Pharmacognosy
ELEVENTH EDITION

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Preface

THE new edition has the same purpose as its predecessors, namely to give a comprehensive presentation of pharmacognosy which complements the very varied treatments which the subject receives in schools of pharmacy throughout the world.

Rapid development of the subject has made necessary extensive revision for each edition and once again this is the case. Until relatively recently the active principles of some of the vegetable drugs used in Western medicine had not been fully elucidated; this situation has now altered completely and we therefore feel the time opportune to rearrange the monographs on individual drugs (Part Six) according to the biosynthetic origin of the active constitutents; this gives a more uniform and concise treatment to the phytochemical approach. However, certain classes of drugs of varying chemical constituents such as tumour inhibitors and vitamins, still seem most adequately treated as individual groups. To meet this situation, a number of new and rewritten chapters have been included in Parts Four and Six, while the general revision has taken into account the techniques and requirements of the European Pharmacopoeia, the U.S.P. 1975, the B.P. 1973 and the B.P.C. 1973.

For a study of natural products of medicinal importance, a knowledge of the botanical principles associated with drug description and evaluation remains necessary. Part Three consists of a taxonomic arrangement and discussion of those families relevant to pharmacognosy; it includes the characteristic secondary metabolites associated with important families and the *Chemical Abstracts* phytochemical research references for each family for the period 1971 to June 1976 (research references dating from 1964 are to be found in the Appendix of previous editions).

We are indebted to colleagues at Nottingham University and at other institutions for helpful discussions, and especially to Dr P. M. Dewick who has contributed Chapter 31 (tumour-inhibitors from plants) and Dr R. E. Gilbert for suggestions on Chapter 18 (pharmacological activities). We also thank the Boots Company, Nottingham; John Kellys, London; Kimpton Bros, London; S. B. Penick, New York; Sandoz, Basle; and Professor P. Tetenyi, Budapest for information on commercial aspects relating to crude drugs; Exeter University for library facilities; the many suppliers of photographs who are individually acknowledged in the figure legends, and Miss E. M. Brown for technical assistance. We are again grateful to Dr Valerie A. Woolley for undertaking the task of proof-reading and to our publishers and printers for their customary help and courtesy.

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May 1977

Pharmacognosy

Once again developments in the subject have made necessary important revisions to this standard textbook.

The active principles of the vegetable drugs most frequently used in Western medicine have now been elucidated, so that it is now possible to give accounts of individual drugs in terms of the biosynthetic origin of their constituents and thus allow a more uniform and concise treatment of the phytochemistry of pharmacognosy.

The book has therefore been partially rearranged, with much of the material in Parts Four and Six being heavily revised, and with chapters appearing for the first time, on the pharmacological action of plant drugs, on tumour inhibitors from plants and on microbiological conversions and aberrant syntheses in higher plants.

The general revision takes into account the techniques and requirements of the European Pharmacopoeia, the U.S.P. 1975, the B.P. 1973 and the B.P.C. 1973.

The book continues in its latest form to give a comprehensive presentation of pharmacognosy which complements the very varied treatments which the subject receives in schools of pharmacy throughout the world.

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PART ONE

Introduction

1 The Scope of Pharmacognosy

ONE of the oldest of human activities is the study of plants and animals, particularly as sources of food. From the earliest times man had to distinguish between those plants which were poisonous and those which were not and there gradually developed a knowledge of naturally occurring drugs which was transmitted at one time orally, later in written form as papyri, baked clay tablets, parchments, manuscript herbals, printed herbals, pharmacopoeias and other works, and most recently by computerized, information retrieval systems. The name pharmacognosy, derived from the Greek, *pharmakon*, a drug, and *gignosco*, to acquire a knowledge of, was not introduced until 1815 and had its origin in a small work by Seydler entitled *Analecta Pharmacognostica*. For a historical account of the development of the subject the reader is referred to *Pharmacy in History* (Trease, 1964). Whilst pharmacognosy is mainly concerned with naturally occurring substances having a medicinal action, it is not entirely limited to such substances. Thus natural and synthetic fibres, and the surgical dressings prepared from them, are most conveniently studied in pharmacognosy; such materials may constitute some 20 per cent of a hospital's drug bill so that their evaluation can constitute an important part of the quality control pharmacist's duties. Pharmacognosy also includes the study of other materials used in pharmacy such as flavouring and suspending agents, disintegrants, filtering and support media, and so on. Other fields which have natural associations with the subject are those of poisonous and hallucinogenic plants, raw materials for the production of oral contraceptives, allergens, herbicides and insecticides.

