of the tree with an axe. After the infliction of such injury the cambium rapidly produces new wood in which a ring (or sometimes two rings) of oleo-resin ducts are formed. By the breaking down of the tissue intervening between the ducts large schizolysigenous ducts are produced in which considerable quantities of oleo-resin are secreted. These ducts open on to the wounded surface over which their secretion is discharged. Similar ducts are also formed in the bark. The benzoin thus formed partly accumulates between the bark of the tree and the trunk and partly exudes from the incisions; it is allowed to get firm and is then collected, bought by Chinese traders, softened by heat or hot water, and packed in oblong boxes, being often, it is said, mixed with vegetable débris in the course of repacking.

Several commercial varieties are known, the chief of which are Siam, Sumatra, and Palembang; Penang benzoin is imported to a smaller extent.

SIAM BENZOIN

Description.—This variety of benzoin is collected in the Siamese province of Luang Prabang, in the neighbourhood of the Mekong River. Part is exported to London via Singapore, but much reaches the market by way of France. It appears in commerce either as separate tears or in the form of masses composed of tears more or less firmly cemented together by a dark reddish brown, transparent resin.

The tears vary considerably in size, but seldom exceed 5 cm. in length, by 1 cm. in thickness; usually they are much smaller. They are flattened, or sometimes, if large,

concavo-convex, this shape being evidently caused by the resin accumulating between the trunk and bark of the tree. They are opaque, brittle, and milky-white internally, but are usually covered with a thin coating of brownish resin, which increases as the tears are kept, being produced from the opaque tear by a change that is not at present understood.

Block Siam benzoin consists of small tears cemented together by a glassy, reddish brown, transparent or translucent resin, which gives them a peculiar varnishy appearance. In this case also the proportion of the red, transparent resin increases as the drug is kept until it becomes its most prominent feature.

Both varieties of Siam benzoin are characterised by their agreeable fragrant odour, recalling vanilla; they are almost entirely soluble in alcohol and in ether, yielding only about 2 per cent. of insoluble residue. When quite pure Siam benzoin affords traces only of ash.

Good commercial samples of Siam benzoin should not yield more than 3 per cent. of substances insoluble in alcohol or more than 1 per cent. of ash.

Constituents.—Siam benzoin consists mainly of two substances of alcoholic nature, siaresinotannol (56 per cent.) and benzoiresinol (5 per cent.) combined with benzoic acid and associated with free benzoic acid (total benzoic acid 38 per cent.). The characteristic fragrant odour is due to vanillin (0.15 per cent.), and an oily, aromatic liquid (0.3 per cent.) that appears to be an ester of benzoic acid, but the exact composition of which is not known. Siam benzoin contains *no* cinnamic acid, a fact which assists in distinguishing this variety of benzoin from that exported from Sumatra.

Siaresinotannol is a light brown, amorphous substance, soluble in alcohol, and resembling tannin in its reactions with ferric salts, potassium bichromate, &c. Benzoiresinol is colourless and crystalline and forms a crystalline potassium salt.

SUMATRA BENZOIN

Description.—This variety is obtained on the west coast of the island of Sumatra, and is exported via Penang or Singapore to London in wooden cases. It occurs only in masses consisting of opaque white tears embedded in a resin which in this case is

of a dull reddish brown colour, and usually wanting in the transparent, varnishy appearance of the Siam drug. It differs also in its odour, which recalls storax rather than vanilla, and in the fact that it contains cinnamic acid, from which Siam benzoin is free. The presence of this acid is easily detected by boiling a fragment of the drug with solution of soda, filtering, and warming again with potassium permanganate, when the evolution of benzaldehyde indicates the presence of cinnamic acid.

Sumatra benzoin is usually less pure than Siam. Apparently during the repacking in Singapore much vegetable débris finds its way into the angles and round the sides of the boxes into which it is packed. Good Sumatra benzoin should not contain more than 10 per cent. of substances insoluble in alcohol, whilst inferior qualities often yield up to 30 per cent.; it should also not afford more than 5 per cent. of ash.

Constituents.—Sumatra benzoin consists principally of two alcohols combined with cinnamic acid, and associated with free benzoic and a little free cinnamic acid. Of the two alcohols, one, benzoiresinol, is identical with the benzoiresinol of Siam benzoin; the other, sumaresinotannol, is similar to, but not identical with, siaresinotannol. The drug contains, in addition, traces of benzaldehyde, vanillin (1 per cent.), phenylpropyl cinnamate, styrol, and styracin, all of which combine to produce its particular fragrance.

From Sumatra benzoin 18 per cent. or even more of benzoic acid has been obtained, and about 20 per cent. of cinnamic acid.

PENANG BENZOIN

Two distinct varieties of Sumatra benzoin have been known under this name. The one, now generally termed storax-benzoin, has a very agreeable odour resembling storax; the other, known as 'glassy Penang' or simply 'Penang' benzoin, is distinguished by its glistening, glassy fracture and slight odour. Both varieties are packed like Sumatra benzoin.

PALEMBANG BENZOIN

This variety, which is not official, is produced in Sumatra, it is said from *S. Benzoin*. It is commonly imported in tins, four of which are packed in a wooden case. It differs markedly

in appearance from both Siam and Sumatra benzoin, consisting principally of a translucent, greyish-brown or reddish resinous mass in which a few scattered, opaque, white tears are embedded. It breaks with an irregular fracture, the fractured surface being uneven and often exhibiting small cavities. The odour, which is not strong, recalls that of Sumatra benzoin. Its constituents have not yet been accurately investigated; it appears to contain benzoic but no cinnamic acid. It is not official, and is used only for the preparation of benzoic acid.

Uses.—Benzoin taken internally acts as a carminative expectorant and diuretic; externally it is stimulant and antiseptic.

DRAGON'S BLOOD

(Sanguis Draconis)

Source &c.—Dragon's blood is a resinous secretion produced on the fruits of *Daemonorops propinquus*, Beccari, *D. ruber*, Martius, and probably other species. The two species named were formerly included in *Calamus Draco*, Willdenow (N.O. *Palmeæ*); they are climbing palms with long, flexible stems, and are indigenous to Sumatra and Borneo.

The plant produces numerous small fruits about the size of a cherry, covered with hard, yellowish, imbricated scales, which overlap one another from apex to base. From between these scales a red resin, probably produced in the pulp of the fruit, exudes and more or less completely covers the fruit. The fruits are shaken together in a basket, and the separated resin mixed with water, pressed into moulds, and then melted, or it is made into a cake which is wrapped in a cloth, steeped in hot water and pressed to form a solid block. It is said to be nearly always mixed with the milky juice of *Garcinia parviflora*, Miquel (Treub, 1891).

Description.—Dragon's blood occurs in lumps of very varying size and shape. They are often large rounded masses, sometimes weighing several kilogrammes, bearing the impress of sacking or reed-matting, or they may be rounded, flattened cakes 10 cm. or more in diameter and about 5 cm. in thickness; sometimes the cakes are smaller and thinner. Occasionally it is imported in sticks about 20 to 25 cm. long and 2 to 3 cm. thick,

or 30 cm. long and 1.5 cm. thick, each carefully wrapped in a palm leaf. These varieties are known as 'lump,' 'saucer,' 'reed,' &c. dragon's blood.

Good samples of the drug usually have a dull, dark red colour, and are more or less covered, where the pieces have rubbed against one another, with a crimson powder. They are brittle and friable, breaking with a glossy but irregular, uneven, fracture, and although opaque in lump, minute fragments are translucent and of a deep garnet-red colour.

The drug yields when crushed a bright crimson powder, has no odour, and is practically tasteless, breaking up when chewed into a fine gritty powder. Inferior qualities are duller in colour and tougher. They yield a duller crimson or even brick-red powder, and exhibit less powder on the surface of the lumps. Such specimens frequently contain numerous fragments of the fruit scales, which are easily seen when the drug is broken, or are left when it is exhausted with alcohol.

Tears, in which form the drug is now seldom seen, give a glassy, conchoidal fracture, thin flakes being of a clear garnet-red colour.

Constituents.—Dragon's blood has been carefully examined by Dieterich (1896), who found it to consist principally of a red resin (56.8 per cent.) that proved to be a compound of dracoresinotannol with benzoic and benzoylacetic acids. Other constituents are a white, amorphous body, dracoalban (2.5 per cent.), a yellow resinous substance, dracoresene (13.58 per cent.), vegetable débris (18.4 per cent.), and ash (8.3 per cent.).

It is frequently considerably adulterated both with earthy matter and with fragments of the scales of the fruits, the amount of residue insoluble in alcohol amounting sometimes to as much as 40 per cent. of the drug.

Uses.—Dragon's blood is chiefly used for colouring varnishes &c.

Varieties.—The term dragon's blood has also been applied to several other resins resembling Sumatra dragon's blood in appearance. They may be distinguished by their insolubility in benzene and carbon disulphide. The only one of these that appears in commerce is Socotrine dragon's blood which is occasionally imported from Bombay and Zanzibar and is technically termed 'Zanzibar drop' dragon's blood. It is obtained from *Dracæna Cinnabāri*, Balfour. It occurs in small

tears or fragments seldom exceeding 2 cm. in length with a vitreous fracture, thin splinters being of a ruby red colour. It does not when heated evolve an odour of benzoic acid, and contains no scales similar to those found in Sumatra dragon's blood.

MASTICH

(Mastiche)

Source &c.—Mastich is a resin obtained from a broad-leaved variety of *Pistacia Lentiscus*, Linné (N.O. *Anacardiaceæ*), a shrub or small tree indigenous to the countries bordering on the Mediterranean. The resin, which has been known from the earliest times, and was formerly much more highly prized than it is now, is collected on the island of Scio in the Grecian Archipelago, and also in Cyprus, and possibly on other islands, but is exported only from Scio.

The bark of the tree, which contains a circle of oleo-resin ducts in the bast, is punctured with a small instrument resembling a chisel; the oleo-resin exudes in the form of small tears which in a few days become dry and hard. It is then collected, that taken from the tree itself forming the best qualities, whilst that which has dropped upon the ground is inferior.

Description.—Mastich occurs in small hard tears about the size of peppercorns. The majority are pear-shaped, ovoid, or nearly globular; sometimes, but not often, they are elongated and resemble small stalactites. When fresh they are nearly colourless and quite clear and bright, but by keeping and handling they become pale yellow in colour and acquire a dull, dusty surface. They are brittle, breaking with a clear, glassy, conchoidal fracture, the interior of the tears being quite transparent. When chewed the tears break up at first into a sandy powder, which subsequently agglomerates into a plastic mass. The drug has an agreeable, rather aromatic odour, and a slight agreeable taste, both of which, though not pronounced, are characteristic.

The student should observe

- (a) The preponderance of rounded or pear-shaped tears,
- (b) The characteristic odour,

(c) The formation of a *plastic mass when the resin is chewed*;

and should compare the drug with

Sandarac resin (see below).

Constituents.—Mastich has approximately the following composition :

α - and β -Masticonic acid, amorphous, soluble in alcohol	38.0 per cent.
α -Masticoresene, soluble in alcohol	30.0 „
β -Masticoresene, insoluble in alcohol	20.0 „
α - and β -Masticinic acids	4.0 „
Volatile oil	2.0 „
Masticolic acid, crystalline	0.5 „

It consists, therefore, chiefly of resin acids and resenes associated with about 2 per cent. of volatile oil (chiefly d-pinene).

Uses.—Mastich was formerly employed as a stimulant, and was also used in the manufacture of varnishes. For the latter purpose it has been superseded by other cheaper resins, whilst as a medicine it is obsolete.

Varieties.—Bombay or East Indian mastich is obtained from *P. Khinjuk*, Stokes (and probably other species); it is darker than genuine mastich, less vitreous, more soluble in alcohol and less soluble in turpentine. It may also be distinguished by the acid number (103 to 109) which is much higher than that of genuine mastich (45 to 67).

SANDARAC

(Gum Juniper, Sandaraca)

Source &c.—Sandarac is a resin obtained from *Callitris quadrivalvis*, Ventenat (N.O. *Coniferae*), a small tree about 7 metres high, growing on the mountains in the north-west of Africa. It is usually obtained by incision, the tears when sufficiently hard being collected and exported, chiefly from Mogadore.

Description.—Sandarac occurs in small tears about the same size as mastich, but usually of an elongated, more or less cylindrical or stalactitic form, several of which are sometimes united into a small flattened mass. Globular or pear-shaped

tears are comparatively rare in it, and by this means it can be distinguished at sight from mastich.

The tears, as usually seen in commerce, have a dull dusty surface and a pale yellowish colour; they are brittle, breaking with a glassy, conchoidal fracture, and displaying a clear, transparent interior, in which, as in amber, small insects are occasionally embedded. The resin has a slight terebinthinate odour and a terebinthinate, slightly bitter taste; when chewed it breaks up between the teeth into a sandy powder which, unlike mastich, shows no disposition to agglomerate into a plastic mass.

It is completely soluble in alcohol and ether, partially only in chloroform, carbon disulphide, and oil of turpentine.

The student should observe

- (a) The *preponderating stalactitic form*,
- (b) The *terebinthinate odour*,
- (c) The *indisposition to form a plastic mass between the teeth*;

and should compare this drug with

- (i) *Mastich* (see p. 534),
- (ii) *Olibanum* (see p. 552).

Constituents.—Sandarac consists of resin associated with traces of volatile oil, bitter principle, &c. The chief constituent of the resin is (optically) inactive pimaric acid (sandaracopimaric acid, 85 per cent.), obtainable in acicular crystals melting at 170° C.; other constituents are sandaracinic acid (2·3 per cent.), amorphous callitrolic acid (10 per cent.), and sandaracoresene. Callitrolic acid is easily converted into the lactone which is insoluble in alcohol.

Uses.—Sandarac is chiefly used in the manufacture of varnishes; it is paler in colour than shellac, and is therefore more suitable for light woods.

Varieties.—*Australian sandarac*, from *C. verrucōsa*, Robert Brown, is occasionally imported. The tears are softer, larger, and more aromatic than those of African sandarac, which it otherwise resembles. Its composition is similar, but it contains more volatile oil and more inactive pimaric acid.

SHELLAC

(Lac, Lacca)

Source &c.—Shellac is a resinous exudation that encrusts the bodies of *Coccus* (*Tachardia*) *Lacca*, Kerr (Order *Hemiptera*, Family *Coccidæ*).

These minute insects live upon plant juices sucked up by a proboscis that penetrates the succulent tissues of the host. Twice or sometimes three times in the year the larvæ emerge from the dead bodies of the females, crawl away and establish themselves in new situations. They are minute creatures, about 0.5 mm. long, of an orange-red colour with fully formed feelers and powerful legs, but no visible separation of the body into head, thorax, or abdomen. They puncture the young twigs with their probosces and suck up the juices; they become fixed, and their legs, being no longer required, drop off; a resinous secretion forms around their bodies and gradually more or less encrusts the twigs. At the period of maturity the males, which undergo a complete metamorphosis, escape from their pupæ, impregnate the females and shortly afterwards die. The females rapidly increase in size, assume a bright red colour, develop viviparous larvæ and die. New colonies are established by cutting off twigs with the gravid females and tying them on to various trees.

The principal trees visited by the lac insects are *Aleurites laccifera*, Willdenow (N.O. *Euphorbiaceæ*), *Ficus religiosa*, Linné (N.O. *Urticaceæ*), *Schleichëra trijuga*, Willdenow (N.O. *Sapindaceæ*), *Butëa frondosa*, Roxburgh (N.O. *Leguminosæ*). *Acacia arabica*, Willdenow (N.O. *Leguminosæ*), and *Cajānus indica*, Sprengel (N.O. *Leguminosæ*) are cultivated for that purpose.

Whether the resin is secreted by the insects or produced by the plant as a result of the irritation caused by the insects is at present not definitely known. The resin shows, in its chemical composition, a variation from vegetable resins, and this seems to indicate that it owes its origin, in part at least, to a change effected by the insects in the constituents of the plant.

After the secretion of the resin the twigs are broken off, and form without further preparation the stick lac of commerce. Stick lac therefore consists of the twigs of the trees coated with

a granular brownish or reddish resin which is frequently 7 mm. thick. Enclosed in this resin are the bodies of the insects, which contain a valuable colouring matter. The latter is extracted by breaking the lac from the twigs, crushing it, and exhausting it with water and sometimes subsequently with dilute soda solution. The aqueous solution contains a red colouring matter, laccaic acid, that resembles carminic acid, but is not identical with it; it is evaporated to dryness, and the residue, pressed into cakes, constitutes the lac dye of commerce. After the resin has been crushed and freed from colouring matter, it is spread out on floors to dry and bleach; it then forms brownish grains which are known as seed lac. This still contains various *débris* of the insects &c.

It is melted with a little orpiment and resin (2 to 5 per cent.) and pressed whilst hot through a cloth. The strained lac thus obtained is spread into sheets about 3 mm. thick which are further stretched to thin sheets. These sheets, broken up and sorted, constitute the shellac of commerce. Garnet lac is a dark coloured variety, and button lac is in the form of thin discs.

Lac is prepared in various parts of India, particularly in Bengal and Assam, and is exported chiefly from Calcutta.

Description.—Shellac usually occurs in thin, brittle, translucent, leafy flakes devoid of odour and taste. The colour varies from brownish yellow (orange shellac) to deep reddish brown (garnet shellac), the palest being considered the best. It melts when heated, evolving a characteristic odour.

Constituents.—A recent investigation of stick lac (Farner, 1899) resulted in the separation of the following constituents :

Wax	6.0 per cent.
Colouring matter (laccaic acid)	6.5 „
Resin	74.5 „
Residue (sand, vegetable and animal <i>débris</i>)	9.5 „
Moisture and loss	3.5 „

Of the resin 35 per cent., composed principally of fatty acids, was soluble in ether containing alcohol. The part insoluble in ether (65 per cent.) consisted of a resinotannol combined with aleuritic acid, a crystalline acid belonging to the fat acid series. A colouring matter, erythrolaccin, crystallising in golden yellow crystals is also present.

Shellac consists principally of the resin (90 per cent.) and wax and other substances (10 per cent.) Orpiment, although

used in its preparation, seldom occurs in shellac. Adulteration with colophony may be detected by dissolving in alcohol, precipitating the resin with water, filtering, drying, and digesting with petroleum spirit; if colophony is present the petroleum spirit solution will assume an emerald-green colour when shaken with a 0.1 per cent. aqueous solution of cupric acetate. The presence of colophony is also indicated by the iodine value which should not exceed 12 in pure shellac (colophony 105 to 120).

Bleached shellac is made by dissolving shellac in hot solution of sodium carbonate and adding chlorinated lime, which forms chlorinated soda and deposits calcium carbonate. The resin is then precipitated, collected, 'pulled' under water, twisted into sticks, and kept under water.

Uses.—Shellac is largely used in varnishes, but is not employed medicinally.

EUPHORBIIUM

(Euphorbium)

Source &c.—Euphorbium is a resin obtained from *Euphorbia resinifera*, Berg (N.O. *Euphorbiaceæ*), a plant about a metre in height, resembling in appearance and habit a cactus, and common in the mountainous districts of Morocco, especially on the spurs of the mountains in the neighbourhood of the town of Morocco, where the drug is principally collected.

The plant produces green, fleshy, quadrangular stems and branches which bear small scaly leaves supported by two persistent thorny stipules; the flowers are small and borne on short peduncles; the fruit consists of three carpels, and resembles typical Euphorbiaceous fruits.

The drug, which has long been known, for both Pliny and Dioscorides were well acquainted with it, is obtained by wounding the plant.

Both the cortex and the pith of the plant contain long, branching, laticiferous cells; these when wounded discharge their latex, which exudes in the form of milky drops, the exudation in rainy seasons being very copious.

The milky juice dries to a resinous mass which is collected in the autumn by the poorer class of Arabs and brought to

Morocco for sale. It is exported chiefly from Mogadore. So acrid is the drug that the faces of persons handling it have to be protected by cloths.

Description.—The drug occurs in dull yellow or brown, dusty-looking pieces seldom exceeding 1.5 cm. in width, often mixed with fragments of the quadrangular, thorny stem and other debris. Many of the pieces have evidently solidified round a pair of stipules and are pierced by holes corresponding to them, or sometimes even include the stipules themselves; some are pierced with single holes and retain the fruits or flowers or

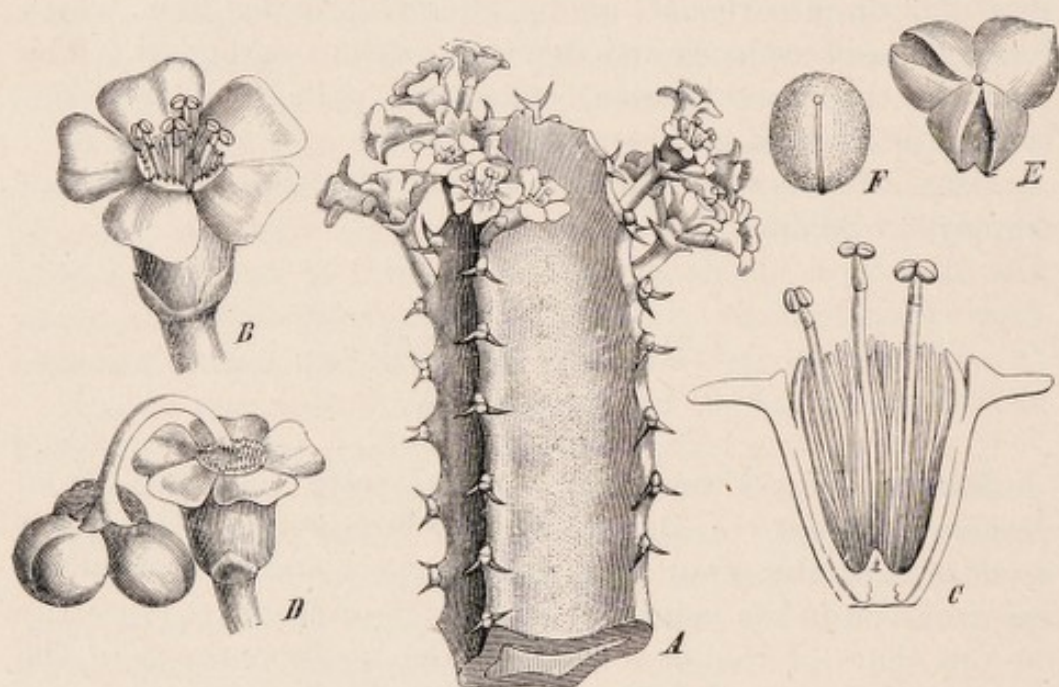


FIG. 258.—*Euphorbia resinifera*. A, flowering branch, natural size. B and C, staminate, D, pistillate flower, magnified. E, fruit, and F, seed, magnified (Luerssen, after Berg and Schmidt).

portions of them. The fruits are characterised by their shape, each consisting of three nearly separate, one-celled, compressed, keeled carpels attached at the apex and base to a central axis.

The resin itself is very brittle, breaking readily between the fingers; internally it is of a dull yellowish brown colour. It has no particular odour, but the powder if inhaled excites violent sneezing; the drug has, however, an extremely acrid taste.

It is partially (62 per cent.) soluble in 90 per cent. alcohol, in ether (56 per cent.), and in water (32 per cent.), but

almost completely in glacial acetic acid. Petroleum spirit dissolves about 36 per cent., and the solution, carefully poured over sulphuric acid containing one drop of nitric acid in 20 c.c., develops a blood-red zone; this reaction is characteristic of euphorbium.

Constituents.—Euphorbium consists chiefly of euphorbone (40 per cent.), euphorbo-resene (20 per cent.), euphorbic acid (0.7 per cent.), calcium malate (25 per cent.) together with an intensely acrid substance which has not yet been isolated, vegetable debris, &c. The drug contains no gum, which was for a long time supposed to be present.

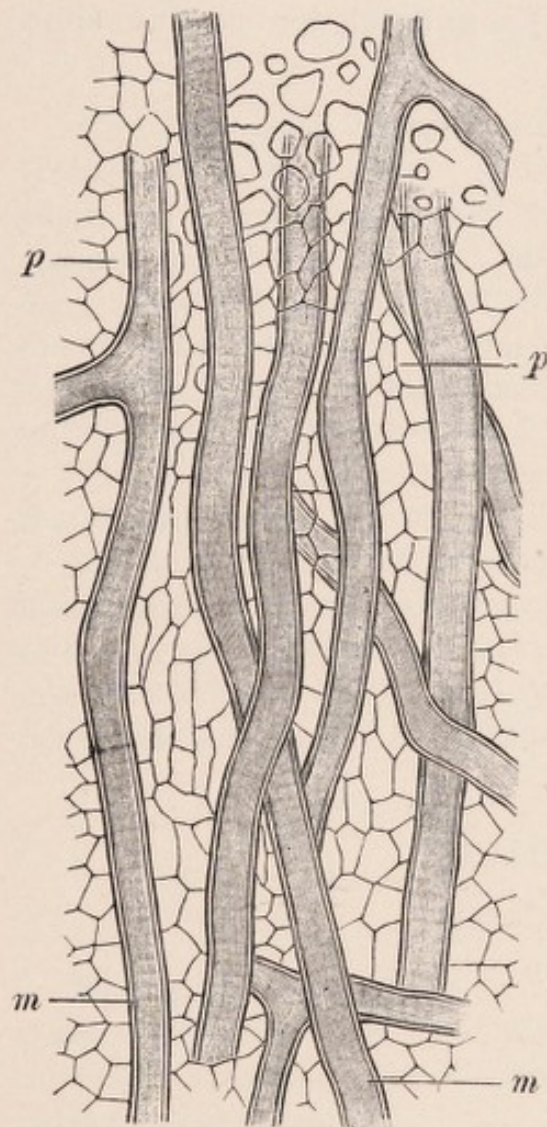


FIG. 259.—Laticiferous cells in the stem of *Euphorbia resinifera*. *p*, parenchyma; *m*, laticiferous cells. Magnified. (Tschirch.)

115°–116° C. Euphorbo-resene is yellowish brown, amorphous, and tasteless. The acrid substance to which the physiological action of the resin is due is soluble in water, alcohol, and ether, but so far all attempts to purify it or isolate it in crystalline form have failed; it has



FIG. 260.—Euphorbium. 1, pair of stipules; *a* and *b*, stipules covered with gum-resin; 2, fruit; *c*, fruit covered with gum-resin. Natural size. (Vogl.)

The resin separated from the vegetable debris &c., yields about 5 per cent. of ash.

Euphorbone crystallises from acetone in colourless, odourless, and tasteless acicular crystals melting at

been obtained as an amorphous mass of intensely and persistently acrid taste.

Many species of *Euphorbia* yield an acrid, milky juice analogous in composition to the above (Hencke, 1886).

Uses.—Euphorbium possesses very acrid properties. It has been employed as a drastic purgative, but is now chiefly used as a vesicant in veterinary practice, and also for various technical purposes, such as an antifoul for coating ships' bottoms.

SECTION XV

GUM-RESINS

The gum-resins consist, as their name indicates, chiefly at least of resin and gum. With these constituents, however, there are always associated small quantities of other substances such as volatile oil, bitter principle, enzyme ferment, &c. They are secreted in schizogenous or schizolysigenous ducts, being formed in the resinogenous layer of the walls of the tapetal cells, and discharged into the ducts in the form of milky liquids which are exuded when the ducts are punctured.

The resins contained in the gum-resins exhibit in general the characters detailed on pp. 516, 517.

The gum of most of the gum-resins resembles, but is not identical with acacia gum, very possibly it consists of mixtures of two or more glucosidal acids in varying proportions. It is always accompanied by an enzyme ferment from which it has never yet been freed ; it therefore always contains nitrogen.

GAMBOGE

(Cambogia)

Source &c.—Gamboge is a gum-resin obtained from *Garcinia Hanburii*, Hooker filius (N.O. *Guttiferae*), a tree of moderate size found in Cambodia, Siam, and the southern parts of Cochin China.

The bark of the tree contains in the cortex, as well as in the bast, secretory ducts filled with a yellow, milky gum-resin, the two systems being connected by transverse canals at the nodes.

The gamboge is obtained by making, in the rainy season, a spiral cut in the bark from a height of about 3 metres down to the ground. The gum-resin wells out and trickles down the

incision into a hollow bamboo placed to receive it. From this it is transferred to smaller bamboos; these are set aside until, in about a month, the gamboge has solidified. It is removed from the bamboo by drying over a fire until the bamboo cracks and can be stripped off. The drug is sold to local collectors, who convey it to Bangkok or Saigon, whence it is exported to Europe, usually via Singapore.

It is occasionally formed whilst soft into cakes of various shapes or into thick sausage-like masses, which are wrapped in leaves, the impression of which they bear on their surface (Saigon gamboge).

Description.—The finest qualities of gamboge occur in rolls, 3 to 5 cm. in thickness, and from 10 to 20 cm. in length, nearly cylindrical, solid or hollow in the centre, and marked externally with longitudinal furrows derived from the inner surface of the bamboos in which they have been dried. The drug breaks easily, with a smooth, uniform, conchoidal fracture, the freshly fractured surface having a dull gloss and being of a rich reddish yellow or brownish orange colour. It is easily reduced to a bright yellow powder, with little odour, but with an acrid taste.

Thin splinters mounted in oil and examined under the microscope exhibit a ground-mass of gum in which numerous minute granules of resin are scattered accompanied by occasional crystals of calcium oxalate and starch grains derived from the incised tissues.

Rubbed with the wet finger gamboge instantly forms a yellow emulsion. It is almost completely dissolved by the successive action of alcohol and water. The yellow emulsion yielded with water becomes nearly clear and deep orange red on the addition of ammonia.

Constituents.—Gamboge consists essentially of a mixture of 70 to 80 per cent. of resin, with 15 to 25 per cent. of gum.

The resin, formerly known as cambogic acid, is soluble in alcohol, ether, chloroform, benzene, petroleum spirit, &c., as well as in solutions of alkaline hydroxides and carbonates; from its alkaline solutions it is precipitated by acids. From it three organic acids have been separated, viz. α - β - and γ -garcinolic acids, the last named being characterised by the red colour of even a very dilute alkaline solution.

The gum is analogous to acacia gum; it is lævorotatory and contains an oxydase enzyme.

Uses.—Gamboge produces purging and in large doses vomiting. It has been employed as a hydragogue cathartic, but is now seldom used as a medicine.

Adulterants.—The chief adulterants are starch, inorganic matter (such as sand &c.), and vegetable débris. These are all easily detected by their insolubility in alcohol and water used successively, or in dilute ammonia. Starch is officially tested for by adding iodine to a cooled decoction, which should not then assume a distinct green colour (*traces* of starch are usually present in gamboge). Inorganic substances would also be detected by the ash, which should not exceed 3 per cent.

Varieties.—*Pipe gamboge*, as above described, is the best variety.

Inferior gamboge breaks with a dull, rough, granular fracture, and the fractured surface, which often exhibits small cavities, is of a dark brownish colour.

Lump or cake gamboge consists of pipe gamboge bent and pressed whilst soft so as to form a cake; or it may occur in irregular lumps which are frequently soft in the interior and often contain abundant visible impurity in the shape of sand, small stones, &c.

Saigon gamboge is occasionally exported from Saigon in short, thick, cylindrical cakes wrapped in palm leaves.

Indian gamboge is obtained in India from *G. Morella*, Desrousseaux, and resembles Siam gamboge in its essential qualities; it is used as an equivalent of gamboge in India and the Eastern Colonies.

SCAMMONY

(Scammonium)

Source &c.—Scammony is a gum-resin obtained by incision from the living root of *Convolvulus Scammonia*, Linné (N.O. *Convolvulaceæ*).

The scammony plant is a twining plant indigenous to the eastern Mediterranean and resembles the common bindweed but is much larger. It produces a root attaining as much as a metre in length and 10 cm. in thickness, from which a

number of slender aerial stems spring. The gum-resin is collected in Asiatic Turkey, chiefly near Smyrna and Aleppo.

The abnormal structure of the root has been already alluded to (see Scammony Root). In the cortex as well as in the parenchyma surrounding each of the columns of wood are cells containing a liquid gum-resin. These cells are arranged in vertical rows, and when an incision is made the contents drain from a series of cells by the breaking of the transverse walls. In collecting the gum-resin the workman clears away the earth surrounding the upper part of the root so as to leave 10 or 15 cm. of the root exposed. This is then cut off in a slanting direction 5 to 10 cm. below the crown, and a mussel shell is stuck into it just beneath its lowest edge so as to receive the milky sap which instantly flows out. The shells are usually left till the evening, when they are collected and the cut parts of the roots scraped with a knife so as to remove any partially dried drops of juice (Pharmacographia). If the gum-resin were then dried at once a drug of fine golden brown colour and translucent appearance would be produced; but as a rule the contents of the shells are collected, and daily added to, until a sufficient quantity has accumulated; this is then softened, mixed into a homogeneous mass, and allowed to dry. During the long standing in a more or less moist condition the scammony undergoes a fermentative change, and the drug when dry has a dark colour and porous appearance when broken. It is also frequently adulterated whilst in the soft state.

Description.—Scammony is usually imported in flattened cakes about 1.5 cm. thick and 10 or 15 cm. in diameter. It varies in colour from dark grey to dark brown or nearly black, the surface being often covered with a grey powder. It breaks very readily, and the freshly exposed surface is glossy, resinous, often more or less porous, and of a dark brown or nearly black colour. Thin fragments, however, when viewed by transmitted light, are seen to be brown in colour and translucent. It is very easily reduced to an ash-grey powder, and readily yields a milky emulsion when rubbed with water. Scammony has a characteristic cheesy odour and an acrid taste.

Very fine qualities of the drug which, however, are scarce, differ in being of a golden brown colour, almost transparent in thin fragments, and less porous.

The student should observe its *brittle nature, translucent brown colour* in thin fragments, and *characteristic odour*; it yields a milky emulsion when rubbed with the wet finger, a character that distinguishes it from scammony resin, which does not emulsify when so treated.

Constituents.—Pure scammony contains about 88 or 90 per cent. of resin identical with that obtained from the root (see before) and entirely soluble in ether; the residue consists principally of gum. But scammony of such purity as this is seldom met with in commerce. Good qualities yield from 75 to 80 per cent. of resin to ether, and are known as 'virgin' scammony. The official standard has been fixed at a minimum of 70 per cent.

Uses.—Scammony is used as a brisk cathartic and vermifuge, especially for children.

Adulteration.—The high price of scammony and its plastic nature before it is dried invite and facilitate adulteration. Starch, chalk, and earthy matter are frequently used to increase its weight, and occasionally other resins are fraudulently mixed with it.

Adulteration with inorganic matter is readily detected by incineration. Good scammony should not yield more than 3 per cent. of ash. Starch is easily recognised by microscopical examination or by the iodine test, but traces of the starch of scammony root are often present in genuine scammony, and caution must be used in concluding that the drug has been adulterated. Guaiacum resin has been used to adulterate scammony, and a specific test for it has been introduced into the Pharmacopœia; the alcoholic solution of scammony should not be coloured blue by solution of ferric chloride (compare Guaiacum Resin). Foreign resins may often be detected by dissolving the drug in hot solution of potassium hydroxide; on the addition of an acid, scammony resin is not precipitated, it having been converted into scammonic and other water-soluble acids, whereas foreign resins not undergoing a similar change are reprecipitated.

Inferior scammony is usually tough and has a dull fracture, small splinters being opaque instead of translucent. Factitious scammony that was practically free from resin soluble in ether has even been offered for sale as genuine scammony.

MYRRH

(Myrrha)

Source &c.—Myrrh is a gum-resin obtained from the stem of *Balsamodendron Myrrha*, Nees (N.O. *Burseraceæ*). It is collected chiefly in Somaliland (in the north-east of Africa), brought down to the coast and sent to Aden, whence it is shipped to Europe, either direct or via Bombay. Some myrrh is said also to be collected in the south of Arabia. Several other species of *Balsamodendron* are found in Arabia and north-eastern Africa yielding gum-resins that more or less resemble the official myrrh in appearance and odour.

These plants are shrubs or small trees, and, like most other plants belonging to the same natural order, they contain numerous schizogenous ducts in the bark, in which an oleo-gum-resin is secreted. In the case of the species from which the official myrrh is derived the tissue intervening between the ducts frequently breaks down, and thus lysigenous cavities of considerable extent are produced which, together with the ducts that remain intact are filled with a granular secretion. When the bark is wounded, therefore, the secretion is discharged in considerable quantity. It is at first yellowish white and fluid, but soon hardens to a firm, reddish brown mass which constitutes the commercial drug. The secretion also exudes from fissures that are formed in the bark by natural causes; indeed the bulk of the drug is said to be naturally exuded.

It not unfrequently contains other gums and gum-resins from which it is freed by hand-picking.

Description.—Myrrh occurs in irregular rounded tears, or lumps composed of agglutinated tears, varying in size from small grains up to masses nearly as large as the fist, pieces about the size of a walnut being of common occurrence. They have a reddish yellow or reddish brown colour and a rather rough, dull, dusty surface. They break fairly easily, the fractured surface having a rich brown or reddish brown colour and translucent, unctuous, granular appearance, often exhibiting whitish spots or veins; thin splinters are translucent or almost transparent. The drug has an agreeable aromatic odour and an aromatic, bitter and acrid, but not unpleasant taste. Triturated with water it yields a yellowish emulsion. If one

gramme of the coarsely powdered drug is shaken for a few minutes with 10 c.c. of ether and 2 c.c. of the ethereal solution allowed to evaporate to a thin film in a small porcelain dish, the residue is coloured instantly deep violet-black by the vapour of bromine, or slowly violet by the vapour of nitric acid; the latter reaction is best produced by inverting the dish

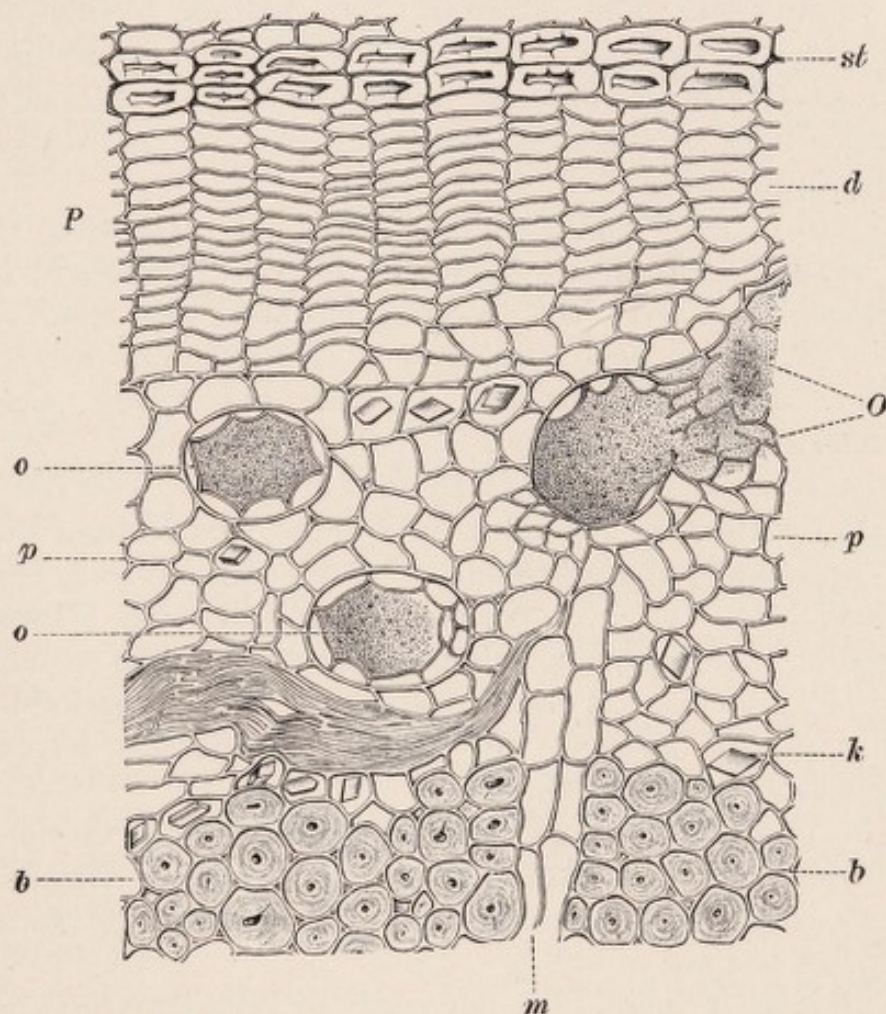


FIG. 261.—Myrrh. Section of a portion of bark, probably of *Balsamodendron Myrrha*. *P*, outer portion (bark) in which layers of sclerenchymatous cells, *st*, alternate with thin-walled cells, *d*; *p*, bast parenchyma; *b*, bast fibres; *m*, medullary ray; *o*, oleo-resin ducts containing a granular secretion (myrrh); *O*, tissue breaking down to form a cavity filled with the secretion. Magnified 280 diam. (Vogl.)

containing the film over a second dish the inner surface of which has been moistened with the acid. Tincture of myrrh will also yield similar reactions.

The student should observe

- (a) The *unctuous, granular* (not uniform or vitreous) *fracture*,

- (b) The *translucent* (not opaque) *appearance of thin fragments*,
- (c) The *aromatic, bitter taste*.

The taste and the violet colour-reaction are, perhaps, the most characteristic features of myrrh.

Constituents.—Myrrh consists of a mixture of resin, gum, and volatile oil. The latter can be obtained by distillation with water to the extent of 2.5 to 6.5 per cent. (Schimmel). The resin occurs in amounts varying from 25 to 35 per cent., the remainder of the drug consisting of gum, moisture, and various impurities.

Myrrh of good quality should yield not more than 10 per cent. of ash or less than 30 per cent. of resin (Dieterich, 1898).

Alcohol dissolves the volatile oil and the resin. The volatile oil is yellowish and viscous and resinifies with great rapidity. Both the volatile oil and the resins give the characteristic violet reaction.

The resin is not entirely soluble in ether. The insoluble (smaller) portion is separable into three free resin-acids, viz. α -, β - and γ -commiphoric acids, a combined resin-acid, commiphorinic acid, and two phenolic resins, α - and β -heerabomyrrholol. The portion soluble in ether contains α - and β -myrrholic acids. These constituents are remarkable for exhibiting little analogy with the substances that have been isolated from other resins.

The gum is apparently allied to acacia gum; it yields by hydrolysis arabinose and contains an oxydase enzyme the activity of which is destroyed by a temperature (in solution) of 100° C. but not of 90° C.

The bitter principle has not yet been isolated.

Good myrrh yields about 60 per cent. of substances insoluble in alcohol and about 4 per cent. of ash; commercial powdered myrrh often yields much more ash.

Uses.—Myrrh has stimulant and antiseptic properties; it is used as a mouth-wash and as a uterine stimulant and emmenagogue.

Varieties.—In addition to Somali myrrh (the official drug), as above described, the following varieties may be briefly alluded to.

Fadhli or *Arabian myrrh*, which occurs in smaller pieces made up of agglutinated tears, presenting a less dusty surface,

and free from white markings. The odour is less fragrant and taste less bitter than that of genuine myrrh. It is said to be collected on the mountains to the east of Aden.

Yemen myrrh, which occurs in large pieces of dark reddish brown colour and dusty surface. It exhibits no whitish streaks and exudes no oil. The taste is bitter, the odour resembles that of myrrh but is less aromatic. It is exported from Makullah to Bombay and Aden.

Substitutes and Admixtures. — *Perfumed bdellium* or *bissabol* which closely resembles myrrh. It breaks with a waxy fracture and yields to the nail, giving an oily exudation like soft myrrh. It has a yellowish colour and exhibits white markings which, however, are traversed by angular interstices filled with a brown resin. It has a taste and odour quite distinct from those of myrrh and it does not yield the violet reaction. It is frequently seen in the London market, where it is offered for sale under various names. It is probably derived from *B. erythraeum*, var. *glabrescens*, Engler.

Opaque bdellium, a very hard, yellow ochre-coloured, opaque gum-resin with but a slight odour and a bitter taste. Portions of a papery bark are frequently found associated with it. The tincture (1 in 6) assumes an intense greenish black colour with solution of ferric chloride.

African bdellium, in hard pieces, translucent in thin layers, and red when viewed by transmitted light. The fracture is dull and slaty, the margins possessing a powdery appearance; it has a bitter taste and an odour recalling pepper. The tincture gives no precipitate with ferric chloride.