Pharmacognosy is closely related to both botany and plant chemistry and its history entitles it to be regarded as the parent of both. As late as the beginning of the present century pharmacognosy had developed mainly on the botanical side, being particularly concerned with the description and identification of drugs, both in the whole state and in powder, and with their history, commerce, collection, preparation and storage. Such branches of pharmacognosy are still of fundamental importance but the rapid development of plant chemistry and pharmacology in recent years has led to an increased interest in these aspects of the subject. In particular, the elucidation of the biogenetic pathways for the formation of medicinally active secondary metabolites of plants has afforded a new phytochemical foundation on which to consider the subject. Much modern pharmacognosy owes its existence to the work of pure scientists who would not normally regard themselves as pharmacognosists. It is perhaps thought-provoking that pharmacognosy, which was the direct predecessor of botany and organic chemistry has now, in the last two decades been revitalized by work in these two disciplines and their off-shoots.

Undoubtedly the plant kingdom still holds many species of plants containing substances of medicinal value which have yet to be discovered; large numbers of plants are constantly being screened for their possible pharmacological value (particularly for their anti-inflammatory, hypotensive, cytotoxic, antibiotic and anti-Parkinsonism properties). A fascinating area of research, which has not proved unrewarding, is the examination of plants used for medicinal, narcotic and other purposes by primitive tribes. As a result of modern isolation and pharmacological testing procedures, new plant drugs usually find their way into medicine as purified substances rather than in the form of older galenical preparations. Preparation is usually confined to one or a few firms who handle all the raw material; thus few pharmacists have occasion to handle dried *Catharanthus roseus* but are familiar with formulated forms of the isolated alkaloids vinblastine and vincristine. For these new drugs it is important that the pharmacist, rather than be fully conversant with the macroscopical and histological characters of the dried plant, is able to carry out the chromatographic and other procedures necessary for the identification and determination of purity of the preparation supplied. Similar remarks apply to such drugs as *Rauwolfia*, the modern preparations of ergot, and the cardioactive and purgative drugs.

Many of the botanical, chemical and physical techniques employed in pharmacognosy are also applicable to the analysis of other commodities (e.g. foods, spices, gums, narcotics, cosmetics and perfumes) and are, therefore, also used by public analysts, forensic scientists and quality-control chemists associated with other industries.

Whilst pharmacognosy has been generally pursued for utilitarian ends and may thus be called an applied science it has played an important role in the development of the pure sciences, e.g. in descriptive botany, plant classification (taxonomy) and plant chemistry (phytochemistry). Chemical plant taxonomy, genetical studies involving secondary metabolites, the artificial and tissue culture of plants, the effects of chemicals on plant metabolites and the induction of abnormal syntheses in plants are now attracting the attention of more and more botanists and chemists; pharmacognosists, being trained in both botany and chemistry, are able to make valuable contributions in these rapidly developing fields.

FURTHER READING

Trease, G. E. (1964) *Pharmacy in History*. London: Baillière Tindall & Cox.

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2 The Classification of Drugs for Study; The Literature of Pharmacognosy

VEGETABLE drugs can be arranged for study under the following headings:

1. *Alphabetical.* Using either Latin or English names, the drugs are arranged in alphabetical order.
2. *Taxonomic.* Using one of the accepted systems of botanical classification referred to in Chapter 3, the drugs are arranged according to the plants from which they are obtained in phyla, orders, families, genera and species.
3. *Morphological.* Here the drugs are divided into groups such as the following: leaves, flowers, fruits, seeds, herbs and entire organisms, woods, barks, rhizomes and roots (known as organized drugs) and dried latices, extracts, gums, resins, oils, fats and waxes (unorganized drugs).
4. *Pharmacological or Therapeutic.* This classification involves the grouping of drugs according to the pharmacological action of their most important constituent or their therapeutic use.
5. *Chemical or Biogenetic.* Here the drugs are divided into groups according to their most important constituent, e.g. alkaloids, glycosides, volatile oils etc. or according to the biosynthetic pathways by which the active constituents are produced.