Indian bdellium, which occurs in large irregular masses of a dark reddish brown colour. The fractured surface resists the nail, and is covered with characteristic, minute, shiny points of resin which also appear on the outer surface. The odour is feeble and cedar-like; it appears to be developed only on keeping. The taste is slightly acrid and devoid of bitterness.

Several other gums have also been found in commercial myrrh. But as genuine myrrh can be distinguished from all of these impurities or substitutes by its characteristic odour and taste and by the chemical test above mentioned, the student is recommended to make himself acquainted with these, and content himself with the information here given concerning the substitutes.

OLIBANUM

(Frankincense, Olibanum)

Source &c.—Olibanum or, as it is sometimes termed, frankincense (to be carefully distinguished from American frankincense) is a gum-resin obtained from *Boswellia Carterii*, Birdwood, and other species of *Boswellia* (N.O. *Burseraceæ*).

These plants are small trees that grow in Southern Arabia and in Somaliland. Like the trees that yield myrrh they contain schizogenous ducts in the bark, in which an oleo-resin is secreted. The Somalis obtain this by incising the bark and collecting the gum-resin as soon as it has sufficiently dried. The drug is conveyed to Aden and thence to Bombay, whence it is exported to Europe.

Description.—Olibanum occurs in small tears varying from 0.5 to 3 cm. in length and usually ovoid, pear-shaped, or club-shaped, but sometimes stalactitic in form, occasionally agglutinated into small masses. They are usually of a pale yellowish colour, frequently with a greenish, bluish, or reddish tinge, semi-translucent and covered with a dull white dust, the surface of the tear being dull even after the dust has been removed. They are brittle, breaking easily between the fingers; internally they are opalescent and translucent, the fractured surface being dull and waxy.

The drug has a fragrant, balsamic odour and an aromatic, slightly bitter taste, softening when chewed to a plastic mass. Triturated with water it yields a whitish emulsion.

The student should observe

- (a) The *fragrant odour*,
- (b) The *opalescent, waxy interior of the tears*.

Constituents.—Olibanum consists principally of resin (60 to 70 per cent.), gum (27 to 35 per cent.), and volatile oil (5 to 7 per cent.). These constituents have been further investigated, with the following results (Halbey, 1898) :

Soluble in alcohol, 72 per cent.	Boswellic acid, free	33.0 per cent.
	" " combined	1.5 "
	Olibanoresene	33.0 "
	Volatile oil	7.0 "
	Bitter principle	0.5 "

Insoluble in alcohol, 28 per cent.	Gum (arabic acid with Ca and Mg)	20.0	..
	Bassorin	6.0	..
	Vegetable débris	2.0	..

According to this analysis the resin consists principally of a resin acid (boswellic acid) and an indifferent resin (olibanoresene) in about equal proportions. The gum consists mainly of arabin, with which is associated a little bassorin. The volatile oil is yellowish and fragrant; it contains pinene, dipentene, and phellandrene, but the aromatic constituent is not yet known.

Uses.—Olibanum is used chiefly in the manufacture of incense and as an ingredient in plasters and fumigating pastilles.

AMMONIACUM

(Ammoniacum)

Source &c.—Ammoniacum is a gum-resin exuded from the flowering and fruiting stem of *Dorēma Ammoniacum*, D. Don (N.O. *Umbelliferae*), and probably other species, distributed throughout Persia and extending into Southern Siberia.

The drug is collected chiefly in Central Persia.

The stems of the ammoniacum plants contain, especially in the cortex, numerous, large, schizogenous ducts full of a milky secretion. In the summer, when the plant is fruiting, it is visited by numbers of beetles, which puncture the stem and cause an abundant exudation of the secretion in the form of milky drops, some of which harden on the stem, whilst others drop on to the ground. All of it is collected and sent in a very crude state, mixed with stones, stalks of the plant, and other impurities, from the ports on the Gulf of Persia to Bombay, where the drug is sorted, and whence it is exported to Europe.

Description.—Ammoniacum occurs in commerce in two forms—viz. *tear ammoniacum* and *lump ammoniacum*, the former being alone official.

The tears are small, rounded or nodular masses varying usually from 0.5 to 3 cm. in diameter. When fresh they are of a pale, dull yellow colour, which, however, darkens by keeping. They are hard and brittle when cold, but soften when warmed. Internally the tears are opaque, and vary in colour from milky white to pale brownish yellow, the freshly

fractured surface having a waxy lustre. The drug has a characteristic but not alliaceous odour, and a bitter, acrid taste. Triturated with water it forms a white emulsion, which is coloured deep orange red by a solution of chlorinated lime, yellow by solution of potash, and transiently violet by ferric chloride. The latter reaction, although not strong, should be noted, as it depends upon the presence of a constituent (salicylic acid) that is absent from other similar gum-resins, and is characteristic therefore of ammoniacum.

Lump ammoniacum consists of agglutinated, whitish, yellowish grey or bluish grey tears, mixed with varying quantities of extraneous substances, such as stones, dirt, stems and other débris of the plant, and occasionally the broad, flat mericarps of the fruit, the presence of which indicates the time at which the drug has been collected. The substance of the tears agrees with the description of the tears already given.

Good qualities of lump ammoniacum consist of tears varying in size from a pea to a hazel-nut or even larger, with a little intervening dark-coloured ground substance, and but few pieces of stem, fruits, &c. Intermediate forms composed of more or less agglutinated tears also occur.

If about 1 gramme of the drug is boiled for a few minutes with 20 c.c. of equal volumes of hydrochloric acid and water, and the solution filtered into water made strongly alkaline with ammonia, no blue fluorescence should be developed. This reaction indicates the absence of umbelliferone, which in alkaline solution exhibits a strong blue fluorescence, and distinguishes Persian ammoniacum from galbanum, asafetida, and African ammoniacum, all of which yield umbelliferone. Umbelliferone may also be tested for by strongly heating a small fragment of the gum-resin in a test-tube, boiling the contents of the tube with water, filtering, and adding ammonia as directed in the Pharmacopœia, but the former method is preferable.

The student should observe

- (a) The *clean, hard tears*, which do not crumble between the fingers,
- (b) The *characteristic odour*,
- (c) The *positive result of the test for salicylic acid*,
- (d) The *negative result of the test for umbelliferone* ;

and should compare the drug with selected tears of galbanum, which are much softer, have a distinctive odour, and yield a positive result with test for umbelliferone.

Constituents.—Ammoniacum consists of volatile oil (1 to 2 per cent.), resin (about 65 to 70 per cent.), gum (about 20 per cent.), moisture (2 to 12 per cent.), ash (1 per cent.), and insoluble residue (3.5 per cent.).

Luz (1893) found that the resin could be separated into two portions, one consisting of a resene not attacked by caustic alkalies, and the other and larger portion decomposed by long continued boiling with solution of caustic potash into salicylic acid and a resin-alcohol, ammoresinotannol, which was obtained as a brownish powder. The resin chiefly consists therefore of ammoresinotannol combined with salicylic acid.

The gum is allied to acacia gum.

Luz was unable to detect sulphur in either the volatile oil or the resin, although that element had previously been reported present in ammoniacum.

The drug contains also traces of free salicylic acid, which is the source of the reddish colour produced when ferric chloride is added to an aqueous emulsion.

Good qualities of the drug yield about 3 per cent. of ash and 65 per cent. of resin.

Uses.—Ammoniacum is a stimulant, and, being excreted by the bronchial mucous surfaces, stimulates and disinfects the secretion. It is used as a disinfectant expectorant in chronic bronchitis with profuse discharge, and in plasters as a stimulant to the skin.

Varieties &c.—The official or Persian ammoniacum is distinguished from African ammoniacum, which is obtained in Africa from (it is said) *Ferula communis*, Linné, var. *brevifolia*, by the orange red colour it yields with solution of chlorinated lime, as well as by not yielding a fluorescent solution when treated as above described. This indicates the absence of umbelliferone, which is present in African ammoniacum as well as in galbanum and asafetida.

GALBANUM

(Galbanum)

Source &c.—Galbanum is a gum-resin obtained from *Ferula galbaniflua*, Boissier and Buhse (N.O. *Umbelliferae*), and probably from other species.

These plants are, like those yielding ammoniacum, large Umbelliferous plants indigenous to and widely distributed over Persia. Two varieties at least of the drug are well recognised—viz. Persian, which is soft and contains fruit and stalks, and Levant, which is dried and contains slices of the root, seldom fruits or stalks. The latter is the variety at present usually met with.

How this drug is obtained is not exactly known.

Like the ammoniacum plants the galbanum plants contain, especially in the cortical portion of the stem (and root), numerous schizogenous ducts that secrete a milky gum-resinous fluid.

Part of the drug is apparently obtained by natural exudation from the stem, but part is certainly produced by laying bare the root, cutting the stem off near the crown, and collecting the juice that exudes and hardens, successive slices of root being removed at intervals of several days. The former procedure would probably yield the tears that are found in commercial galbanum, whilst the slices of root found in the drug indicate the latter method as the one by which that part of the drug not in distinct tears is obtained.

Galbanum reaches Europe partly viâ Russia (especially Persian galbanum), partly viâ Bombay, or viâ Turkish ports or Alexandria.

Description.—Galbanum occurs in distinct tears, in small agglutinated masses, and in lump form. The tears are rounded or irregular in form, and, though they vary in size, are usually about as large as or rather larger than a pea. Externally they are yellowish brown or orange brown in colour, and often rough and dirty. They are not, like the tears of ammoniacum, hard, but are so soft that they can usually be squeezed flat between the finger and thumb, becoming ductile and sticky. They break easily with a granular, irregular fracture, and are opaque, yellowish, and soft internally. Sometimes the tears are more or less translucent and of a bluish green colour.

Thin transverse slices of the root are commonly found mixed with commercial galbanum; they are usually about 2 or 3 cm. in diameter and frequently bear on one side the dried secretion derived from the freshly cut surface.

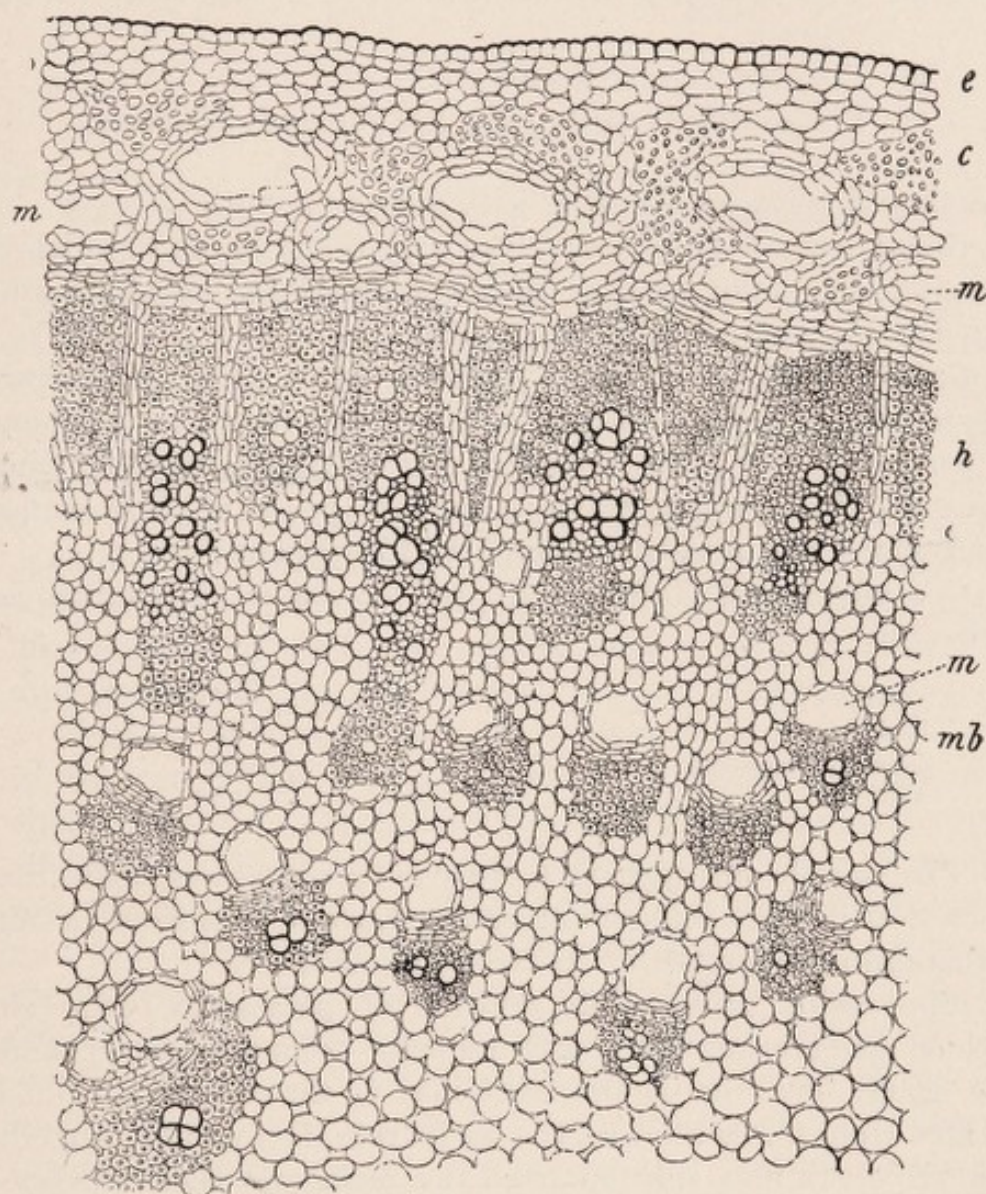


FIG. 262.—Transverse section through a portion of the stem of *Ferula galbaniflua*, showing the distribution and structure of the gum-resin ducts. *e*, epidermis; *c*, collenchyma; *m*, gum-resin ducts; *h*, wood; *mb*, bundles in pith; magnified. (Tschirch.)

The drug has a characteristic, not exactly unpleasant, aromatic odour, and a rather disagreeable, aromatic, and bitter taste.

Galbanum occurs also in lumps, corresponding to lump ammoniacum; these consist of yellowish or bluish green or

brownish tears embedded in a brownish mass and mixed with slices of root and various foreign substances.

The student should observe

- (a) The *soft yellowish brown tears*, occasionally *bluish green*,
- (b) The *characteristic odour*,
- (c) The *positive result of the test for umbelliferone*;

and should compare the drug with ammoniacum.

Small fragments of galbanum may easily be distinguished from ammoniacum by their yielding umbelliferone when subjected to the test described on p. 554.

Constituents.—Galbanum consists, apart from extraneous substances, of volatile oil (about 5 to 10 per cent.), resin (about 60 per cent.), and gum (about 20 per cent.), the residue being made up of inorganic matter (about 2 per cent., sometimes much more) and moisture (from 1 to 10 per cent.)

Conrady found (1894) in a good specimen of commercial galbanum

Volatile oil	.	.	.	.	.	.	.	.	9.5 per cent.
Resin	.	.	.	.	.	.	.	.	63.5 "
Gum and impurities	.	.	.	.	.	.	.	.	27.0 "
Ash	.	.	.	.	.	.	.	.	8.25 "

The volatile oil appears to vary in its properties, that from Persian galbanum being dextrorotatory, while that from Levant galbanum is lævorotatory (Hirschsohn, 1875).

The resin, boiled with solution of potassium hydroxide, yielded galbaresinotannol and umbellic (dioxycinnamic) acid; the latter, however, is not contained in the drug itself, but is formed from umbelliferone, the anhydride (lactone) of umbellic acid which is first split off from the resin and then converted into umbellic acid. The galbaresinotannol was obtained as a brown powder.

Umbellic acid yields in the cold with solution of potassium hydroxide and chloroform an intense green colour. Umbelliferone when boiled with solution of potassium hydroxide and chloroform yields a similar colouration, as does also galbanum itself. Galbanum also assumes a violet red colour when warmed with hydrochloric acid; the constituent to which this characteristic reaction is due is not known.

Good qualities of galbanum should yield about 40 per cent. of substances insoluble in alcohol, about 10 per cent. of moisture, and give on incineration not more than about 7 per cent. of ash.

Use.—Galbanum is used chiefly as a stimulant in plasters.

ASAFETIDA

(Asafetida)

Source &c.—Asafetida is a gum-resin obtained from the root of *Ferula fetida*, Regel, *F. asafetida*, Linné (N.O. *Umbelliferae*), and probably other species. These plants are, like those yielding ammoniacum and galbanum, large Umbelliferous plants growing in Eastern Persia and Western Afghanistan, but, as in the case of galbanum, an exact knowledge of the plants themselves or of the mode of procuring the drug is still wanting. In the cortex of the stem, and especially in that of the root, there are numerous large, schizogenous ducts filled with a milky, gum-resinous emulsion; these when wounded discharge their contents, which then gradually acquire by evaporation a firmer consistence.

Part of the drug is certainly collected in a manner similar to that in which part at least of commercial galbanum is obtained—viz. by laying bare the root of the plant and cutting off the stem close to the crown; the emulsion that flows from the cut surface is allowed to harden, for which purpose the root is protected by a dome-like covering of sticks and leaves; the hardened gum-resin is then scraped off, a slice of the root cut off, and the juice again allowed to exude, and so the process is repeated. The scrapings are united and mixed with earthy matter &c., for the purpose, it is said, of facilitating the transport of the drug, which is still inconveniently soft. Some is probably obtained by incision.

Herat and Kandahar are the centres of the asafetida trade. The drug is conveyed chiefly to Bombay, where it is sorted and whence it is exported to Europe, usually in large cases.

Description.—As in the case of ammoniacum and galbanum two forms of the drug are known—viz. tear and lump; the former, which is as a rule much purer, is alone official.

The tears, some of which are separate, some more or less agglutinated together, are rounded or flattened, and vary from

1 to 3 cm. in diameter. They are of a dull yellow or sometimes dirty grey colour, which in some cases darkens on keeping, finally becoming reddish brown, but others retain their original colour for years, thus indicating some difference in the drug. When fresh they are usually tough at ordinary temperatures, becoming harder when cooled and softer when warmed. Internally they may be yellowish or milky white, translucent or opaque; the freshly exposed surface often passes gradually through a very characteristic change of colour, becoming first pink, then red, and finally reddish brown. The drug has an intense, penetrating, persistent, alliaceous odour, and a bitter, acrid, alliaceous taste.

Lump asafetida consists of the tears agglutinated into a more or less uniform mass and mixed with varying quantities of extraneous substances such as stones, slices of the root, earthy matter, and so on. It is thus much inferior to the tears, and generally has a dark reddish colour.

Asafetida, when tested as described under Ammoniacum, yields a fluorescent solution, indicating the presence of umbelliferone or a substance yielding it, a reaction which it therefore shares with galbanum, but which serves to distinguish it from a variety of the drug met with in Bombay yielding no umbelliferone. From galbanum the tears of asafetida may be distinguished by the green colour the freshly fractured surface assumes when it is touched with nitric acid diluted with an equal volume of water.

The student should observe

- (a) The *change in colour* of the fractured surface,
- (b) The *nitric acid reaction*,
- (c) The *intense, alliaceous odour*,
- (d) The *positive result of the test for umbelliferone*.

Constituents.—Asafetida consists principally of volatile oil, resin, and gum.

The composition of typical asafetida can be well seen from the following analysis by Polasek (1897) :

Resin	.	.	.	.	.	.	62.0 per cent.
Gum	.	.	.	.	.	.	25.1 "
Volatile oil	.	.	.	.	.	.	6.7 "
Free ferulic acid	.	.	.	.	.	.	1.28 "
Moisture	.	.	.	.	.	.	2.36 "
Impurities	.	.	.	.	.	.	2.5 "

The resin consists of ferulic acid combined with asaresino-tannol; although the drug easily yields umbelliferone by the action of sulphuric acid on the ferulic acid and on the resorcin produced simultaneously from the resin, Polasek was unable to detect free umbelliferone in the drug.

The volatile oil contains pinene together with various disulphides, $C_7H_{14}S_2$, $C_{11}H_{20}S_2$, $C_{10}H_{18}S_2$, &c.

The ash varies with the quality of the drug, fine tears yielding about 5 per cent., whilst lump asafetida may contain 50 or more per cent., according to the amount of admixture that has taken place. The British Pharmacopœia places the limit at 10 per cent.

The volatile oil varies also from 3 to 9 per cent. and the substances soluble in alcohol from about 70 per cent. to less than 30 per cent., the official limit for the latter being 65 per cent., a limit which, according to Dieterich (1898), is rather too high for the average of good commercial qualities of the drug.

Uses.—Asafetida is a powerful nervine stimulant, and is used in the nervous disorders of hysteria. It has also a well-marked stimulant action on the bowel, and is employed to expel flatulence and relieve constipation.

SECTION XVI

OLEO-RESINS

The drugs that are grouped together under the above heading are mixtures of resins with volatile oils or oily liquids. They are secreted in schizogenous or schizolysigenous ducts which may be of either normal (Canada turpentine, copaiba) or pathological (balsam of Peru, storax) origin.

All of the constituents may vary considerably in their composition. Those oleo-resins which contain benzoic or cinnamic acid are frequently termed 'balsams.'

CANADA TURPENTINE

(Canada Balsam, *Terebinthina Canadensis*)

Source &c.—Canada turpentine is an oleo-resin obtained by incision from the balsam fir, *Abies balsāmea*, Miller, and the hemlock spruce, *A. canadensis* (Linné), Miller (N.O. *Coniferae*), trees widely distributed over the northern United States and Canada, extending to Hudson's Bay. The drug, which has long been known, is collected in Lower Canada, especially in the province of Quebec.

The tree contains schizogenous oleo-resin ducts, as most Coniferous trees do, but they are restricted to the bark, none occurring normally in the wood. In addition, however, to these secretion ducts, cavities are formed which fill with oleo-resin and produce blisters on the smooth trunk of the tree. From these blisters the oleo-resin is obtained by puncturing them with the pointed spout of a can which serves to receive the turpentine.

Description.—Canada turpentine is a clear, transparent liquid, about as viscid as honey, and of a pale yellow or greenish yellow colour, often exhibiting a slight greenish fluorescence.

By keeping it becomes more viscid, and finally it gradually dries to a hard resin which remains transparent and shows no disposition to crystallise, a quality that renders it particularly valuable as a medium in which to preserve microscopical preparations. It has an agreeable balsamic odour and a rather bitter and acrid taste. It is completely soluble in chloroform, benzene, and ether, but only partially in alcohol.

Constituents.—Canada turpentine consists approximately of 16 to 24 per cent. of volatile oil mixed with from 70 to 80 per cent. of resin.

The volatile oil consists chiefly of l-pinene.

Of the resin about 20 per cent. is composed of an indifferent resene, canado-resene, which is remarkable for its insolubility in alcohol. A further 20 per cent. of the resin is amorphous canadinic acid. The remaining 60 per cent. consists of two amorphous resin acids, α - and β -canadinolic acids, associated with 0.5 per cent. of crystalline canadolic acid.

The bitter principle, which is soluble in water, has not yet been isolated.

Uses.—Canada turpentine is extensively used as a microscopic mountant. For this purpose the resin, obtained by heating the turpentine until the volatile oil is driven off, is dissolved in xylol, or some other suitable solvent.

COPAIBA

(Copaiva, Balsam of Copaiba)

Source &c.—Copaiba is an oleo-resin obtained from the trunk of *Copaifera Lansdorfii*, Desfontaines (N.O. *Leguminosae*), and other species of *Copaifera*.

The trees from which the official oleo-resin is obtained are large trees attaining over 100 metres in height, indigenous to Brazil and the north of South America. The drug, which was highly esteemed by the natives of Brazil and had probably long been used by them as a medicine, was introduced into Europe about the beginning of the seventeenth century.

The oleo-resin is contained in anastomosing, schizogenous secretion ducts that form an extensive network in each zone of the secondary wood of both stem and root, extending through-

out the entire length of the zone, resembling therefore in arrangement the laticiferous tissue of the dandelion. These ducts are formed in the young wood and rapidly attain their normal diameter, which is often very considerable; at the level of the insertion of the branches a number of lateral ducts connect zone with zone. In addition to these schizogenous ducts lysigenous cavities also appear to be formed by the breaking down of the cell walls and their probable transformation into resinous or oleo-resinous substances.

The oleo-resin is collected by cutting in the trunk of the tree near the base a cavity sloping inwards and downwards, and penetrating to the centre of the trunk, resembling the 'box' made in the trunk of the turpentine trees. Into this cavity the oleo-resin is discharged; it is transferred to barrels and other vessels for exportation.

The large size of the secretion ducts, and their extensive distribution in each zone of wood throughout the entire length of the tree, render the amount of oleo-resin secreted by each tree very considerable. Even as much as 48 litres is said to have been obtained from a single tree, others again yielding but little.

The drug is exported from the seaports on the northern coast of South America—viz. Para, Maranhão, Maracaibo, Bahia, Cartagena, &c., these towns giving their names to the commercial varieties of the drug. As these differ in the percentage of volatile oil and of resin and in the composition of the latter the following typical commercial varieties may be described at length.

MARACAIBO COPAIBA

Description.—Maracaibo copaiba is a clear, viscous, brownish-yellow liquid with a slight but distinct green fluorescence. It possesses a characteristic aromatic odour and an unpleasant, acrid and rather bitter taste. It is miscible in all proportions with chloroform, carbon disulphide, and benzene, and also with an equal volume of petroleum spirit, but with larger proportions of the latter a slight precipitation takes place; with absolute alcohol it behaves similarly. The specific gravity varies from 0.980 to 0.999, or even slightly higher. The proportion of volatile oil varies from 42 to 53 per cent.

Constituents.—Maracaibo copaiba consists of a mixture of resin and volatile oil with which traces of bitter principle and fluorescent substance are associated.

The volatile oil is invariably lævorotatory, the rotation in 100 mm. tube varying from -5° to -35° , usually, however, it does not exceed -25° . Its specific gravity varies from 0.900 to 0.910 and its boiling-point from 250° to 275° C. These details are important indications of the purity of the oleo-resin.

The resin contains a small proportion of copaivic acid (removed by ammonium carbonate from ethereal solution), but consists chiefly of β -metacopaivic acid (extracted by sodium carbonate after removal of the copaivic acid); with these there is associated a small quantity of two indifferent copaibo-resenes and of crystalline illurinic acid (compare African copaiba).

The bitter principle and fluorescent substance have not yet been obtained in a pure state.

PARÁ COPAIBA

Description.—Pará copaiba is a thin, clear, bright yellow liquid quite free from any fluorescence. The specific gravity varies from 0.917 to 0.980, but is usually low. In accordance with the greater fluidity of this variety the percentage of volatile oil is high, viz. from about 55 to 90 per cent. In other characters the drug resembles the Maracaibo variety.

Constituents.—Pará copaiba also consists essentially of volatile oil and resin.

The volatile oil resembles that of Maracaibo copaiba.

The resin consists of amorphous resin-acids associated with crystalline parácopaivic acid (2 per cent.), homoparácopaivic acid, and two resenes.

The volatile oil appears to be identical with that of Maracaibo copaiba, but the resins are certainly not.

AFRICAN COPAIBA

African copaiba, the botanical source of which is not known but is possibly a species of *Hardwickia* (N.O. *Leguminosæ*), is imported from the Niger basin in West Africa. It is a rather dark yellow slightly fluorescent oleo-resin possessing an aromatic, piperaceous odour and frequently depositing crystals on standing. The specific gravity varies from 0.985 to 1.000.

It contains about 40 per cent. of volatile oil and 60 per cent. of resin (including the crystalline substance).

Constituents.—The oil boils at 260° to 275° C. and differs essentially from the oil of South American copaiba in being dextrorotatory, the rotation in 100 mm. tube being about 10° , $21'$.

The crystalline deposit consists of illurinic acid identical with that obtained from Maracaibo copaiba. The remainder of the resin consists of amorphous resin-acids, fluorescent substance, &c.

ADULTERANTS OF COPAIBA

The British Pharmacopœia (1897) recognises any variety of South American copaiba containing not less than 40 per cent. of volatile oil, and admits therefore the thin Parà variety which is less valuable, as well as the viscous Maracaibo copaiba which is more esteemed and realises a higher price. Hence the definition of the drug is difficult and sophistication comparatively easy and common.

The following are the chief adulterants and the means of detecting them.

Fixed vegetable oils, such as castor oil, render the resin left after evaporation of the volatile oil (best at a temperature of about 120° to 130° C.) tough or pasty, whereas it is usually (in Maracaibo copaiba) hard and brittle. The presence of fixed oil can also be detected by the high ester number; copaiba resin consists almost entirely of resin-acids and has a very low ester number (seldom over 15; fixed oils about 190).

Volatile oils, such as turpentine, may often be detected by distilling off the volatile oil and determining its specific gravity (usually 0.903 to 0.908), boiling-point (250° to 270° C.), and optical rotation (-7° to -25°) (sp. gr. of turpentine 0.850 to 0.880; b.pt. 155° to 165° C.). The optical rotation is important; a dextrorotatory oil would indicate the presence of African copaiba.

Colophony.—Colophony may be added to thin copaibas without making them suspiciously viscous. It is difficult to detect. One gm. of the copaiba shaken with 10 c.c. of solution of ammonia (10 per cent.) will become turbid, but should not gelatinise or deposit gelatinous lumps.

Paraffin oil.—Five gm. of the copaiba boiled with 15 c.c.

of 95 per cent. alcohol for one minute and cooled should not separate oily drops (of paraffin oil).

Gurjun balsam, an oleo-resin obtained by incision from the trunk of *Dipterocarpus turbinatus* (N.O. *Dipterocarpeæ*) and other species, large trees indigenous to Eastern India and Burmah, is used both as a medicine and for various technical purposes. It somewhat resembles copaiba in odour and taste, but is usually much darker (dark red) in colour and fluorescent. Its presence in copaiba may be recognised by adding 4 drops to a mixture of 15 c.c. of glacial acetic acid (according to Kebler 1 c.c.) and 4 drops of nitric acid; a purple or reddish colouration indicates gurjun balsam. It may also be detected by dissolving 2 drops of the balsam in 20 drops of carbon disulphide and adding a drop of a freshly prepared and cooled mixture of nitric and sulphuric acids; if gurjun balsam is present a violet colouration will be produced, but it has been shown that a similar colour has been occasionally yielded by genuine balsams.

Sophistication by mixing a cheap thin copaiba with a more valuable thick copaiba is difficult to detect.

Uses.—The active principles of copaiba are absorbed into the blood, the volatile oil, at least, being excreted by the kidneys, bronchi, and skin; hence copaiba produces along the whole genito-urinary tract, as well as in the bronchi, a stimulant and disinfectant action, increasing the mucous secretion and exciting expectoration. It is now chiefly employed in inflammatory affections of the bladder and urethra, and occasionally in chronic bronchitis. The resin has a diuretic action.

ELEMI

(Manila Elemi, Resina Elemi)

Source &c.—The term elemi is a generic one and is applied to a number of oleo-resins having certain physical properties in common. Tschirch¹ enumerates no less than 46 varieties, all of which are derived from plants belonging to the natural orders Burseraceæ or Rutaceæ. The most important and formerly official variety is exported from Manila and distinguished as Manila elemi.

¹ Die Harze, 1905, p. 421.

Manila elemi is an oleo-resin obtained from a species of *Canarium*, probably *C. luzonicum*, Gray (N.O. Burseraceæ). It is obtained by making incisions in the tree and promoting the flow of oleo-resin by the application of heat. When first obtained it is probably a clear, viscid, honey-like liquid which, however, rapidly becomes crystalline. It is exported chiefly from Manila, and arrives in this country in lead-lined cases, in a more or less solid condition.

Description.—Elemi when fresh and of good quality is pale yellow in colour, soft and granular, resembling a crystalline honey, but on keeping it gradually becomes firmer and finally hard. It is soluble in alcohol and ether, partially only in petroleum spirit. It has a fragrant, balsamic odour recalling fennel and mace, and a spicy, rather bitter taste. Under the microscope it is seen to contain an abundance of acicular crystals.

Constituents.—Manila elemi, in the soft condition in which it is usually imported, contains about 20 to 30 per cent. of volatile oil associated with amorphous and crystalline resin acids, bitter principle, &c.

The volatile oil (sp. gr. 0.87 to 0.91) consists chiefly of terpenes; the aromatic constituents have not been examined.

The resin contains α - and β -manelemic acids (soluble in solution of ammonium carbonate), α - and β -manamyrrin (insoluble in ammonium carbonate and in alcohol), maneleresene (insoluble in ammonium carbonate, soluble in alcohol), bryoidin, and bitter principle. The composition of the drug may be seen from the following table:

α -Manelemic acid	5 to 6 per cent.
β -Manelemic acid	8 to 10 „
α - and β -Manamyrrin	20 to 25 „
Maneleresene	30 to 35 „
Volatile oil	20 to 25 „
Bryoidin	1 „
Bitter principle and impurities	6 to 8 „

α -Manelemic acid is crystalline and forms crystalline salts; α - and β -manamyrrin are both crystalline, as is also bryoidin.

Uses.—Elemi has been employed in the form of ointment, as a stimulant and antiseptic application. It is now seldom prescribed.

BALSAM OF TOLU
(*Balsamum Tolutanum*)

Source &c.—Balsam of Tolu is a balsam obtained by making incisions in the trunk of *Myroxylon Toluifera*, Humboldt, Bonpland, and Kunth (N.O. *Leguminosæ*).

The tree is a native of Colombia, and occurs plentifully in the forests near the River Magdalena and its tributary the Cauca. The balsam, which receives its name of Tolu from a small town near Cartagena, on the northern coast of Colombia, is collected by cutting a V-shaped notch in the bark, and fixing below it a gourd into which the balsam flows. Many such incisions at varying heights may be made on the same tree, which, however, is much exhausted by the tapping. The contents of these gourds are emptied into skin bags and conveyed to the coast, where the balsam is transferred to tins for exportation. It is shipped chiefly from Savanilla and Cartagena.

Although the twigs of the tree contain schizogenous secretion ducts, these are soon thrown off and no new ones are formed. The bark of the trunk, from which the balsam is obtained, contains no secretory tissue, and the balsam is probably secreted in ducts formed in the new wood, a change induced by the incisions made in the tree (compare the production of colophony).

Description.—Balsam of Tolu when freshly imported is a soft, tenacious, yellowish brown, resinous mass, not soft enough to flow, but taking the form of the vessel in which it is kept. By keeping, it gradually hardens to a brownish, and, especially in cold weather, brittle and easily powdered mass which, however readily softens when warmed. It has an agreeable, fragrant, though not powerful odour, an acidulous balsamic taste, and adheres to the teeth when chewed. A small piece warmed and pressed between two glass slides to a thin film exhibits, when examined by the microscope, numerous colourless crystals embedded in a transparent mass and accompanied by a little vegetable débris.

It is easily soluble in alcohol, acetone, and chloroform, but only partially soluble in carbon disulphide, yielding to the latter principally cinnamic acid. The solution in carbon

disulphide leaves when evaporated about 25 per cent. of crystalline residue which requires for saponification not less than 30 per cent. of its weight of potassium hydroxide. These characters are important, as the balsam has been adulterated with resinous substances soluble in carbon disulphide, which give the evaporation-residue a resinous instead of crystalline character, and require less potassium hydroxide for their saponification.

Constituents.—Tolu balsam was examined by Oberländer (1894), who found it to contain the following constituents: about 7·5 per cent. of an oily liquid consisting of benzyl benzoate with a little benzyl cinnamate, traces of vanillin, and 12 to 15 per cent. of free acid, principally cinnamic acid; the resin, amounting to about 80 per cent. of the drug, yielded by saponification an alcohol (toluresinotannol), and cinnamic acid, with which was associated a little benzoic acid.

Distilled with water good fresh balsam of Tolu yields from 1·5 to 3·0 per cent. of a very aromatic volatile oil containing toluene, styrol, and free benzoic and cinnamic acids.

Uses.—Tolu balsam is used chiefly as a pleasant ingredient in cough mixtures. It possesses antiseptic properties due to the cinnamic and benzoic acids contained in it.

Adulterants.—The chief adulterants of balsam of Tolu are colophony and balsam that has previously been used in making syrup of Tolu and hence deprived of most of its free cinnamic acid and aromatic constituents.

Colophony may be detected by exhausting the balsam with carbon disulphide and evaporating the filtered solution. Pure balsam gives a crystalline residue; if colophony is present the residue is resinous and gives with concentrated sulphuric acid a green colour. A petroleum spirit extract shaken with an equal volume of a 0·1 per cent. solution of cupric acetate assumes a bright green colour if colophony is present.

Exhausted balsam may be detected by the deficient amount of substances soluble in carbon disulphide.

BALSAM OF PERU

(Balsamum Peruvianum)

Source &c.—Balsam of Peru is a balsam exuded from the trunk of *Myroxylon Pereira*, Klotzsch (N.O. *Leguminosæ*), after the bark has been beaten and scorched.

The tree grows in the forests of that part of San Salvador (Central America), near the Pacific Ocean, and known as the Balsam Coast, and probably also in other parts of Central America, as, for instance, in Honduras (Dieterich), the drug having received the name 'Peruvian' from the fact that it was originally sent from San Salvador to Callao, the port of Lima, and thence to Spain.

As in the case of *Myroxylon Toluifera*, the bark of young twigs contains secretion ducts which, however, are soon thrown off, after which no fresh ones are formed. The formation of the balsam is induced by certain treatment to which the bark is subjected, and it is, therefore, not a normal secretion of the tree, but a pathological product. Of the exact nature of the changes induced we have no knowledge, but probably, as has been proved for colophony and for storax, schizogenous secretion-ducts are formed in the new wood after the infliction of injury.

The following is a brief account of the production of balsam of Peru. The bark of the tree is first beaten with the handle of an axe or with a stone over a space about 25 × 15 cm. and the cork removed. After five days a little balsam exudes, which is soaked off by rags. Now the wounded place is heated by torches and after about a week a more abundant flow takes place which is again absorbed by rags. The place is subsequently again cut and scorched and finally the scorched bark is itself detached. The wood thus laid bare is subjected to similar treatment lasting in all about six weeks. When the secretion of balsam ceases the bark immediately above the exhausted spot is treated.

The rags are collected and when sufficient have accumulated the balsam is pressed out and boiled with water which is poured off carrying impurities with it. The bark removed from the trees is also boiled with water and the balsam thus extracted mixed with the rag-balsam. The balsam is then

filled into tin canisters with screw openings holding about 27 kilos. each; these are conveyed on mules to Acajutla and Belize, whence the balsam is shipped to Hamburg &c.

Description.—Balsam of Peru, as seen in commerce, is a rather viscid, oily liquid, resembling common black treacle, but rather thinner, and not of an adhesive or glutinous nature; it appears black in bulk, but in thin layers it is dark reddish brown and transparent. It has a fragrant, balsamic odour, and although it has no marked taste it produces, when swallowed, a burning sensation in the throat.

Balsam of Peru is heavier than water, its specific gravity varying within narrow limits—viz. from 1.137 to 1.155, being usually between 1.141 and 1.153, and this forms a valuable means by which adulteration can be detected, for many liquids that might be used for that purpose are lighter than water, and would appreciably depress the gravity. It is soluble in chloroform, and also in an equal volume of 90 per cent. alcohol, but with a larger proportion of the latter the mixture becomes turbid. It is practically insoluble in water, that liquid removing from it only a little cinnamic acid.

Its physical characters are so well marked, especially the odour and taste, that the drug is easy to recognise, but the detection of adulteration, especially with inferior qualities of the drug, which appears to be more or less regularly practised, is a more difficult problem.

Constituents.—Balsam of Peru consists essentially of an oily fluid portion mixed with a dark resin. The fluid portion (cinnamein) constitutes from 56 to 66 per cent. of the commercial drug, and consists of benzyl benzoate and benzyl cinnamate in the proportion of about three of the former to two of the latter, although this varies. Both esters are colourless, crystalline aromatic bodies which readily liquefy on heating.

The resinous portion, amounting to about 28 per cent. of the commercial drug, is composed of an alcohol, peruresinotannol, combined with cinnamic and a little benzoic acid.

The drug also contains an alcohol, peruvial, which possesses a sweet odour and taste, traces of vanillin, and free cinnamic acid.

Uses.—Balsam of Peru is antiseptic and disinfectant. It is chiefly used as an external application in certain skin diseases

and for bed sores. It has also been employed as a stimulant and disinfectant expectorant in bronchitis.

Adulterants.—Balsam of Peru is, from its nature and high price, liable to adulteration, chiefly with such liquids as alcohol, fixed oils, turpentine, copaiba, gurjun balsam, and the like. Any such admixture lowers the specific gravity, and can generally be detected by this means. Alcohol can be removed from the balsam by shaking it with water, which with the genuine drug should cause no appreciable diminution in volume. The presence of copaiba and of gurjun balsam can be detected by taking advantage of the insolubility of the resin of balsam of Peru, in carbon disulphide. One part of carbon disulphide makes a clear mixture with three parts of balsam of Peru, but on the further addition of nine parts of carbon disulphide the resin should separate leaving a clear yellow non-fluorescent liquid which on evaporating should leave a yellowish brown oil, and this warmed to 150° C. should not evolve an odour foreign to balsam of Peru. Another useful test is to warm 1 gm. of the balsam with 10 c.c. of petroleum spirit, pour off the clear liquid and shake it with an equal volume of a 0.1 per cent. solution of cupric acetate; it should not acquire a bluish green colour (absence of colophony, copaiba, &c.)

The assay of the balsam may be effected by dissolving 2 gm. of the balsam in ether, removing the resin by shaking this solution with a 2 per cent. solution of sodium hydroxide, evaporating the ethereal solution, and drying and weighing the residue; it should amount to not less than 57 per cent. Each gramme of this residue (cinnamein) should require not less than 42 c.c. decinormal alcoholic solution of potassium hydroxide for saponification, corresponding to a saponification number of at least 235 (the saponification number of benzyl benzoate being 264.3, and of benzyl cinnamate 234.0).

Recently a factitious substitute, 'perugen,' has been made by mixing synthetically prepared benzyl benzoate ('peruscabin') with storax, benzoin, and balsam of Tolu. It has an odour quite distinct from that of genuine balsam.

STORAX

(Styrax)

Source &c.—Storax is a balsam obtained from the trunk of *Liquidambar orientalis*, Miller (N.O. *Hamamelidæ*), a tree of medium size forming forests in the south-west of Asiatic Turkey.

Neither the bark nor the wood of the tree possesses the agreeable odour of storax, and under normal conditions this substance is not produced in any part of the plant. In the early summer, incisions are made or the bark is beaten but not so vigorously as to kill it; a formation of storax takes place, and the balsam soaks into the wounded bark, which is stripped off in the autumn. From the bark thus saturated the balsam is obtained by pressing it, the residue being subsequently mixed with boiling water (or boiled with water) and again pressed. The liquid balsam thus obtained forms the storax of commerce, whilst the pressed bark was formerly an article of commerce, under the name of *Cortex Thymiamatis*. The latter, coarsely ground and mixed with storax, formed 'Styrax calamitus,' under which name at the present time a factitious mixture is generally sold.

Although the bark of the tree contains secretion ducts these do not take part in the production of storax, which is secreted in schizogenous ducts in the young wood; these, by the breaking down of intervening tissue, form schizolysigenous cavities from which the balsam exudes into the wounded bark. The secretion is therefore purely pathological, and it is produced in the young wood, subsequently finding its way thence into the bark, with which it is removed when the latter is stripped off.

Description.—Crude storax is a greyish, semi-fluid, viscid substance with an agreeable, aromatic, balsamic odour and a sharp, pungent taste. By long standing it separates into a supernatant, aqueous liquid and a dark-brown, oleo-resinous layer. It is rather heavier than water, and contains usually vegetable debris, amongst which numerous bast fibres may be found. By drying it loses from 17.4 to 25.8 per cent. of water.

The crude drug is purified by dissolving it in three or four times its volume of hot alcohol filtering, and removing the

alcohol by gentle evaporation, care being taken to lose as little of the volatile constituents as possible. From 13 to 18 per cent. of the crude storax is insoluble in alcohol, the residue consisting principally of vegetable *débris* associated with inorganic matter (*Pharmacographia*). According to Evers (1896) storax contains from 6 to 9 per cent. of a greyish substance insoluble in alcohol, probably a resin ester of cinnamic acid.