Each of the above arrangements has advantages and disadvantages and sometimes different arrangements are best suited to different aspects of the subject. In this edition, the plant families and recent research references of relevance to pharmacognosy are treated taxonomically (Part Three); the individual drugs are grouped largely on a phytochemical basis with particular groups being treated pharmacologically (Part Six); and the identification of powdered drugs is based on a micro-morphological system (Chapter 39).

The following list of works, arranged in the above five groups will serve as examples and also provide a useful list of textbooks and works of reference.

1. Alphabetical

European Pharmacopoeia, Vols I–III, 1969–1975 (Latin titles) Paris: Maisonneuve.
British Pharmacopoeia, 1973 (English titles) London: H.M.S.O.
British Pharmaceutical Codex, 1973 (English titles) London: Pharmaceutical Press.
United States Pharmacopoeia, 1975 (English titles). Rockville, Maryland: U.S. Pharmacopoeial Convention.
United States Dispensatory, 1970 (English titles) ed. Osol. Philadelphia: Lippincott.
Hoppe, H. A. (1975) *Drogenkunde*, 8th ed. Vol. 1, Angiospermen. Berlin: Walter de Gruyter.

2. Taxonomical

Benigni, R., Capra, C., & Cattorini, P. E. (1962) *Piante Medicanali.* Milan: Inverni & Della Beffa.

Flück, H. (English trans., Rowson, J. M.) (1976) *Medicinal Plants.* Slough: Foulsham.

Flückiger, F. A., & Hanbury, D. (1879) *Pharmacographia.* London: Macmillan.

Perrot, E. (1943–1944) *Matières Premieres Usuelles du Règne Végétal*, 2 vols. Paris: Masson.

Thoms, H. (1929) *Handbuch der Pharmazie* (Band V, 2 vols, Pharmacognosy). Berlin and Vienna: Urban & Schwarzenberg.

Trease, G. E., & Evans, W. C. (1972) *Pharmacognosy*, 10th ed. London: Baillière Tindall & Cassell.

3. Morphological

Berger, F. *Handbuch der Drogenkunde*, Vol. I, Barks and Flowers, 1949; Vol. II, Leaves, 1950; Vol. III, Fruits and Woods, 1952; Vol. IV, Herbs, 1954; Vol. V, Roots, 1960: Vol. VI, Resins etc. and Seeds, 1964: Vol. VII, Index, 1967. Wien: Maudrich.

Jackson, B. P., & Snowdon, D. W. (1968) *Powdered Vegetable Drugs*, London: Thornes.

Moll, J. W., & Janssonius, H. H. (1923) *Botanical Pen-Portraits.* The Hague, Holland: Nijhoff.

Stahl, E. (1962) *Lehrbuch der Pharmakognosie.* Stuttgart: Fischer Verlag.

Wallis, T. E. (1967) *Textbook of Pharmacognosy*, 5th ed. London: Churchill Livingstone.

Winton, A. L., & Winton, K. B. (1932–1939) *The Structure and Composition of Foods*, 4 vols. New York: Wiley.

4. Pharmacological

Pratt, R., & Youngken, H. W., Jr. (1956) *Pharmacognosy*, 2nd ed. Philadelphia: Lippincott.

5. Chemical

Gammermann, A. F. (1960) *Pharmacognosy*, Leningrad.

Paris, R. R., & Moyse, H. (1965, 1967) *Matière Médicale.* Paris: Masson et Cie.

Steinegger, E., & Hansel, R. (1972) *Lehrbuch der Pharmakognosie*, 3rd ed. Berlin: Springer Verlag.

Trease, G. E. & Evans, W. C. (1977) *Pharmacognosy*, 11th ed. London: Baillière Tindall.

Tschirch, A. *Handbuch der Pharmakognosie* (Two editions and numerous volumes up to 1933). Leipzig: Tauchnitz.

Tyler, V. E., Brady, L. R., & Roberts, J. E. (1976) *Pharmacognosy*, 7th ed. Philadelphia: Lea & Febiger.

Van Os, V. H. L. (1962) *Farmacognosie.* Groningen.

Flora and Poisonous Plants. The following may be found useful:

Bentham, G. & Hooker, Sir Joseph D. *The British Flora*, 7th ed., revised by A. B. Rendle. Reprinted 1954. Hythe: Reeve.

Chopra, Col. Sir R. N., Badhwar, R. L., & Ghosh, S. (1965) *Poisonous Plants of India* (2 vols). Delhi: Government of India Press.