Thus purified, storax is a semi-transparent, yellowish brown, semi-liquid balsam, entirely soluble in alcohol, ether, chloroform, and carbon disulphide. It should have a specific gravity of 1.109 to 1.114 at 100° C.

Constituents.—Purified storax consists of a resin mixed with an oily liquid.

The resin is composed of storesinol partly free, partly combined with cinnamic acid. Storesinol is a white odourless amorphous substance which, however, forms a crystalline potassium compound.

The oily liquid contains styrol (phenylethylene, a colourless aromatic liquid), ethyl cinnamate, phenylpropyl cinnamate (odourless liquid), cinnamyl cinnamate (=styracin, odourless crystals), vanillin, and free cinnamic acid.

The approximate composition of storax, which, however, varies considerably, may be seen from the following table :

Free cinnamic acid	17 to 23 per cent.
Esters of cinnamic acid	24 to 25 „
Water	14 to 21 „
Resin	36 „

Purified storax may contain as much as 47 per cent. of cinnamic acid (free and combined), and is, in this respect, one of the richest drugs known.

Uses.—Storax is a local and remote stimulant and antiseptic, resembling in these respects balsam of Peru, benzoin, &c. It is now seldom used.

Adulteration.—The quantitative composition of storax is so variable that its purity can with difficulty be ascertained. Cold petroleum spirit should extract from it from 25 to 45 per cent. The evaporation residue should have an acid number of 40 to 60 and an ester number of 124 to 160.

SECTION XVII

TARS AND EMPYREUMATIC
OILS

These are viscous or oily substances produced by the destructive distillation of organic substances such as wood, coal, &c.

TAR

(Wood Tar, Stockholm Tar, Pix Liquida)

Source.—Tar, or, as it is better termed, wood-tar (*Pix liquida*), to distinguish it from coal-tar (*Pix carbonis*), is a bituminous liquid obtained from the wood of *Pinus sylvestris*, Linné (N.O. *Coniferae*), and other species of *Pinus* by destructive distillation.

Various methods have been adopted for the destructive distillation of wood. The simplest consists in constructing a mound of the material and covering it with earth, leaving spaces by which air can be admitted and through which the tar produced can drain off. The wood is fired, and, the heat being carefully controlled, charcoal is left as a residue in the mound, whilst a tarry and an aqueous liquid are collected.

More modern apparatus consists of either upright or horizontal iron retorts arranged singly or in a battery of about twenty. These are heated from without, and the products of distillation may be ranged under three heads :

- (i) Gaseous products analogous to coal-gas; these are conducted back to the hearth and burnt, serving to economise fuel, or they are stored in a gasometer until required for some such purpose.
- (ii) Watery products; water containing acetic acid, methyl alcohol, acetone, &c.; these pass over and are con-

densed. They serve as a source of acetic acid, methyl alcohol, &c.

- (iii) Tarry products ; these separate from the watery liquid on standing.

Coniferous wood is chiefly employed, as it yields more tar than the wood of foliage trees (beech, birch, &c.) From the former 15 to 20 per cent. of tar may be obtained, from the latter 6 to 8 per cent.

Description.—Tar is a dark-brown or blackish, semi-liquid substance, with a peculiar aromatic odour and a bitter, pungent taste ; it is heavier than water, its specific gravity varying from 1.02 to 1.15. By keeping, it becomes thicker, and acquires a granular appearance, due to the formation of minute crystals (probably pyrocatechin, resin acids, &c.). Water agitated with it acquires a yellow colour and acid reaction (distinction from coal-tar, which imparts to water an alkaline reaction). The filtered aqueous liquid is coloured red by very dilute (0.1 per cent.) solution of ferric chloride, and dark olive green by a drop of the official test solution (5 per cent.) of the same substance (distinction from juniper-tar oil). Tar is completely soluble in ten volumes of alcohol.

Constituents.—The composition of tar is very complex ; the following are its chief constituents : benzene, toluene, xylene, and styrolene (styrol) ; phenol, cresol, guaiacol and its homologues ; pyrocatechin and paraffin. The most important of these, as far as the medicinal activity is concerned, are probably pyrocatechin, phenol, cresol, guaiacol, and their homologues.

Tar from Coniferous woods, which alone is official, is especially rich in guaiacol and its homologues, beech-tar in guaiacol and pyrogallol derivatives, birch-tar in guaiacol and benzophenol derivatives.

Uses.—Tar is used as an external stimulant and antiseptic in certain skin diseases ; given internally in the form of pills or syrup, it acts as a disinfectant and deodorant of offensive discharges from the bronchial tubes.

COAL-TAR

(Pix Carbonis)

Source &c.—Coal-tar is obtained by the destructive distillation of coal in iron or clay retorts. The gaseous products that are formed during the process constitute ordinary illuminating gas; the liquid products are a watery solution of ammonium carbonate, sulphide, &c., and a heavy, dark, viscid, tarry liquid, coal-tar. The retort contains a porous, carbonaceous residue, coke.

Description.—Coal-tar is a nearly black, viscid liquid, with a strong, penetrating, disagreeable odour; it is heavier than water, its specific gravity varying from 1.1 to 1.2. It is only slightly soluble in water, to which it imparts an alkaline reaction (distinction from wood-tar). It consists of a large number of substances, amongst which benzene, toluene, xylene, phenol, cresol, naphthalene, anthracene, and pitch may be mentioned.

Uses.—The chief medicinal use of coal-tar is as an antiseptic application in certain skin diseases.

JUNIPER-TAR OIL

(Huile de Cade, Oil of Cade, Oleum Cadinum)

Source &c.—Juniper-tar oil is obtained by the destructive distillation of the wood of *Juniperus Oxycedrus*, Linné; it is prepared chiefly in the mountains in the south-east of France, in the department of Alpes Maritimes, Var, and Gard.

Selected portions of the trunk of the tree are cut into small pieces, and placed in a crude distilling apparatus consisting of an iron pot inverted over a concave stone slab, from the centre of which a pipe leads downwards. The smaller pieces of wood are used to heat the iron pot, and the distillate which passes down the delivery pipe is collected and allowed to stand for several weeks. At the end of this time it will have separated into three distinct layers, viz. a heavy, tarry mass, an aqueous liquid, and a lighter dark oily layer. The latter, which is true huile de cade, is separated and conveyed to neighbouring towns (Nismes, Avignon, &c.) for sale.

Description.—Juniper-tar oil is a dark reddish brown or nearly black liquid, with a tarry, but by no means disagreeable, odour and a bitter, acrid taste. It is less viscid than wood-tar, having an oily consistence. The specific gravity is usually rather less than that of water (about 0.990), but in some (old) specimens it is rather higher. It is completely soluble in ether and chloroform, partially in cold but almost completely in boiling alcohol. Water agitated with it dissolves but little, acquiring a yellowish colour and an acid reaction (distinction from coal-tar). The filtered aqueous solution assumes a reddish colour with a very dilute solution of ferric chloride (distinction from birch-tar), but an olive-brown colour with the official test solution (5 per cent.) of the same reagent (distinction from ordinary wood-tar). The petroleum spirit solution of the tar should acquire a brown and not a green colour when shaken with a 0.1 per cent. solution of cupric acetate (absence of pine tar). Not less than 63 per cent. should distil between 150° and 300° C.

Constituents.—The composition of juniper-tar oil is but very imperfectly known. The chief constituent appears to be a sesquiterpene, $C_{15}H_{24}$, boiling at 250°–260° C. Cadinene, $C_{15}H_{24}$, boiling-point 272°–275° C., is also present, but in small quantity. The tar also contains guaiacol, ethylguaiacol, propylguaiacol, creosol, &c., together with acetic acid and its homologues.

Uses.—Juniper-tar oil is used as an application in various skin diseases.

SECTION XVIII

FIXED OILS, FATS, AND WAXES

Fixed oils and fats are substances of either vegetable or animal origin, and consist of various organic acids of high molecular weight belonging chiefly to the stearic, oleic, linolic or ricinoleic acid series combined with glyceryl; they yield by saponification with caustic alkalies the alcohol glycerol (glycerin), the alkali combining with the organic acids to form soaps.

Waxes are solid or, occasionally, liquid substances resembling the fats and oils but differing in yielding monatomic alcohols instead of glycerol by saponification which is readily effected by boiling alcoholic solutions of caustic alkalies, but not by aqueous.

OLIVE OIL

Source &c.—Olive oil is the oil expressed from the pericarp of the ripe fruit of the olive tree, *Olea europæa*, Linné (N.O. *Oleaceæ*).

The olive is a small tree widely distributed by cultivation, especially in the countries bordering on the Mediterranean, and has been introduced into America (California), where it promises so well and is increasing so rapidly that that country will probably soon be independent of Europe for her supply of olive oil.

The tree produces a small, ovoid, drupaceous fruit about 2 or 3 cm. in length, which, whilst unripe, is green in colour and in this state is pickled and used as a table relish. As the fruits ripen the cells of the mesocarp become filled with a fixed oil, the colour at the same time changing from green to purple. They are collected in the winter and spring (December to April) when ripe or nearly ripe, crushed, and subjected to a moderate pressure. The crude oil that flows

from the press is run into tubs and mixed with water; the latter removes colouring matter and other impurities from the oil, and the oil, after it has completely separated from the water by standing, is skimmed off and filtered; in this way the finest quality of olive oil (virgin oil) is obtained. The marc is again ground, mixed with hot water, and again pressed, this time more strongly, and thus a second quality of oil is obtained. The residue still contains a little oil which may be obtained by a third pressing or by extraction with solvents; such oil is usually used for soap-making &c. Sometimes the entire fruits are thrown into heaps and allowed to ferment; on pressing, the whole of the oil is obtained, but it is of inferior quality, and is used principally for technical purposes.

Description.—For medicinal use only the first pressings, obtained without heat, should be employed. Such oil has a pale yellow or greenish yellow colour, a slight characteristic odour, and a bland taste without rancidity. Its specific gravity varies from 0.914 to 0.919. It is liquid at ordinary temperatures, but when cooled to 10° C. it often assumes a pasty consistence, from deposition of solid fats, and at 0° C. it becomes a nearly solid, granular mass.

Constituents.—Olive oil consists chiefly of olein and a little palmitin, together with linolein and traces of arachin, the palmitin and arachin separating out in the solid form when the oil is cooled. By saponification these compounds yield respectively oleic, palmitic, linolic, and arachic acids together with glycerin.

Uses.—Olive oil has nutritive and laxative properties. Applied externally it is emollient and soothing.

Adulterants.—Valuable indications of purity are to be found in the specific gravity (0.914 to 0.919) and in the quantity of iodine with which the oil is capable of combining (79 to 88 per cent.; Hübl's test). The free acid present should not exceed 1 per cent., calculated as oleic acid (absence of lower qualities, which usually contain excess of acid). Cotton-seed oil, a frequent adulterant, is best detected by Halphen's (Bevan's) test which consists in warming 2 c.c. of the oil mixed with 1 c.c. of amylic alcohol and 1 c.c. of a 1 per cent. solution of sulphur in carbon disulphide for ten minutes in a brine bath when no red colour should be developed. The official test consists in warming with an acidified ether-alcohol

solution of silver nitrate, when no reduction of the silver salt should take place, but this fails if the cotton-seed oil has been previously refined by heating. Sesamé oil (from the seeds of *Sesāmun indicum*, Linné, N.O. *Pedalineæ*, India) is tested for by mixing 2 c.c. with 1 c.c. of hydrochloric acid containing 1 per cent. of sugar, shaking for half an hour, adding 3 c.c. of water, again shaking and setting aside, when the aqueous liquid should not be pink.

For details of other tests for ascertaining the purity of olive oil, reference should be made to works on analytical chemistry, such as Allen's 'Commercial Organic Analysis,' 2nd Edition, Vol. II. Part I.

COD-LIVER OIL

(*Oleum Morrhuæ*)

Source &c.—Cod-liver oil is the oil extracted from the fresh liver of the cod, *Gadus morrhua*, Linné (Phylum *Chordata*, Sub-phylum *Craniata*, Class *Pisces*, Order *Teleostei*).

The cod inhabits the North Atlantic Ocean in great numbers, leaving the deeper seas and approaching the coasts, chiefly of Norway and Newfoundland, towards spawning time, that is, from January to April. During that time immense quantities of the fish are taken both by nets and lines. The livers are cut out whilst the fish is quite fresh, the healthy ones selected, and, after the removal of the gall bladders, subjected to a gentle heat, usually about 70° C. (according to the British Pharmacopœia not exceeding 82.2° C.). The oil that separates is drawn off and exposed to a low temperature (about -5° C.), at which a considerable quantity of solid fat separates. This is removed by filtration and pressure, and the oil thus purified forms the finest medicinal oil.

Inferior qualities of the oil are obtained from the residual livers (to which are added the unhealthy and injured livers previously rejected), by subjecting them to a higher temperature. Much oil, also of inferior quality but suitable for many technical purposes, is obtained by keeping the livers until they are partially decomposed, skimming off the oil that has separated and heating and pressing the residue; such oil is usually of a brownish colour.

After the livers have been removed and the offal separated the fish are dried, and form an important article of commerce. The chief seats of the cod fishery are the shallow banks off Newfoundland, and the Loffoden Islands near the north-west coast of Norway.

Description.—Cod-liver oil should be of a pale yellow colour, and have a slight fishy, but not rancid odour. Its specific gravity should vary from 0.920 to 0.930; it is readily soluble in ether and chloroform, but sparingly in alcohol. It may be distinguished from vegetable oils by the violet colour which is developed when a drop of sulphuric acid is added to a few drops of the oil on a porcelain slab (indicating the presence of cholesterin).

Constituents.—Cod-liver oil consists chiefly of jecolein and therapin associated with palmitin and probably other fat-acids combined with glyceryl. Traces of biliary acids, alkaloids (morrhaine, aselline), cholesterol, iodine, &c., are also present.

Jecolein and therapin consist of jecoleic and therapeutic acids combined with glyceryl. Jecoleic acid is a very unstable acid belonging to the oleic acid series.

Uses.—Cod-liver oil is employed as a nutritive and is a food rather than a drug.

Adulteration.—Cod-liver oil is liable to adulteration with other fish-liver oils and with seal oil, the detection of which is exceedingly difficult. The following characters have been suggested for a pure cod-liver oil for medicinal use :—

Colour	Pale yellow
Odour	Slightly fishy, not rancid
Taste	Bland, not rancid
Specific gravity	0.925 to 0.931
Saponification number	179 to 198
Free fat-acid calculated as oleic	not over 1.5 per cent.
Melting-point of fat-acids	23° to 26° C.
Iodine value	154° to 170° C.
Refractive index (20° C.)	Not under 1.4790

One c.c dissolved in 10 c.c. of carbon disulphide should give a violet blue colour with one drop of sulphuric acid.

If three drops of nitric acid (sp. gr. 1.4) are added to 15 drops of cod liver oil and the mixture vigorously stirred, it should develop a bright, rose-red colour.

SUET

(Sevum)

Source &c.—The official suet is mutton suet, obtained from the abdomen of the sheep, *Ovis aries*, Linné (Phylum *Chordata*, Sub-phylum *Craniata*, Class *Mammalia*, Order *Ungulata*). It is purified by thoroughly crushing it so as to break the membranous vesicles in which the fat is contained, melting, and straining. During the cooling it should be stirred, so as to prevent the constituents of higher melting-point separating in a more or less granular form.

Description.—Suet should be white, smooth, and uniform in appearance, and possess a slight characteristic odour, but be free from rancidity. It melts at about 45° C. to 49° C., and has a specific gravity of 0.948 to 0.953 (at 15° C.).

Constituents.—It consists principally of stearin and palmitin (about 80 per cent.), associated with olein (about 20 per cent.). The acid number should not exceed 2; the iodine number ranges from 35 to 45.

LARD

(Adeps)

Source &c.—Lard is the purified fat from the abdomen of the hog, *Sus scrofa*, Linné (Phylum *Chordata*, Sub-phylum *Craniata*, Class *Mammalia*, Order *Ungulata*).

The abdominal fat of the hog is obtained in the form of flat, leafy masses known as 'flare.' These should be first washed to free them from any salt that may have been used to preserve them, then stripped as far as possible of external membrane, and hung in a current of air for a few hours to dry. They must then be crushed or comminuted in any suitable manner, such as by beating in a stone mortar or passing through a mincing machine, in order to break the membranous vesicles and liberate the fat contained in them. If this were not done, either the fat would be retained in the vesicles or so high a temperature would have to be applied that the fat would acquire an unpleasant taste and odour. The crushed fat is exposed to a temperature which should not exceed 57° C. (in order to avoid

the injurious effect of too great a heat), and when completely melted strained through fine muslin and gently stirred till cool, avoiding any form of beating which would introduce air into the melted fat and favour the development of rancidity. If not stirred the lard is liable to assume a granular condition, from the crystallisation of the constituents of higher melting-point (stearin and palmitin).

Description.—Lard is a uniform, soft, white, fatty substance melting at about 38° C. and having at 15° C. a specific gravity of about 0.934 to 0.938. It has a slight fatty, but not rancid or otherwise disagreeable odour, and should not be granular in appearance. It should be entirely soluble in ether.

Constituents.—Lard consists of about 40 per cent. of stearin and palmitin mixed with about 60 per cent. of olein, but these proportions are subject to a little variation, and with them both melting-point and specific gravity.

Adulterants.—Lard is liable to contain common salt, which is often added to preserve it for domestic use; it may be tested for chlorides by boiling with water, cooling, filtering the aqueous liquid, and adding silver nitrate and nitric acid. Starch, which might be added to give it a whiter appearance, could also be detected in the filtrate by solution of iodine.

But the most frequent adulterant of lard is cotton-seed oil, which has been found in American lard, large quantities of which are imported. It may be detected by the tests described under 'olive oil' and by a rise in the iodine number which should not exceed 60.

BEESWAX

(Cera flava; Cera alba)

Source &c.—Beeswax is the wax separated from the honeycomb of the hive bee, *Apis mellifica*, Linné (Phylum *Arthropoda*, Class *Insecta*, Order *Hymenoptera*).

Wax is a material secreted by the bee on the under surface of its body, and employed to form the walls of the cells of the honeycomb. After the separation of the honey the residual wax is purified by melting with water, separating, and straining; it then forms the yellow wax of commerce. White wax is obtained by exposing thin bands of yellow wax for several weeks to the action of air and sunlight, occasionally watering

it, and if necessary remelting, to promote the bleaching by exposing fresh surfaces to these influences. Yellow wax is also largely bleached by chemical means, such as the action of chromic acid.

Wax is imported from Jamaica, California, Chili, Egypt, Syria, Madagascar, Morocco, &c.

Description.—Yellow wax is a yellowish or brownish yellow solid, with an agreeable, honey-like odour, breaking with a granular fracture, and not unctuous to the touch. It is readily and entirely soluble in hot oil of turpentine, sparingly in cold alcohol, but entirely in about 300 times its weight of boiling 96 per cent. alcohol. It is practically insoluble in water and in boiling solution of sodium hydroxide, the two latter liquids after filtration being neither turbid, nor becoming turbid on the addition of hydrochloric acid.

The specific gravity of wax varies from 0.960 to 0.970, and its melting-point from 62.5°C. to 64°C. These limits are narrow, and the specific gravity and melting-point often afford very valuable information as to the purity of the sample under examination.

Constituents.—Beeswax consists principally of melissyl palmitate (myricin), with which is associated free cerotic acid (cerin), an aromatic body cerolein, and probably melissyl stearate.

Cerotic acid, $\text{C}_{25}\text{H}_{51}\text{COOH}(?)$, is an acid belonging to the formic acid series, the formula of which is not definitely established. It crystallises from alcohol in granular colourless crystals melting at $78^{\circ}\text{--}79^{\circ}\text{C.}$ Ceryl cerotate, $\text{C}_{25}\text{H}_{51}\text{COOC}_{26}\text{H}_{53}$, occurs in Chinese wax, the produce of *Coccus pela*, Westwood, and in wool fat.

Melissyl palmitate, $\text{C}_{15}\text{H}_{31}\text{COOC}_{30}\text{H}_{61}$, is the palmitic ester of melissyl alcohol; the latter occurs in colourless crystalline needles melting at 85°C.

Adulterants.—Beeswax is liable to adulteration with solid paraffin, with various fats and waxes of vegetable or animal origin, with resin, stearic acid, &c. The melting-point and specific gravity are two very important constants, varying within narrow limits, and of great service in indicating adulteration.

Paraffin and bodies belonging to this class are not attacked by hot, concentrated sulphuric acid, whereas beeswax is entirely destroyed; hence if 5 grammes of beeswax are heated for fifteen minutes with 25 grammes of concentrated sulphuric acid to

160° C., and the mixture afterwards cooled, rinsed with alcohol and then extracted with ether the latter solution should leave no appreciable solid residue on evaporation. A better test for paraffin (and other foreign waxes) is Weinwurm's which is performed as follows:

Saponify 5 gm. of the wax by boiling it with 25 c.c. of semi-normal alcoholic solution of potassium hydroxide, evaporate to dryness, dissolve the residue in 20 c.c. of glycerin on a water-bath, and add 80 c.c. of boiling distilled water; a clear or at least translucent solution should be obtained.

Resin (colophony) would be readily dissolved by cold alcohol, in which genuine beeswax is sparingly and only partially soluble.

Soap would be removed by hot water, and the filtrate would become cloudy when acidified with hydrochloric acid from separation of the fat acid.

Stearic acid, Japan wax (obtained from the fruits of various species of *Rhus* (N.O. *Anacardiaceæ*), tallow, and all fats easily saponified, would be converted into soap by the action of boiling aqueous solution of sodium hydroxide which does not appreciably attack wax; the solution after separation and filtration would then be rendered turbid by hydrochloric acid from separation of the free fat acids.

Starch (which might be added to white wax) would be detected by boiling with water and applying the iodine test. Inorganic substances, such as kaolin, would be detected in the ash, and by their insolubility in oil of turpentine.

Foreign colouring matters may be detected by boiling the wax with alcohol for five minutes, cooling thoroughly for several hours, and filtering; the filtrate should be almost colourless.

Further information respecting the purity of wax may be obtained by determining the acid number, which should be not less than 17.9, and the ester number (69.6 to 76.1) as directed in the Pharmacopœia.

SPERMACETI

(Cetaceum)

Source &c.—Spermaceti is a concrete, wax substance obtained mixed with oil from the head of the sperm whale, *Physēter macrocephālus* (Phylum *Chordata*, Sub-phylum *Craniata*, Class *Mammalia*, Order *Cetacea*).

The sperm whale inhabits the Pacific, Atlantic, and Indian Oceans. Its head is of enormous size, occupying about one-third of the animal, which varies from 50 to 70 metres in length. In a special, large cylindrical organ in the upper region of the huge jaw and above the right nostril an oily liquid, crude sperm oil, is secreted. After the whale has been captured this cavity is emptied of its oil, which on keeping deposits a quantity of crystalline matter. This, the spermaceti, is separated by pressure and purified by remelting, and washing with dilute solution of sodium hydroxide to free it from the last traces of oil; the spermaceti separated from the soap thus produced, and from excess of free alkali, forms as it cools crystalline masses.

Description.—Spermaceti occurs in translucent, crystalline masses, pearly white in colour and unctuous to the touch; it has but little odour or taste. Its specific gravity varies from 0.94 to 0.95 (Kebler, 0.905 to 0.945), and its melting-point from 46° C. to 50° C. (Kebler, 42° to 47° C.). It is insoluble in water and cold alcohol, but soluble in ether, chloroform, and boiling alcohol, crystallising from the latter solvent on cooling.

Constituents.—It consists principally of cetyl palmitate, $C_{15}H_{31}.COOC_{16}H_{33}$, together with a small proportion of esters of other fat acids.

Cetyl alcohol, $C_{16}H_{33}OH$, which can be obtained from spermaceti by saponifying with alcoholic solution of potassium hydroxide, diluting with hot water, filtering from the soluble potassium palmitate and crystallising from hot alcohol, forms brilliant, colourless crystals melting at 49.5° C.

Adulterants.—Spermaceti may be adulterated with stearic acid, stearin, tallow, and paraffin wax. Stearic and other fat acids may be detected by the amount of volumetric solution

of sodium hydroxide required for neutralisation; 0.2 gramme of spermaceti dissolved in 20 cubic centimetres of alcohol should be made alkaline by one drop of volumetric solution of soda. Stearin, tallow, and paraffin are insoluble in boiling alcohol; stearin and tallow increase the saponification number but paraffin wax lowers it.

The purity of spermaceti may be judged by its pearly, crystalline appearance, by its not exceeding the above limit of acidity, and by its requiring between 125 and 135 milligrammes of potassium hydroxide to saponify one gramme of the drug.

WOOL FAT

(Lanolin, Adeps Lanæ)

Source &c.—Wool fat is a fatty or, more correctly, waxy substance secreted by the hairs constituting the fleece of the sheep *Ovis aries*, Linné (Phylum *Chordata*, Sub-phylum *Craniata*, Class *Mammalia*, Order *Ungulata*).

If a few threads of raw sheep's wool are examined under the microscope little masses of a fatty substance may be seen adhering to them. This is the crude, natural wool fat; part of it is soluble in water and is removed during the first cleansing process which consists in steeping the fleeces in water; part is insoluble in water and can subsequently be removed by benzene, acetone, or other suitable solvent, forming, after evaporation, a brownish grease. It is also removed when the fleeces are scoured with soap and water, the second cleansing process. When the emulsion thus produced is acidified the wool fat is separated together with the fat-acids produced by the decomposition of the soap. These fat-acids can be converted into the corresponding calcium salts and the wool fat separated by treating the product with acetone; the acetone solution, evaporated to dryness, yields crude wool fat which has to be purified by suitable means.

Wool fat may also be extracted by scouring the fleeces with hot water, and allowing the emulsion thus produced to stand, when impure wool fat rises as a cream. This can be cleansed by repeatedly mixing with water and separating by centrifugation, the resulting wool fat being subjected to a final process of purification.



Description.—Purified wool fat is a yellowish, tenacious, unctuous solid with a characteristic odour. It melts at about 42° C. and is soluble in acetone, benzene, and the usual fat solvents. It may be distinguished from other fats by its solubility in boiling alcohol and also by the following test (for cholesteryl alcohol) : shake 0.1 gm. of wool fat with 2 c.c. of warm acetic anhydride, cool, pour the clear solution into a porcelain dish and stir in five drops of sulphuric acid ; a transient pink colour passing to green will be produced.

Constituents.—Wool fat consists chiefly of cholesteryl and isocholesteryl alcohols combined with lanoceric, lanopalmitic, carnaubic, myristic, a little oleic, and possibly also palmitic and cerotic acids.

Uses.—Wool fat is largely used as an emollient and for promoting the absorption of drugs by the skin.

Adulterants.—The most probable adulterants of wool fat are mineral fats (soft paraffin) or animal and vegetable fats and oils. Wool fat, like most waxes, is not readily attacked by boiling aqueous solution of potassium hydroxide, but may be saponified by boiling, or heating under pressure, with alcoholic solution of the same, the saponification number varying from 90 to 102. Mineral fats are not attacked by either aqueous or alcoholic solution of potassium hydroxide, and their presence would lower the saponification number. Animal and vegetable fats and oils would by the same treatment be saponified and raise the saponification number ; they would also be saponified by aqueous alkalies which would not attack wool fat or mineral fats. Glycerin can be detected by shaking the wool fat with hot water and evaporating the aqueous solution.

SECTION XIX

SACCHARINE SUBSTANCES

MANNA

(Manna)

Source &c.—Manna is strictly a generic term applied to the saccharine exudations from a number of different plants belonging to various natural orders, but when not otherwise specified is understood to mean the saccharine exudation from the stem of the manna ash, *Fraxinus Ornus*, Linné (N.O. *Oleaceæ*), a small tree widely distributed over Southern Europe and cultivated especially in Sicily for the production of manna.

The trees are considered fit for yielding manna when they are about ten years old. Every day a transverse or oblique incision is made through the bark on one side of the stem; the saccharine liquid that exudes flows down the stem in favourable seasons, and dries to stalactitic masses, but in rainy weather it drops from the trunk and is caught upon cactus leaves (more strictly branches), placed beneath it, yielding an inferior quality. In the following year the tree is cut upon the opposite side, and in the succeeding year again on the first side. The stem is then exhausted, the tree is cut down, and from the stool two or more shoots are allowed to grow, which in ten years are again



FIG. 263.—Portion of the stem of a Manna tree, showing the incisions and adhering manna. Reduced. (Vogl.)

ready for tapping. In good seasons about 500 gm. of manna is obtained from each stem.

Description.—The finest qualities of manna, known in commerce as 'flake manna,' are in stalactitic pieces about 10 or 15 cm. long and 2 or 3 cm. wide, which are more or less conspicuously three-sided, one of the sides (that which has been next the stem) being concave and smooth. It is yellowish white in colour and very brittle, even friable, exhibiting when broken an indistinctly crystalline structure. It has a slight agreeable odour and a sweet taste.

Inferior qualities of manna are of a darker, brownish yellow colour, and composed of broken flakes agglutinated into a more or less sticky, gummy mass.

Constituents.—Manna consists principally of mannite (mannitol), $C_6H_8(OH)_6$, of which it may contain from 40 to 60 per cent. Mannite is a well-defined, crystalline substance belonging to the class of alcohols (a hexahydric alcohol), and is widely diffused throughout the vegetable kingdom. It is associated in manna with two sugars, viz. manninotriose (6 to 16 per cent.) and manneotetrose (12 to 16 per cent.). Each molecule of manninotriose yields by hydrolysis two molecules of galactose and one of dextrose; each molecule of manneotetrose yields two of galactose and one each of dextrose and lævulose. Dextrose, mucilage, inorganic substances, a minute quantity of a fluorescent substance, fraxin, and about 10 per cent. of moisture also occur in manna.

Use.—Manna is used medicinally as a gentle laxative.

HONEY

(Mel)

Source &c.—Honey is a saccharine substance deposited by the hive bee, *Apis mellifica*, Linné (Phylum *Arthropoda*, Class *Insecta*, Order *Hymenoptera*), and other species in the cells of the honeycomb.

The nectar secreted by the nectaries of numerous flowers contains as its principal constituent cane-sugar (sucrose). This nectar is sucked up by the bee through an air-tight tube formed from its ligula and labial palps. It is carried through the œsophagus into the crop or honey-sac, becoming mixed

on its way with the salivary secretion from special glands. During its stay in the honey-sac, the cane-sugar of the nectar is converted into invert-sugar (dextrose and levulose) by the enzyme, invertase, which is contained in the salivary secretion. Arrived in the hive, the bee empties the honey-sac by regurgitation into a cell of the honeycomb. From the cells of the honeycomb the honey is separated by cutting and draining, or by centrifugation, or by pressure with or without heat.

Some quantity of honey is produced in England, but the chief sources of supply are California, Chili, and Jamaica.

Description.—Honey, when fresh, is a viscous, transparent liquid, becoming semi-solid on standing from crystallisation of the dextrose contained in it. It varies in colour from nearly white to reddish brown. It has an agreeable odour and a sweet, slightly acrid taste, both odour and flavour being to a great extent dependent upon the nature of the flowers from which the nectar was collected.

Constituents.—Pure honey consists chiefly of dextrose and levulose together with water in which these are at first dissolved. It also contains small quantities of volatile oil, formic acid, cane-sugar, dextrin, proteids, wax, pollen grains, and often fragments of dead insects, &c. It yields from 0·3 to 0·8 per cent. of ash containing traces only of sulphate and chlorides, and usually exhibits slight lævo-rotation (-2° to -20°).

Uses.—Honey is largely used as a demulcent and sweetening agent as well as for its nutritive properties.

Varieties.—Honey obtained from heather and clover is considered to have the finest flavour, while that from Coniferous plants and species of *Eucalyptus* is the least agreeable. Some indication of the source of the honey may be obtained from the identity of the pollen grains contained in it. Jamaica honey is often dark in colour, while Australian honey usually has an unpleasant eucalyptus flavour.

Adulterants.—The most common adulterants are cane-sugar and commercial glucose both of which produce dextro-rotation in the honey. The presence of calcium sulphate, which may be tested for in the usual way either in the honey or in the ash, indicates commercial glucose. Pure honey should show at most a slight turbidity when mixed with three or four volumes of alcohol (absence of dextrin, a frequent constituent of commercial glucose).

SECTION XX

ANIMALS AND ANIMAL
GLANDS AND SECRETIONS

Although but few entire animals are used in medicine, the treatment of disease by the employment of animal secreting organs or preparations derived from them ('organotherapy') has recently been considerably extended, and it has become necessary for the student of pharmacognosy to include such secreting organs in his studies. Before proceeding to this section of the work it will be desirable to take a very brief survey of the animal kingdom, more especially as several animal substances have already been described.

Various systems of zoological classification have been from time to time proposed, but the following one is readily intelligible and well adapted for the object in view. By it the animal kingdom is divided successively into Phyla, Classes, Orders, Families, Genera, and Species. The following outline embraces the chief Phyla, Classes, and Orders and indicates their most important characters.

Phylum I.—Protozoa. This phylum includes the simplest and most primitive animals, each consisting of a minute, single cell. Loose colonies are sometimes formed by division or budding, but differentiated tissues are not developed. Most of them live in water, and some form calcareous or siliceous skeletons. They are grouped into three classes, viz. the *Rhizopoda*, which are predominantly amœboid, the *Sporozoa*, which are usually encysted, and the *Infusoria*, which are actively motile by means of cilia or flagella. The *Rhizopoda* include such animals as the Foraminifera, the accumulated calcareous skeletons of which form most chalks and limestones. The *Sporozoa* are mostly parasitic, e.g. the malarial parasite. The *Infusoria* move actively and are found in great numbers in stagnant water, vegetable infusions, &c.

Phylum II.—Porifera. These are mostly passive, vegetative marine animals which form colonies and exhibit slight division of labour, sexuality, &c. Familiar examples are the ordinary sponges in which very minute pores on the surface (inhalant canals) lead into chambers lined with flagellated cells. The movement of the flagella draws a current of water with food particles through the sponge, the waste products being discharged through larger exhalant openings. The Porifera have no body cavity, but often secrete a horny (bath sponge), calcareous or siliceous skeleton.

Phylum III.—Cœlentera. Multicellular animals which, like the Porifera, have no body cavity; they are usually radially symmetrical and develop stinging cells. The most familiar examples are the sea-anemones, jelly-fishes, and corals, the last named being colonies of individuals which secrete a calcareous skeleton.

Phylum IV.—Platyhelminthes or Flat-worms. In this group the primitive radial symmetry is lost; the body is flattened but no true body cavity is formed. Here the first indications of a head and brain are to be discerned. To this phylum belong the Trematodes or Flukes (liver fluke of the sheep) and the Cestodes or Tapeworms, all of which are parasitic.

Phylum V.—Nemertea or Ribbon Worms. These are the first animals possessing an open gut and closed blood-system; they are mostly marine and, for the purpose in hand, unimportant.

Phylum VI.—Nematohelminthes. Thread-like worms, mostly parasitic and provided with a distinct body cavity, a well developed alimentary canal, a mouth, and an anus. To this phylum belong such well-known parasites as the round-worm (*Ascaris*), the thread-worm (*Oxyuris*), the Guinea worm (*Dracunculus*), *Trichina* &c.

Phylum VII.—Annelida. These exhibit a well-developed coelom and a distinct segmentation of body which is visible externally. The Annelida include the *Chaetopoda* or worms with bristles (earth-worm, lob-worm) and the *Hirudinea* or worms devoid of bristles (leech).

Phylum VIII.—Echinoderma. The echinoderms are radially symmetrical animals which exhibit a tendency to form calcareous skeletons. Familiar examples may be found in the sea-cucumbers, sea-urchins, star-fishes, &c.

Phylum IX.—Arthropoda. This important phylum consists of bilaterally symmetrical animals exhibiting numerous segments and bearing paired, jointed appendages; the sexes are always separate. The chief classes are *Crustacea*, *Myriopoda*, *Insecta*, and *Arachnoidea*.

The *Crustaceans* include the crabs, lobsters, cray-fish, shrimps, &c.; they mostly live in water and breathe by gills.

The *Myriopods* embrace the centipedes, millipedes, &c.

The *Insects* are usually winged, breathe by a system of air-tubes and undergo a metamorphosis. They are subdivided into eighteen orders of which the following are the most important for the purposes of the present work.

- (a) *Hymenoptera*.—Ants, bees, wasps, &c.; they have four transparent wings, are usually provided with mandibles, and are furnished with a sting or with an ovipositor.
- (b) *Lepidoptera*.—Butterflies and moths; they have four scaly wings, a suctorial mouth, and no ovipositor.
- (c) *Diptera*.—House-flies, gnats, midges, &c.; they have one pair of transparent wings and a suctorial mouth; the larva is a maggot.
- (d) *Coleoptera*.—Beetles; these have one pair of wings and one pair of hardened wing-cases; they are provided with biting mandibles.

All the members of the foregoing orders undergo a complete metamorphosis from larva to perfect insect.

- (e) *Hemiptera*.—Aphides, Coccus insects, bugs, &c.; these have piercing, suctorial mouths and either two pairs of wings or none (the male Coccus insect alone undergoes complete metamorphosis).

The *Arachnoidea* include the scorpions, spiders, mites, ticks, &c.

Phylum X.—Mollusca. The Molluscs (snails, mussels, oysters, cuttlefishes, &c.) are unsegmented, have no appendages, and have a soft body secreting an outer shell (in the cuttlefish an inner, calcareous shell).

Phylum XI.—Chordata (Vertebrata). These have a dorsal supporting axis and a dorsal, tubular nervous system. The most important classes are the *Pisces*, the *Amphibia*, the *Reptilia*, the *Aves*, and the *Mammalia*.

The chief sub-classes of the *Pisces* are (i) *Elasmobranchii* or Cartilaginous Fishes such as the skate, shark, dog-fish, &c., and (ii) *Teleostomi*, which have a more or less bony skeleton. The most important order of *Teleostomi* is *Teleostei*, or true Bony Fishes, which includes the cod, herring, salmon, and most of the modern fishes.

The class *Amphibia* are those vertebrates which exhibit a transition from aquatic to terrestrial life. The frog, toad, and newt are types.

The class *Reptilia* includes the tortoises, turtles, lizards, snakes, alligators, &c.

The class *Aves* includes the divisions *Ratitæ* or Running Birds (ostrich) and the *Carinatæ* or Flying Birds.

Of the class *Mammalia* the following Orders belonging to Sub-class *Eutheria* or placental animals may be mentioned: (i) *Xenarthra* (sloths, anteaters); (ii) *Nomarthra* (pangolins); (iii), *Sirenia* (dugong, sea-cow); (iv) *Ungulata* (hoofed animals such as the ox, hog, sheep, musk-deer, &c.); (v), *Cetacea* (whales, dolphins, &c.); (vi) *Rodentia* (rats, beavers, &c.); (vii), *Carnivora* (lions, tigers, bears, &c.); (viii) *Pinnipedia* (seals, walruses); (ix) *Insectivora* (hedgehogs, shrews, &c.); (x) *Chiroptera* (bats); (xi) *Prosimiæ* (lemurs); (xii) *Anthropoidea* (monkeys, baboons, apes, man).

SUPRARENAL GLAND

The suprarenal gland is a small, ductless, glandular organ situated above the kidney. It consists chiefly of an outer brownish yellow portion or cortex and an inner brownish black portion or medulla. This inner portion, and extracts made from it, possess remarkable hæmostatic properties which are due to a crystalline body, adrenine or adrenaline, which is present in very small proportion. This substance has been prepared synthetically in the form of a pale buff-coloured crystalline powder.

Adrenine is the most powerful hæmostatic known. By subcutaneous injection the blood-vessels are locally constricted so as to render minor surgical operations almost bloodless. It is similarly used to arrest postpartum and other hæmorrhages.

PANCREAS

(Pancreas)

Source &c.—The pancreas used in medicine is obtained from the pig (*Sus scrofa*, Linné).

Description.—The pancreas is a gland, weighing (in man) from 60 to 100 gm., situated near the stomach in a depression formed by the duodenum to which it is closely attached, and into which it discharges its secretion by means of a principal branching excretory duct called the pancreatic duct. Immediately after the introduction of food into the stomach, the pancreas begins to produce its secretion, which in the case of man averages about 150 gm. a day. This secretion contains guanine, xanthine, leucine, and other bodies, together with the zymogens of four enzyme ferments. These zymogens are converted into the ferments themselves by the enterokinase which is present in the duodenum.

The pancreatic juice contains the zymogens of the following four enzyme ferments:—

(i) Trypsin, which digests proteids as pepsin does, but acts best in alkaline solution.

(ii) Amylopsin, which digests starch by converting it into maltose; it also acts best in alkaline solution.

(iii) Steapsin, which digests fats by converting them into glycerin and fat-acid, the latter uniting with alkalies to form soaps.

(iv) Milk-curdling ferment similar to but not identical with rennin.

Commercial pancreatin is a mixture of these enzymes together with other substances.

OX GALL

(Ox Bile, Fel Bovinum)

Source &c.—Ox gall is the liquid contained in the gall-bladder of the ox, *Bos taurus*, Linné (Phylum *Chordata*, Class *Mammalia*, Order *Ungulata*).

The gall-bladder is a pyriform bag attached to the under surface of the liver. It receives the secretion from the liver

and discharges it into the duodenum ; this action is continuous, but is increased by the arrival of food in the duodenum. In man the quantity secreted varies from 500 to 1,000 c.c. daily. Bile is regarded as a waste product of the liver, the chief function of this organ being the metabolism of carbohydrates and nitrogenous material.

Description.—Fresh ox bile is a brownish yellow or brownish green, rather viscous liquid, with an unpleasant odour and disagreeable bitter taste. It is neutral or faintly alkaline in reaction, has a specific gravity of about 1.022, and is characterised by the following reaction: To 10 c.c. of a 5 per cent. aqueous solution of ox bile add a drop of solution of sugar (1 in 4) and then gradually sulphuric acid until the precipitate at first formed is redissolved ; the mixture will acquire a carmine colour changing to violet. This reaction is due to the action of furfuraldehyde (from the sulphuric acid and sugar) upon cholalic acid (produced by the sulphuric acid acting upon taurocholic and glycocholic acids).

Constituents.—Ox gall contains the sodium salts of taurocholic and glycocholic acids together with colouring substances (bilirubin, biliverdin), mucin, lecithin, cholesterol, fat, soaps, &c., in aqueous solution. For medicinal use the mucin is usually removed by precipitation with alcohol and the filtrate evaporated to a thick extract.

Use.—Ox gall is given in cases of deficiency of bile, but it is of doubtful medicinal value.

PEPSINUM

(Pepsin)

Source &c.—Commercial pepsin is a mixture of the enzyme ferment pepsin with other substances obtained from the mucous membrane lining the stomach of the pig, sheep, or calf.

The surface of this mucous membrane exhibits multitudes of minute pits, each of which is about 0.2 mm. in diameter, and is the common orifice of two or three minute, elongated, tubular ducts. The pit together with the ducts debouching into it is termed a gastric gland. The duct is lined with two kinds of cells, viz. central cells and parietal cells, the former being the more numerous. The central cells secrete substances termed

zymogens which are the precursors of enzyme ferments but are not the ferments themselves, the zymogens comprising pepsinogen and rennin zymogen. The pepsinogen is converted into pepsin and the rennin zymogen into rennin. The parietal cells secrete hydrochloric acid. These substances, probably with others, in aqueous solution constitute the gastric juice which is discharged from the glands into the stomach when meat is introduced into the mouth and masticated. Their action on the food is to convert insoluble proteids into soluble peptones and thus permit of digestion. Peptones differ from (soluble) proteids in not being coagulated by heat or precipitated by nitric acid &c.

Commercial pepsin is obtained by stripping the mucous membrane from the stomach, mincing it and digesting it with water acidified with hydrochloric acid by which insoluble proteids are dissolved. From the filtered liquid it is precipitated by saturation with sodium chloride or ammonium sulphate, the peptones being left in solution. The pepsin is collected, dissolved in water and freed from sodium chloride &c. by dialysis; it may then be precipitated by alcohol, or the aqueous solution may be evaporated to dryness in a vacuum and powdered.