Chopra, Col. Sir R. N., & Chopra, I. C. (1955) *A Review of Work on Indian Medicinal Plants*. New Delhi: C.S.I.R.

Clapham, A. R., Tutin, T. G., & Warburg, E. F. (1962) *Flora of the British Isles*. London: Cambridge University Press.

Everist, S. L. (1974) *Poisonous Plants of Australia*. Sydney: Angus & Robertson.

Fitch, W. H. & Smith, W. G. (1949) *Illustrations of the British Flora*. Reprint. Hythe: L. Reeve.

Forsyth, A. A. (1968) *British Poisonous Plants*, 2nd ed. London: H.M.S.O.

Kingsbury, J. M. (1964) *Poisonous Plants of the United States and Canada*. London: Prentice-Hall.

Kleijn, H. (1962) *Mushrooms and other Fungi* (with excellent coloured illustrations). London: Oldbourne.

Martin, W. K. (1965) *The Concise British Flora in Colour*. London: Michael Joseph.

Muenscher, W. C. (1945) *Poisonous Plants of the United States*. New York: Macmillan.

North, Pamela (1967) *Poisonous Plants and Fungi in Colour*. London: Blandford Press.

Olivier, Bep. (1960) *Medicinal Plants in Nigeria*. Ibadan: Nigerian College of Arts, Science and Technology.

Tutin, T. G., et al. (eds.) (1964–1976) *Flora Europaea*, Vols I–IV London: Cambridge University Press.

Watt, J. M., & Breyer-Brandwijk, M. G. (1962) *The Medicinal and Poisonous Plants of Southern and Eastern Africa*. London: Churchill Livingstone.

Current Awareness. Students wishing to read original research will find many references in this book and should learn how to find similar ones for themselves. Since no one can hope to read all the scientific literature which is published,special journals are devoted to the publication of brief abstracts from the original papers. Such abstracts give the author's name, the subject of the research, the reference necessary to locate the paper in the original journal, and usually a brief outline of the work it contains. Most pharmacy department libraries contain *Chemical Abstracts* and *Biological Abstracts*. In the latter the pharmacognosist will find under the section 'Pharmaceutical Botany and Pharmacognosy' many of the abstracts in which he is likely to be interested. Even so the systematic searching of the abstracts to cover a broad field of interests can itself be most time-consuming and publications such as *Chemical Titles* can be used to give a more rapid indication of current publications. Information storage and retrieval is now itself a science and a glance at the shelf-space occupied by succeeding years of *Chemical Abstracts* is sufficient to indicate that before long, if not already, manual searches of the literature will become impossibly long procedures. Inevitably it will be necessary to rely on computers both for information retrieval and for current literature scanning. Producing a suitable profile for a computer is yet another new area with which the modern scientist must familiarise himself.

An extremely useful publication, *Pharmacognosy Titles*, is a computer abstract coverage of phytochemical research publications up to 1974 (10 vols); it was produced under the direction of Professor N. Farnsworth, University of Illinois. We understand that it will reappear in a revised form (Academic Press)

in 1977 under the heading *Napralert* (Natural products alert). Also, for research references of pharmacognostical interest covering the period January 1971–June 1976 see the appropriate families in Part Three of this book and for 1964–1970 see the appendixes of the ninth and tenth editions.

Some journals, for example *Lloydia*, frequently contain reviews on some aspect of medicinal plants and symposia, which cover various aspects of pharmacognosy, are frequently held in various parts of the world and, with modern travel facilities, scientists can easily become acquainted with others having like interests. Often the informal discussions which invariably arise at such meetings can be an extremely useful means of disseminating information. In addition, the lectures presented at such meetings are often subsequently published in book form; recent examples of topics include aspects of the biology and chemistry of the Umbelliferae (ed. Heywood, 1971), Leguminosae (ed. Harborne et al., 1971), Cruciferae (ed. Vaughan et al., 1976), and Solanaceae (ed. Hawkes & Lester, 1977), *Plants in the Development of Modern Medicine* (ed. Swain, 1972), *Marihuana* (ed. Nahas, 1976), *New Natural Products and Plant Drugs with Pharmacological, Biological or Therapeutic Activity* (ed. Wagner, 1977).