Description.—Pepsin occurs in commerce as a pale yellowish powder, or in translucent scales or grains with a faint odour free from putrescence and a slightly saline bitterish taste. It is soluble in water, especially on the addition of a little hydrochloric acid. It contains the enzyme, pepsin, but does not consist of it. An acidulated aqueous solution converts insoluble proteids into soluble parapeptone (or acid albumose), propeptone, and finally into peptone. Its action is inhibited by sodium chloride and by alcohol, and is completely destroyed at a temperature of 70° C.

Use.—It is employed in dyspepsia caused by deficient gastric secretion.

GELATIN

(Gelatinum)

Source &c.—Gelatin is an albuminoid substance obtained by boiling skins, cartilages, &c., with water, straining, skimming, and otherwise purifying the solution, evaporating and

finally drying by exposure to the air. During the boiling the collagen contained in the cartilages &c. is converted into gelatin, which then passes into solution.

Description.—Gelatin occurs in thin sheets, or in shreds or powder, which may be nearly colourless or pale yellow and almost free from odour and taste. In cold water it swells and when heated dissolves; it is soluble also in acetic acid and glycerin, but not in alcohol, ether, &c. A two per cent. hot aqueous solution should gelatinise on cooling, but this property is destroyed by the prolonged action of heat. Boiling with diluted hydrochloric acid converts it into the hydrochloride of glutin-peptone. An aqueous solution is precipitated by solution of tannic acid but not by dilute solutions of alum, lead acetate, or ferric chloride. It is rendered insoluble when the aqueous solution is mixed with potassium bichromate and exposed to light; formic aldehyde produces a similar change.

Constituents.—Gelatin is composed chiefly of the nitrogenous substance glutin. It should not yield more than two per cent. of ash.

Uses.—Apart from its various technical uses, gelatin has been employed as a nutrient and as a styptic, but its value for these purposes has been over-rated. It is also used as a demulcent, and combined with glycerin as a basis for suppositories.

LEECH

(Hirudo)

Source &c.—Leeches are aquatic worms, and are bred in ponds for medicinal use, chiefly in Germany (near Hanover) and in the south of France (near Marseilles). Two varieties are official—viz. the speckled leech, *Sanguisuga medicinalis*, Savigny, and the green or Hungary leech, *Sanguisuga officinalis*, Savigny (Phylum *Annelida*, Class *Hirudinea*, Order *Gnathobdellida*); they may be distinguished by the ventral surface, which in the former is of a greenish yellow colour, spotted with black, whilst in the latter it is olive green, surrounded with a black line.

Although the dorsal surface of the leech is marked with numerous (about 100) annulations, the body is not divided into distinct segments. It tapers towards each extremity, and is provided

at each with a sucking-disc by which it can attach itself to any object. The anterior disc, which is smaller than the posterior, contains three jaws radiating from a common centre ; each jaw is furnished with a number of minute teeth, and resembles a portion of a circular saw. The animal attaches itself by means of its anterior sucker to the skin, which is thereby slightly raised ; the three jaws, by a saw-like movement, produce three slits which unite to form the characteristic triradiate cut, and the leech gorges itself with blood ; it then relinquishes its hold,

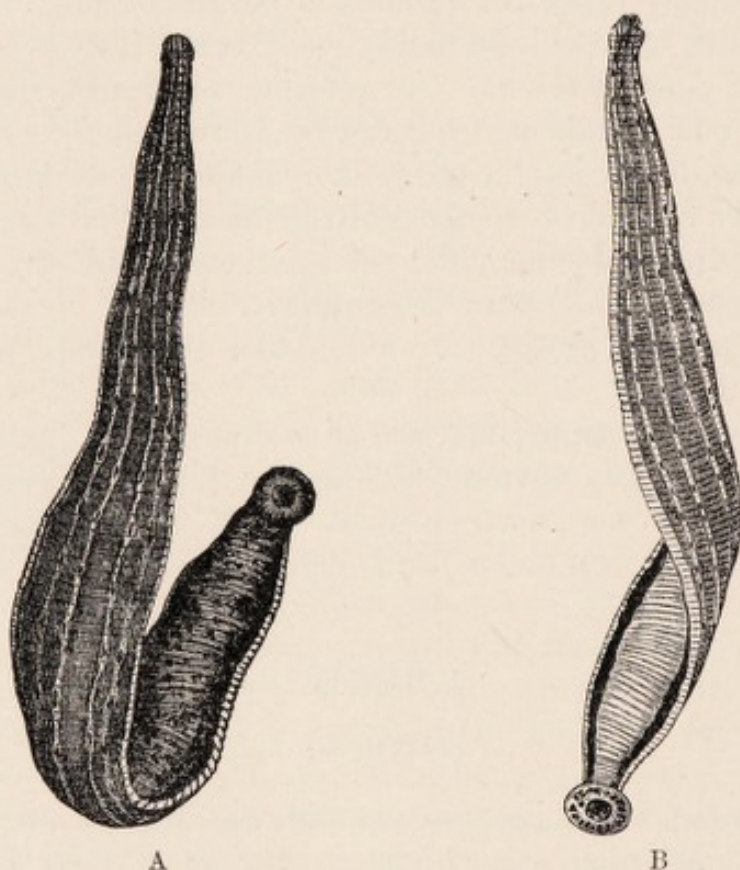


FIG. 264.—Leech. A, speckled leech, *Sanguisuga medicinalis*
B, green leech, *Sanguisuga officinalis*. Magnified. (Moeller.)

and drops from the skin. The blood which it has drawn is so slowly digested that a single meal will last for several months.

Although the leech is hermaphrodite—that is, both sexes are united in the same individual—it is incapable of self-fertilisation. It reproduces itself by means of eggs, and the young require about five years to arrive at maturity.

The quantity of blood that a leech will draw is not large (from 4 to 8 c.c.), but the flow of blood from the cut is often continued for some time ; this appears to be due partly

at least to a substance, hirudin, which is secreted by the salivary glands of the leech and injected into the cut. The flow of blood can also be maintained by fomentation.

Uses.—Leeches are used to reduce inflammation by withdrawing blood. Hirudin, which retards the coagulation of blood, has been suggested for use in thrombosis and other conditions in which the blood shows a disposition to clot too readily.

CANTHARIDES

(Spanish Flies, *Cantharis*)

Source &c.—Cantharides are the dried beetles, *Cantharis vesicatoria*, Latreille (Phylum *Arthropoda*, Class *Insecta*, Order *Coleoptera*).

The number of beetles known to possess vesicating properties is very large, and includes numerous species, but only a few are employed for that purpose, and of these latter one only is official.

Cantharides, or, as they are frequently termed, Spanish flies, are widely distributed over Southern Europe; they are gregarious and inhabit chiefly ash trees, privets, elders, &c. They are collected in the very early morning before sunrise, whilst they are unable to use their wings, by shaking them from the trees on to cloths placed beneath; they are killed by exposing them to the fumes of ammonia, acetic acid, or burning sulphur, or by stove heat. When fresh they possess a powerful, disagreeable odour, which diminishes by keeping.

They are collected in Southern Russia, Galicia, Roumania, and also to a much smaller extent in Italy and Spain.

Description.—Cantharides are about 20 to 25 mm. long, about 7 mm. broad, smooth, and of a shining green or coppery green colour. The wing-cases are long and narrow, and conceal two transparent, brown, membranous wings. Each insect possesses three pairs of legs and one pair of antennæ.

Constituents.—The principal constituent of cantharides is a definite crystalline body, cantharidin, which, although almost



FIG. 265.—Spanish blistering beetle, *Cantharis vesicatoria*. Slightly enlarged. (Maisch.)

insoluble in cold water and only sparingly soluble in alcohol, dissolves readily in acetic ether and in chloroform. With caustic alkalies (potassium or sodium hydroxide) it unites to form soluble salts, and there is evidence to show that in the beetles it exists partly as free cantharidin, partly in combination in the form of salts soluble in water. The soft parts of the insect are the chief seat of cantharidin. Good cantharides contain from 0.5 to 0.8 per cent. or occasionally as much as 1 per cent.

In addition to this substance the beetles contain about 12 per cent. of fixed oil.

Assay.—Moisten 20 gm. of finely powdered cantharides with 3 c.c. of hydrochloric acid, transfer to a Soxhlet apparatus and exhaust with benzene. Distil off the benzene and boil the residual fatty matter for 10 minutes with 105 c.c. of water acidulated with hydrochloric acid, using a reflux condenser. Transfer the hot aqueous solution to a capacious separator, and repeat the boiling with four successive portions of 50 c.c. of water, unite the aqueous solutions, and shake out with successive portions of 30, 30, 20, and 20 c.c. of chloroform. Recover the chloroform by distillation from a tared flask, dry the residue at 60° C., and wash first with 10 c.c. of a mixture of equal volumes of absolute alcohol and petroleum spirit, and finally with petroleum spirit until the latter leaves no appreciable residue on evaporation. Dry at 60° C. and weigh.

Uses.—Cantharides possess rubefacient and vesicant properties; given internally, the drug acts as an irritant poison.

Varieties &c.—The drug is but seldom adulterated. Occasionally the Rose beetle (*Cetonia aurata*, Linné) is found mixed with it; it has a very similar colour, but is easily distinguished by being much broader.



FIG. 266.—Chinese blistering beetle, *Mylabris sidea* (= *M. phalerata*, Pall.). (Maisch.)¹

Chinese Blistering Beetles.—Large quantities of blistering beetles are regularly imported from China, but they are so distinct from the official cantharides that an admixture, with the entire insects at least, would be at once detected.

Two species are imported, viz.

1. *Mylabris sidea*, Fabricius (*M. phalerata*, Pallas), is the larger; it varies from 12 to 30 mm. in length, and from 5 to

¹ Maisch's figure is apparently erroneously named *M. Cichorii*.

10 mm. in breadth. It is black in colour, but the wing-cases are traversed by three broad, brownish-yellow bands. These bands bear black, bristly hairs which, however, are not readily seen in the commercial drug, as most of them have been broken off. The beetles inhabit China, Bombay, Assam, &c.

2. *Mylabris cichorii*, Fabricius, is on the average smaller than the foregoing; it varies from 10 to 15 mm. in length, but is marked with similar yellow bands, which, however, are usually brighter in colour. The chief distinction of this species lies in the yellow downy pubescence with which the yellow bands are covered, the hairs on the black bands being black. It inhabits China and Eastern India.

Chinese blistering beetles are richer in cantharidin than the official cantharides, containing from 1 to 1.2 per cent. They form a useful source of this substance.

In addition to these, several other blistering beetles find their way occasionally to London, e.g. *M. lunata*, Pallas, and *M. bifasciata*, Oliver, from South Africa, *Epicauta gorhami*, Mars, from Japan &c.

Admixture with (entire) exhausted beetles can be detected by the deficiency in cantharidin and in fat.

COCHINEAL

(Coccus)

Source &c.—Commercial cochineal is the dried, fecundated, female insect, *Coccus cacti*, Linné (Phylum *Arthropoda*, Class *Insecta*, Order *Hemiptera*).

The cochineal insects are indigenous to Central America and Mexico, where they live upon the fleshy branches of various species of *Nopalea* (*Cactaceæ*). The production of aniline dyes has, however, largely diminished the trade in cochineal, and at the present time the insects bred in the Canary Islands form the bulk of the commercial drug.

The insects are of a bluish red colour and very minute, measuring about a millimetre in length, and the male alone is provided with wings. After fecundation the female insects rapidly increase in size and develop abundance of a red colouring matter. They are then brushed off the plants and killed either by the fumes of burning sulphur or charcoal, or

by hot water or stove heat; by the first method the waxy secretion (m.pt. 106° C.) with which the body of the insect is covered, and which imparts to it a whitish appearance, is left intact (silver grain cochineal), but by the use of heat this wax is melted and the colour changes from whitish to dark reddish black (black grain cochineal). They are then dried in the sun, during which process they shrivel to about one-third of their size, and sifted to remove foreign fragments &c. The number of harvests varies with the climate; in the Canary Islands there are generally two.

Description.—The dried cochineal insects of commerce are about 5 mm. long, oval in outline, flattish or slightly concave on one side and arched on the other. They are of a purplish black or purplish grey colour, and transversely wrinkled. They scarcely show any resemblance to insects, but when macerated in water they swell considerably, and then the three pairs of legs can be discerned. They are brittle, and easily reduced to a dark red or puce-coloured powder.

Constituents.—Cochineal contains up to 10 per cent. of a red colouring matter, carminic acid, which is obtainable in small, red prismatic crystals; it is soluble in water, alcohol, and in alkaline solutions. The drug also contains fat (about 10 per cent.) and wax (about 2 per cent.), together with albuminoids, inorganic matter, &c.

The exact methods by which commercial carmine is produced are trade secrets; the preparation contains about 15 per cent. of water, 50 per cent. of carminic acid, 7 per cent. of ash, and about 20 per cent. of nitrogenous substances. It appears to be produced by precipitating infusions of cochineal by alum, in the presence of lime salts and either albumen or gelatin.

Adulteration.—Cochineal is frequently adulterated by the addition of inorganic matter such as talc, barium carbonate and sulphate (for silver grain cochineal), or manganese dioxide, lead sulphide, magnetic iron sand, &c. (for black grain cochineal). These can readily be detected by means of the ash which should not exceed 6 per cent., genuine cochineal of good quality yielding generally about 2.5 per cent. Silver grain cochineal, heavily 'dressed,' may yield up to 50 per cent. of ash.

MUSK

(Moschus)

Source &c.—Musk is the dried secretion from the preputial follicles of the musk deer, *Moschus moschiferus*, Linné (Phylum *Chordata*, Class *Mammalia*, Order *Ungulata*).

The musk deer is a small, graceful animal about the size of the roebuck, and inhabits a large area in Central Asia,



FIG. 267.—Musk caddy.

extending from the Caspian Sea to the eastern boundaries of the Chinese Empire. The male animal, which alone produces the musk, bears on its belly, a short distance behind the navel and just in front of the preputial orifice, a small sac produced by an infolding of the skin. This sac is the musk sac or musk pod, and it contains a soft, unctuous, brownish substance, musk, which is remarkable for its intense, penetrating, and persistent odour. The musk is formed in alveoli produced on the inner lining of the sac and is discharged into the cavity. The outer

surface of the pod is covered with hairs and is provided with a small canal, serving for the discharge of the secretion, debouching close to the preputial orifice.

The animals are snared or shot, and the musk pods cut out trimmed and dried; they are then wrapped singly in paper and packed about twenty-five together in a small rectangular box covered with silk; this box is known as a 'caddy.'

Most of the musk of European commerce is obtained from Thibet or from the Chinese province of Szechuen (Tonquin musk); it is conveyed down the Yangtse-Kiang river to Shanghai, whence it is exported. Smaller quantities are obtained from the southern Chinese province of Yunan (Yunan musk), and some finds its way viâ Nepaul or Assam to Calcutta (Nepaul musk, Assam musk).

The musk pods are classified by the Chinese into three qualities, or 'piles' as they are termed. In London they are again examined, probed with a knife &c., and again classified into piles, pile 1 consisting of genuine pods, whilst those of pile 3 are obviously sophisticated.

Description.—The best variety of the drug is that known as Tonquin. This is imported in pods packed in 'caddies' or latterly in larger tins. The pods are nearly circular or sometimes distinctly oval in outline and lenticular in shape; they resemble small dark flattened cakes about 5 to 7 cm. in diameter and 2 to 3 cm. thick. On one of the flattened surfaces (the lower surface of the pod as attached to the animal) is a circular or oval piece of brown skin about 4 cm. in diameter; this is part of the hide of the animal, and exhibits when closely examined a central or nearly central small orifice (the orifice of the pod), around which are arranged tangentially directed hairs. The latter vary from whitish to brown in colour; those near the orifice are naturally short, but those a little distance removed have been clipped, and are stiff and bristly.

The remainder of the pod is covered with a very thin, soft, supple membrane, and appears dark brown in colour when the pod is filled with musk. It often exhibits a fine steel-blue iridescence, whence the term 'blue skin,' by which this variety of Tonquin pods is known. This thin blue skin is the inner skin of the pod; the outer skin, which is tough and fibrous, having been carefully stripped off with the exception of the circular piece surrounding the orifice. By this means the

appearance of the pod is improved and its value enhanced. Good pods weigh about 30 to 40 grammes, and contain about half that weight of granular musk which fills them loosely.

The pods from which the outer skin has not been removed are also imported; these are known as 'natural skin,' 'thick skin,' or 'old style' pods. They are usually convex on the lower surface, which is covered with the hide of the animal, but nearly flat on the upper surface, and there protected by a tough, fibrous but hairless skin.

The musk contained in the pods is always moist, and often has a strongly ammoniacal odour. It can be freed from

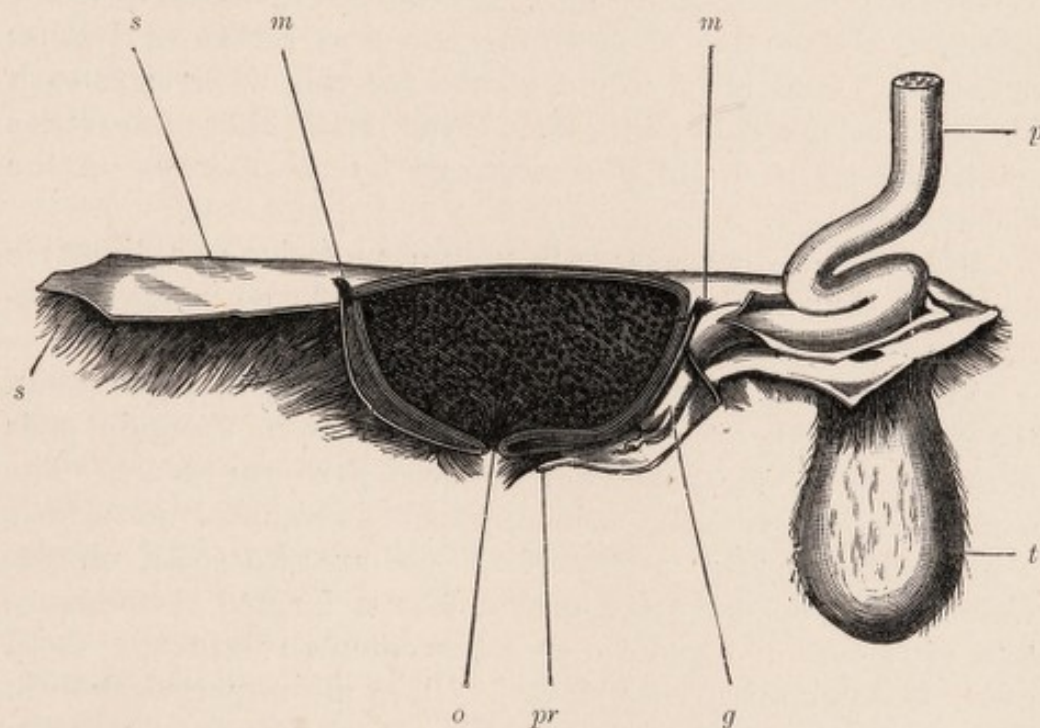


FIG. 268.—Musk pod and generative organs of the male Musk Deer. *s*, skin; *p*, penis; *t*, scrotum; *g*, gland of the penis; *pr*, preputial orifice; *o*, orifice of the musk sac; *m*, muscular coat of musk sac. (Moeller, after Brandt.)

moisture and ammonia by exposing it to the air, and then forms dark reddish brown unctuous grains ('grain musk') with which occasional short hairs are mixed; it possesses a strong characteristic odour and bitter taste.

Constituents.—Musk yields by distillation with steam and subsequent purification a small percentage of a viscid colourless oil with a very powerful and agreeable odour of musk; this oil appears to be a ketone and has been termed muskone. The drug contains moisture, fatty matter, proteids, and

inorganic substances. Water dissolves from 50 to 75 per cent. of it, but alcohol only 10 to 12 per cent. It should not contain more than 15 per cent. of moisture, or yield on incineration more than 8 per cent. of ash.

Adulterations.—Musk is liable to gross adulteration, which is in some cases easy to detect, but in others exceedingly difficult. The sophistication of the drug is effected by the Chinese, and is practised to such an extent as to lead to the assertion that pure musk is scarcely procurable. The pods are skilfully opened, part of the musk is removed and replaced by some worthless substitute. Inorganic substances, such as small stones, leaden shot, &c., are comparatively easily detected, and so are such adulterations as scraps of leather or horn. Dried blood would yield a red ash, whereas the ash of genuine musk is whitish. Resin and other substances soluble in spirit would be recognised by the increase in the alcoholic extract.

Uses.—Musk is occasionally used in medicine as a diffusible stimulant, but the bulk of the drug is employed in the manufacture of perfumes.

Varieties.—1. *Yunan Musk*.—This variety is imported in the pods, which are easily distinguished from Tonquin pods by their more nearly spherical or even pyriform shape. The skin rises towards the orifice, which is situated in a little depression; near the margin of the pod are two small nipples which, with the depressed orifice, bear a fancied resemblance to a pig's eyes and snout, hence the common term 'pig-faced pods,' by which these are known. They are imported both in the natural pod and blue skin. The musk is nearly equal in value to Tonquin.

2. *Assam and Nepaul Musk*.—These varieties are usually imported grained, and are distinguished by the odour. If pure they are of good quality.

3. *Cabardine Musk* is mostly exported from the northern Chinese ports to Japan; a little musk of inferior quality is also brought to Nishni-novgorod, whence it finds its way to London.

CASTOR

(Castoreum)

Source &c.—The drug that is known by this name consists of the dried preputial follicles of the beaver, *Castor fiber*, Linné (Phylum *Chordata*, Class *Mammalia*, Order *Rodentia*).

The beaver inhabits principally the Hudson's Bay territory, but is found also in Western Russia, in Siberia, and elsewhere, living chiefly, if not entirely, upon vegetable matter, such as roots, bark, &c., of trees.

The generative organs of the beaver are concealed in a hollow or cloaca. Into the preputial (or vaginal) canal there open two large glands, one on each side. These glands, cut from both male and female animal and dried, form the commercial drug. In the fresh state they contain a whitish or yellowish creamy substance, but as they dry this becomes dark in colour. Our supplies are derived almost entirely from the Hudson's Bay territory.