3 Plant Nomenclature and Taxonomy

Biological Nomenclature. Before the time of Linnaeus many plants were known by a double Latin title, but it is to this great Swedish biologist that we owe the general adoption of the present binomial system. In this system the first name, which is always spelt with a capital letter, denotes the genus, whilst the second name denotes the species. The Rules of Botanical Nomenclature now permit all specific names to be written with small initial letters and we have therefore adopted this method. It is, however, still equally correct to use capitals where the species is named after a person. Thus the species of *Cinchona* named after Charles Ledger, who brought its seeds from Brazil in 1865, is known as *Cinchona ledgeriana* or *Cinchona Ledgeriana*.

The specific name is usually chosen to indicate some striking characteristic of the plant, e.g. the hemlock with the spotted stem is named *Conium maculatum* (*maculatus*, *-a*, *-um*, spotted). Sometimes the reason for the name is not so obvious as in the example just mentioned, but once it is discovered it will serve as a reminder of a characteristic of the plant, e.g. *Strychnos potatorum* (*potato*, *-oris*, a drinker) bears a name which is only intelligible when it is known that the seeds of this species are used in India for clearing water.

From time to time a plant may require some reclassification in the light of further knowledge. It may be necessary to transfer a genus from one family to another or what has previously been considered a variety may be given specific rank. The decisions made will obviously depend to some extent on the training and experience of the botanists concerned and some differences of opinion are unavoidable. All the information, both botanical and chemical, should be taken into account but as botanists themselves point out 'when primitive tribes name the plants of their environment they are almost as successful in defining limits as the trained taxonomist'.

Subdivisions of the Phyla. The branches of the genealogical tree differ so much in size that it is not easy to decide which are of equal systematic importance and what one biologist may consider as a family another may regard as a subfamily. Similarly, the species of one botanist may be the subspecies or variety of another. The main subdivisions of a phylum may be illustrated by the following example showing the systematic position of peppermint:

Phylum	Angiospermae
Subphylum	Dicotyledons
Grade	Sympetalae
Order	Tubiflorae
Suborder	Verbenineae

Family	Labiatae
Subfamily	Stachydoideae
Tribe	Satureieae
Genus	*Mentha*
Species	*Mentha piperita* Linnaeus (Peppermint)
Varieties	*Metha piperita* var. *officinalis* Sole (White Peppermint)
	Mentha piperita var. *vulgaris* Sole (Black Peppermint)

It will be noted that in pharmacopoeias and in research publications botanical names are followed by the names of persons (e.g. Linnaeus and Sole in the case of peppermint given above). These refer to the botanist who first described the species or variety. It is perhaps needless to inform the student that no attempt should be made to memorize these personal names and in the following pages they are usually omitted except in cases where different botanical names have at different times been applied to the same plant and there is possibility of confusion.

Botanical Systems of Classification. Before the widespread acceptance of the principle of evolution, biologists, being convinced of the fixity of species and lacking much of the information available today, confined themselves to more or less artificial methods of classification, their systems being frequently based on one or a few characters instead of upon the organism as a whole. These earlier systems are now mainly of historic interest but certain of their features, for example the large division of seed plants into monocotyledons and dicotyledons as used by John Ray (1628–1705), survive today. Linnaeus' *Species Plantarum* of 1753 is the starting point for the modern nomenclature of plants although his actual system of classification is entirely artificial and of little significance today. The *Prodromus*, started by A. P. de Candolle (1778–1841) and completed under the editorship of his son Alphonse (1806–93), was a massive work of seventeen volumes which professed to be an account of every flowering plant then known. The system of classification employed was a modification and extension of that introduced earlier by De Jussieu (1748–1836) and further demonstrated the inadequacies of the Linnaean system which were then becoming apparent. Bentham and Hooker's *Genera Plantarum* (1862–1883) was patterned on the de Candolles' work, each genus being redescribed from herbarium specimens and not consisting of a restatement of earlier literature. Although largely artificial, it has been found convenient to retain this system as a basis in such works as the *British Flora* and the more modern *Flora of the British Isles* (Clapham, Tutin & Warburg, 1962) and for museum collections like the herbaria of Kew and the British Museum.

During the last 100 years a considerable number of phylogenetic systems of classification have been propounded; these systems arrange taxa (any groups used for classification such as orders, families, genera, etc.) to indicate the possible relationship of one taxon to another. Such systems are clearly susceptible to change with increasing knowledge and no final product,

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