Description.—The dried glands are of a dark-brownish or greyish colour, pear-shaped, and about 8 or 10 cm. long. They are frequently connected in pairs by a portion of the preputial or vaginal canal which has been cut away with them. They are firm, heavy, and solid, and possess a characteristic, empyreumatic, and not altogether agreeable odour. They contain a brown or reddish brown resinous secretion, in which, under the microscope, spherical grains of crystalline calcium carbonate can be detected, often in considerable quantity. The secretion varies much both in quantity and appearance, being sometimes pale in colour and soft, sometimes hard and dark.

Constituents.—The composition of the resinous secretion appears to be subject to great variation, due probably to the age of the animal, the time of year at which it was killed, and the time the drug has been kept. The amount of moisture present may be as much as 40 per cent., resinous matter soluble in alcohol about 40 to 70 per cent., fatty matter soluble in ether about 8 per cent. Salicin, benzoic acid and a crystalline substance, castorin, are also said to be present, but these statements require confirmation. The characteristic odour is due to a volatile oil.

Uses.—Castor has long been used in the treatment of hysteria and dysmennorrhœa; it also has an action on the heart and is used in certain forms of heart-disease.

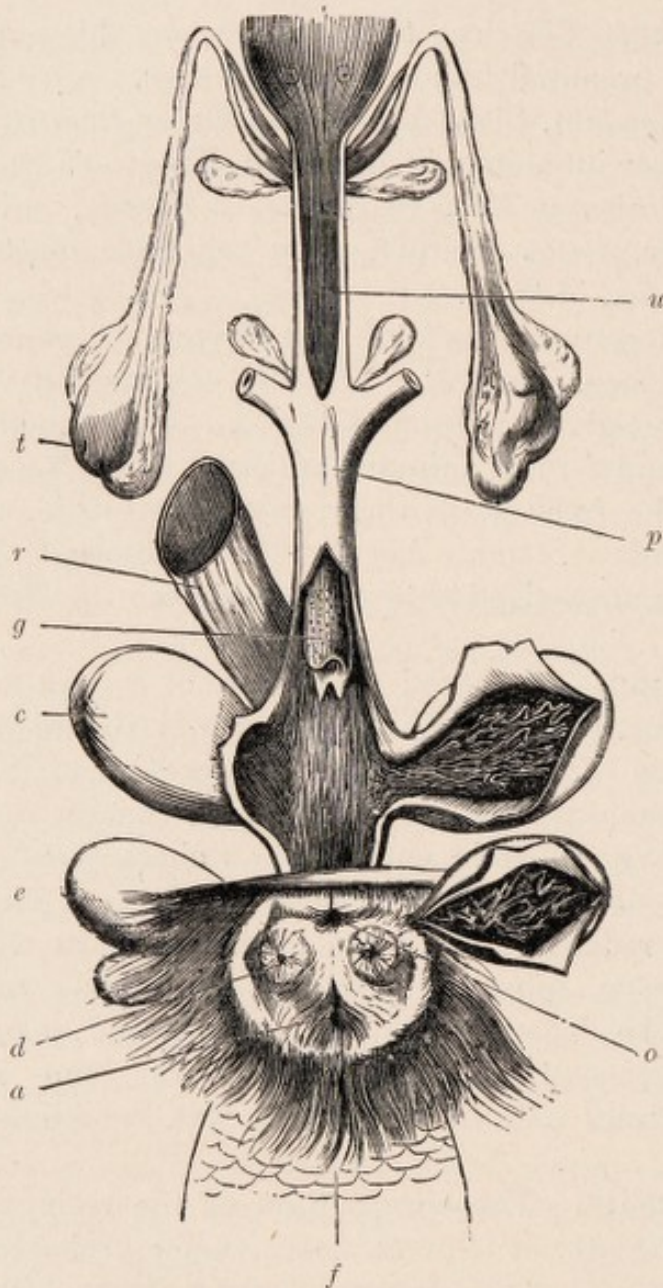


FIG. 269.—Sexual organs of male Beaver, showing the position of the two castor sacs, *c*, communicating by a common aperture with the preputial canal. The latter and one of the castor sacs have been opened. *t*, testicle; *u*, urethra; *c*, castor sacs; *g*, gland of penis; *p*, penis; *r*, rectum; *a*, anus; *e*, anal gland; *d*, aperture of anal gland; *o*, preputial orifice; *f*, undersurface of tail. (Moeller, after Brandt.)

Varieties.—Russian castor, formerly more highly esteemed than the American, is now very rarely imported. It resembles the American, but has a more agreeable, less empyreumatic odour.

THYROID GLAND

(Glandulæ Thyroidei)

Source.—The official thyroid gland is obtained from the sheep, *Ovis aries*, Linné (N.O. *Ungulata*).

The body of this and of other animals contains a number of glands which, having no special duct to convey their secretions away, are termed ductless glands. Chief of these are the spleen, thyroid gland, thymus, suprarenal capsule, pituitary body, and pineal gland, from all of which galenical or other preparations have been made. Such preparations are termed 'organotherapeutical' preparations.

Description.—The thyroid gland is a highly vascular organ consisting of two almond shaped lobes generally united towards their lower ends by a narrow bridge of tissue called the isthmus and forming a rounded projection on the trachea. It is distinguished from the surrounding tissue by its dark red colour and firm, coarsely granular texture. Embedded in its substance are multitudes of closed vesicles containing a yellow glairy fluid termed colloid. This secretion contains the active constituent of the gland which probably passes into the system through the lymphatics. Each lobe of the fresh sheep's thyroid weighs about 2 gm.

The lobes are usually removed separately, freed from surrounding fat, &c., sliced or minced and rapidly dried in a current of warm air at 32° to 38° C. When sufficiently dry they are reduced to a coarse powder and the remaining fat removed by petroleum spirit. They are finally completely dried in a desiccator. Glands that are abnormal in size or that exhibit cysts containing fatty matter when cut should be rejected. The dry thyroid thus produced is a dull brown hygroscopic powder with a slight odour free from putrescence.

Constituents.—The active constituent appears to be a proteid body, thyreoglobulin, which can be dissolved out by a weak solution of sodium chloride and precipitated by the addition of ammonium sulphate. This substance contains uniformly 1.6 per cent. of iodine but no phosphorus. Boiled with dilute sulphuric acid it yields iodothyron (thyroidin) which contains from 9 to 14 per cent. of iodine, the constituent

containing the iodine being apparently resistant to heat. Iodothyron has also been supposed to be the active constituent.

Uses.—Thyroid gland is used in myxœdema, goitre, obesity, and other cases in which a deficient production of the secretion is indicated.

**CLASSIFICATION ACCORDING TO NATURAL ORDERS,
ARRANGED ALPHABETICALLY**

Natural Order and Name	Part used	Page
Ampelideæ		
Vitis vinifera	Fruit	118
Anacardiaceæ		
Pistacia Lentiscus	Oleo-resin	534
Apocynaceæ		
Strophanthus Kombé	Seed	193
Aristolochiaceæ		
Aristolochia reticulata	Rhizome	426
„ Serpentaria	„	426
Aroideæ		
Acorus Calamus	Rhizome	451
Asclepiadeæ		
Hemidesmus indicus	Root	395
Ascomycetes		
Claviceps purpurea	Entire plant	256
Berberideæ		
Berberis vulgaris	Bark	272
Podophyllum peltatum	Rhizome	355
Boragineæ		
Alkanna tinctoria	Root	403
Burseraceæ		
Balsamodendron Myrrha	Gum-resin	548
Boswellia Carterii	„	552
Canarium commune	Oleo-resin	567
Campanulaceæ		
Lobelia inflata	Herb	232
Canellaceæ		
Canella alba	Bark	4
Caprifoliaceæ		
Sambucus nigra	Flower	82
Viburnum prunifolium	Bark	300
Celastrineæ		
Euonymus atropurpureus	Root-bark	280
Cetacea		
Physeter macrocephalus	Spermaceti	588
Coleoptera		
Cantharis vesicatoria	Entire insect	602

Natural Order and Name	Part used	Page
Compositæ		
Anacyclus Pyrethrum	Root	388
Anthemis nobilis	Flowerhead	84
Arnica montana	Rhizome	390
" "	Flowerhead	87
Artemisia maritima	Flowerhead	90
Calendula officinalis	Floret	92
Chrysanthemum cinerariæfolium	Flowerhead	93
Grindelia camporum	Herb	231
Inula Helenium	Root	386
Lactuca virosa	Latex	482
Taraxacum officinale	Root	392
Tussilago Farfara	Herb	229
Coniferæ		
Abies balsamea	Oleo-resin	562
Callitris quadrivalvis	Resin	535
Juniperus communis	Fruit	160
" Oxycedrus	Tar	578
" Sabina	Herb	248
Larix europæa	Bark	334
Picea excelsa	Resin	521
Pinus palustris	"	518
" succinifer	"	522
" sylvestris	Tar	576
Convolvulaceæ		
Convolvulus Scammonia	Root	405
" "	Gum-resin	545
Ipomœa Purga	Tubercules	407
Cruciferæ		
Brassica alba	Seed	174
" sinapioides	"	170
Cochlearia Armoracia	Root	359
Cucurbitaceæ		
Bryonia dioica	Root	372
Citrullus Colocynthis	Fruit	128
Ecballium Elaterium	Deposit from juice	502
Cupuliferæ		
Quercus infectoria	Gall	472
" Robur	Bark	328
Discomycetes		
Cetraria islandica	Entire plant	254
Ericaceæ		
Arctostaphylos Uva-ursi	Leaf	50
Euphorbiaceæ		
Croton Eluteria	Bark	323
" Tiglium	Seed	213
Euphorbia pilulifera	Herb	246
" resinifera	Gum-resin	545
Hevea brasiliensis	Latex	486
Mallotus philippinensis	Glands and hairs	468
Ricinus communis	Seed	210
Filicineæ		
Aspidium Filix-mas	Rhizome	455

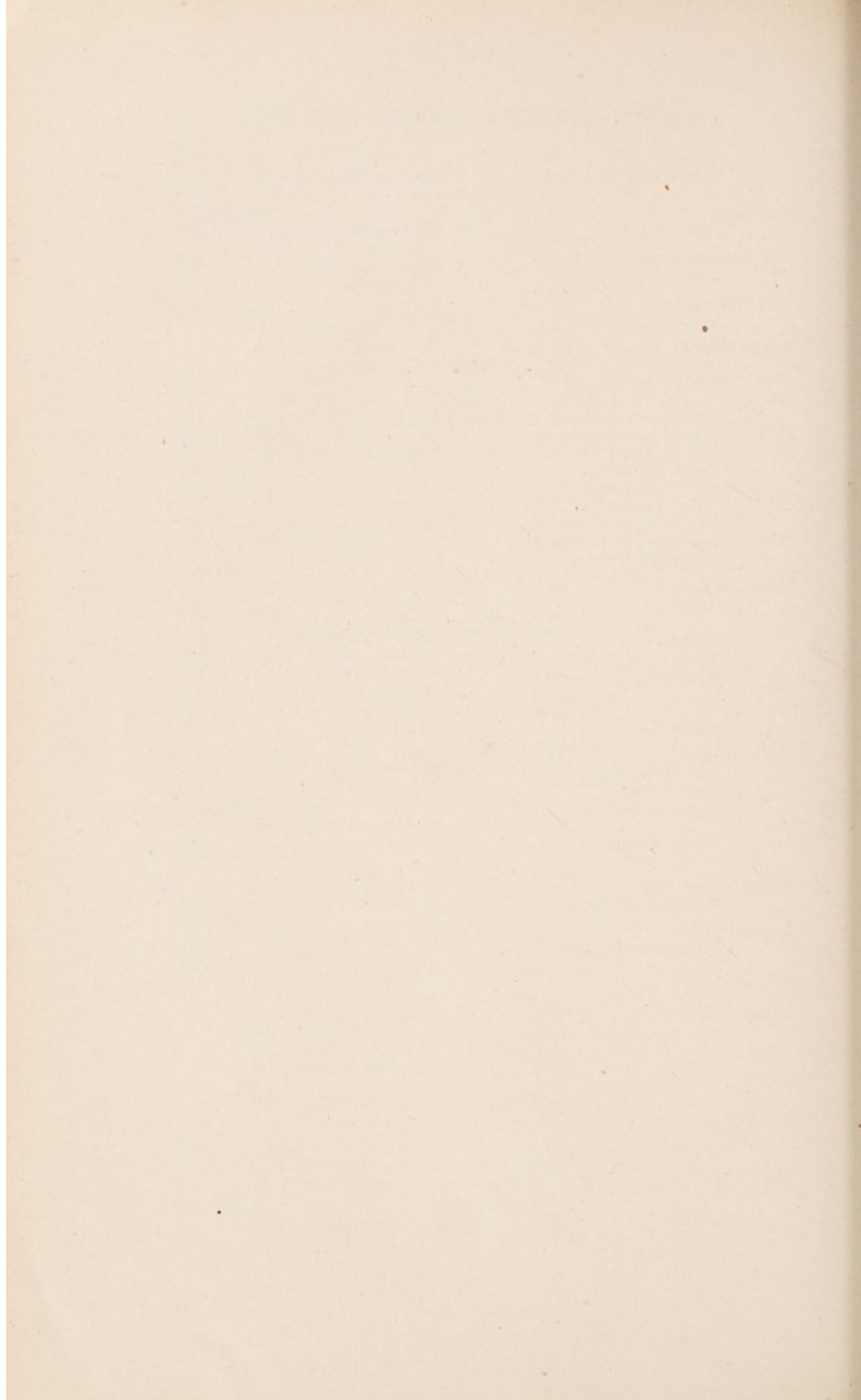
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Fucaceæ		
Fucus vesiculosus	Entire plant	252
Gentianeæ		
Gentiana lutea	Root	399
Swertia Chirata	Herb	237
Gigartinaceæ		
Chondrus crispus	Entire plant	249
Gnathobdellida		
Sanguisuga medicinalis	Live animal	601
" officinalis	" "	601
Gramineæ		
Agropyron repens	Rhizome	454
Oryza sativa	Starch	461
Triticum sativum	"	460
Zea Mays	"	461
Guttiferæ		
Garcinia Hanburii	Gum-resin	543
Hamamelideæ		
Hamamelis virginiana	Bark	296
" "	Leaf	47
Liquidambar orientalis	Oleo-resin	575
Hemiptera		
Coccus Cacti	Female insect	605
" Lacca	Resin	537
Hymenoptera		
Apis mellifica	Wax	585
" "	Honey	592
Irideæ		
Crocus sativus	Stigma	97
Iris florentina, &c. . . .	Rhizome	439
Labiataæ		
Lavandula vera	Flower	95
Marrubium vulgare	Herb	241
Laurineæ		
Cinnamomum Cassia	Bark	314
" zeylanicum	"	312
Laurus nobilis	Leaf	69
" "	Fruit	149
Nectandra Rodiæi	Bark	316
Sassafras officinale	Root	428
Coto	Bark	318
Leguminosæ		
Acacia Catechu	Extract	506
" Senegal	Gum	510
Andira Araroba	Deposit in stem	526
Astragalus gummifer	Gum	514
Cassia acutifolia	Leaf	38
" angustifolia	"	43
" Fistula	Fruit	119
Copaifera Lansdorfii	Oleo-resin	563
Cytisus Scoparius	Herb	226
Dipteryx odorata	Seed	183
Erythrophleum guineense	Bark	289

Natural Order and Name	Part used	Page
Leguminosæ—(cont.)		
Glycyrrhiza glabra . . .	Root	367
" glandulifera . . .	"	370
Hæmatoxylon campechianum . . .	Wood	264
Myroxylon Pereiræ . . .	Oleo-resin	571
" Toluifera . . .	"	569
Physostigma venenosum . . .	Seed	184
Pterocarpus Marsupium . . .	Dried juice	498
" santalinus . . .	Wood	266
Tamarindus indica . . .	Fruit-pulp	121
Trigonella Fœnum-græcum . . .	Seed	187
Liliaceæ		
Aloe species . . .	Dried juice	490
Colchicum autumnale . . .	Corm	447
" " . . .	Seed	216
Convallaria majalis . . .	Flower	100
Schœnocaulon officinale . . .	Seed	218
Urginea Scilla . . .	Bulb	445
Veratrum album . . .	Rhizome	418
" viride . . .	"	450
Lineæ		
Erythroxylum Coca . . .	Leaf	25
Linum usitatissimum . . .	Seed	175
Loganiaceæ		
Gelsemium nitidum . . .	Rhizome	396
Spigelia marilandica . . .	Herb	235
Strychnos Ignatii . . .	Seed	202
" Nux-vomica . . .	"	198
" toxifera, &c. . .	Extract	508
Lycopodiaceæ		
Lycopodium clavatum . . .	Spore	464
Lythrarieæ		
Punica Granatum . . .	Bark	298
" " . . .	Fruit	126
Magnoliaceæ		
Drimys Winteri . . .	Bark	275
Illicium verum . . .	Fruit	104
Malvaceæ		
Althæa officinalis . . .	Root	366
Gossypium barbadense . . .	Seed-hair	471
Marantaceæ		
Maranta arundinacea . . .	Starch	462
Menispermaceæ		
Anamirta paniculata . . .	Fruit	106
Chondrodendron tomentosum . . .	Root	349
Jateorrhiza Columba . . .	"	352
Myristiceæ		
Myristica fragrans . . .	Kernel of seed	206
" " . . .	Arillus of seed	210
Myrtaceæ		
Eucalyptus Globulus . . .	Leaf	49
" rostrata . . .	Dried juice	500
Eugenia caryophyllata . . .	Flower-bud	79
Pimenta officinalis . . .	Fruit	124

Natural Order and Name	Part used	Page
Oleaceæ		
Fraxinus Ornus	Saccharine exudation	590
Olea europæa	Oil from fruit	580
Orchideæ		
Vanilla planifolia	Fruit	162
Palmæ		
Areca Catechu	Seed	220
Dæmonorops propinquus	Resin	532
Papaveraceæ		
Papaver Rhœas	Petal	73
" somniferum	Fruit	108
" "	Latex	475
Sanguinaria canadensis	Rhizome	357
Piperaceæ		
Piper angustifolium	Leaf	71
" Cubeba	Fruit	153
" nigrum	"	157
" officinarum	"	159
Polygaleæ		
Krameria argentea	Root	363
" triandra	"	363
Polygala Senega	"	360
Polygonaceæ		
Rheum officinale	Rhizome	415
" palmatum	"	415
" rhaponticum	"	424
Ranunculaceæ		
Aconitum Napellus	Herb	223
" "	Root	342
Cimicifuga racemosa	Rhizome	347
Delphinium Staphisagria	Seed	169
Helleborus niger	Rhizome	340
Hydrastis canadensis	"	337
Rhamnæ		
Rhamnus Frangula	Bark	282
" Purshianus	"	286
Rodentia		
Castor fiber	Preputial follicle	611
Rosaceæ		
Brayera anthelmintica	Flower	74
Prunus Amygdalus, var. dulcis	Seed	189
" " var. amara	"	191
" domestica	Fruit	122
" Laurocerasus	Leaf	45
" serotina	Bark	291
Pyrus Cydonia	Seed	196
Quillaja Saponaria	Bark	293
Rosa canina	Fruit	123
" gallica	Petal	78
Rubiaceæ		
Cinchona species	Bark	301
" Calisaya	"	304
" lancifolia	"	309
" Ledgeriana	"	306

Natural Order and Name	Part used	Page
Rubiaceæ—(cont.)		
Cinchona officinalis	Bark	306
" succirubra	"	307
Psychotria Ipecacuanha	Root	376
Uncaria Gambier	Extract	505
Rutaceæ		
Ægle Marmelos	Fruit	111
Barosma betulina	Leaf	30
" crenulata	"	32
" serratifolia	"	31
Citrus Aurantium, var. Bigaradia	Fruit	112
" Medica, var. β Limonum	"	115
Galipea officinalis	Bark	276
Pilocarpus Jaborandi	Leaf	33
Salicineæ		
Salix alba	Bark	331
Santalaceæ		
Santalum album	Wood	267
Sapindaceæ		
Paullinia Cupana	Seed	182
Sapotaceæ		
Palaquium oblongifolium, &c. . . .	Latex	483
Scitamineæ		
Alpinia officinarum	Rhizome	436
Amomum Melegueta	Seed	214
Curcuma angustifolia	Starch	463
" leucorrhiza	"	463
" longa	Rhizome	429
Elettaria Cardamomum	Fruit	164
Zingiber officinale	Rhizome	432
Scrophularineæ		
Digitalis purpurea	Leaf	865
Simarubeæ		
Picræna excelsa	Wood	263
Simaruba officinalis	Root-bark	279
Smilaceæ		
Smilax ornata	Root	441
Solanaceæ		
Atropa Belladonna	Root	411
" "	Leaf	53
Capsicum minimum	Fruit	145
Datura Stramonium	Leaf	57
" "	Seed	203
Hyoscyamus niger	Leaf	60
" "	Seed	205
Solanum Dulcamara	Stem	240
" tuberosum	Starch	461
Stereuliaceæ		
Cola vera	Seed	178
Theobroma Cacao	"	180
Styraceæ		
Styrax Benzoin	Resin	528

Natural Order and Name	Part used	Page
Teleostei		
Gadus morrhua	Oil from liver	582
Ternstroëmiaceæ		
Camellia Thea	Leaf	22
Thymelæaceæ		
Daphne Mezereum	Bark	320
Umbelliferæ		
Carum Carvi	Fruit	92
Conium maculatum	"	94
" "	Herb	227
Coriandrum sativum	Fruit	96
Cuminum Cyminum	"	98
Dorema Ammoniacum	Gum-resin	553
Ferula foetida	"	559
" galbaniflua	"	556
" Sumbul	Rhizome	374
Fœniculum capillaceum	Fruit	99
Peucedanum graveolens	"	100
Pimpinella Anisum	"	102
Ungulata		
Ovis aries	Abdominal fat	584
" "	Wool fat	589
" "	Thyroid gland	613
Moschus moschiferus	Preputial follicle	607
Sus scrofa	Abdominal fat	584
" "	Pancreas	598
" "	Pepsin	599
Bos taurus	Ox gall	598
Urticaceæ		
Cannabis sativa	Herb	242
Ficus Carica	Fruit	150
Humulus Lupulus	"	152
" "	Glands	466
Ulmus campestris	Bark	325
" fulva	"	327
Valerianæ		
Valeriana officinalis	Rhizome	383
Zygophylleæ		
Guaiacum officinale	Wood	261
" "	Resin	523



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