

**The Botany and Chemistry  
of Hallucinogens**

*Publication Number 1025*  
AMERICAN LECTURE SERIES®

*A Monograph in*  
*The BANNERSTONE DIVISION of*  
AMERICAN LECTURES IN LIVING CHEMISTRY

*Edited by*  
I. NEWTON KUGELMASS, M.D., Ph.D., Sc.D.  
*Consultant to the Departments of Health and Hospitals*  
*New York City*

Revised and Enlarged Second Edition

# The Botany and Chemistry of Hallucinogens

*By*

**RICHARD EVANS SCHULTES, Ph.D., M.H. (Hon.)**

*Professor of Biology  
Director and Curator of Economic Botany  
Botanical Museum of Harvard University  
Cambridge, Massachusetts*

*and*

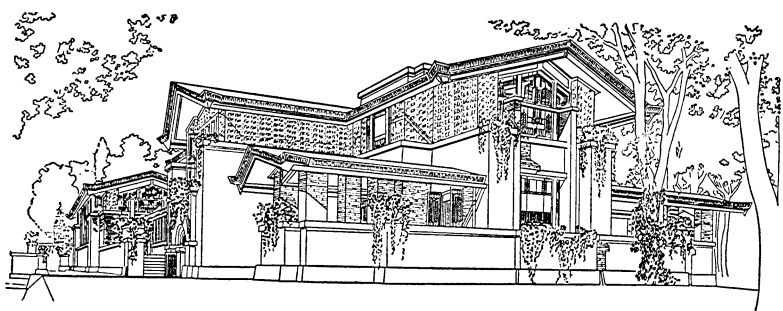
**ALBERT HOFMANN, Ph.D., Dr. Pharm. H.C., Dr. Sc. Nat. H.C.**

*Formerly, Head of the Pharmaceutical-Chemical Research Laboratories  
Division of Natural Products, Sandoz Ltd.  
Basel, Switzerland*

*With a Foreword by*

**Heinrich Klüver, M.D. (Hon.), Ph.D.**

*Professor Emeritus  
Division of the Biological Sciences  
University of Chicago  
Chicago, Illinois*



**CHARLES C THOMAS • PUBLISHER**  
*Springfield • Illinois • U.S.A.*

*Published and Distributed Throughout the World by*  
CHARLES C THOMAS • PUBLISHER  
Bannerstone House  
301-327 East Lawrence Avenue, Springfield, Illinois, U.S.A.

This book is protected by copyright. No part of it  
may be reproduced in any manner without written  
permission from the publisher.

© 1980, by CHARLES C THOMAS • PUBLISHER

ISBN 0-398-03863-5 (cloth)  
ISBN 0-398-06416-4 (paper)

Library of Congress Catalog Card Number: 78-27883

*With THOMAS BOOKS careful attention is given to all details of  
manufacturing and design. It is the Publisher's desire to present books that  
are satisfactory as to their physical qualities and artistic possibilities and  
appropriate for their particular use. THOMAS BOOKS will be true to those  
laws of quality that assure a good name and good will.*

**Library of Congress Cataloging in Publication Data**

Schultes, Richard Evans.

The botany and chemistry of hallucinogens.

(American lecture series; publication no. 1025)

Bibliography: p. 369

Includes index.

1. Hallucinogenic drugs. 2. Hallucinogenic  
plants. 3. Chemistry, Pharmaceutical. I. Hofmann,  
Albert, 1906- joint author. II. Title.

[DNLN: 1. Plants, Medicinal. 2. Hallucinogens.

QV77.7 S386b]

RM315.S38 1979 615'.7883 78-27883

ISBN 0-398-03863-5. — ISBN 0-398-06416-4 (pbk.)

*Printed in the United States of America*

**C-1**

## EDITOR'S FOREWORD

OUR LIVING CHEMISTRY SERIES was conceived by Editor and Publisher to advance the newer knowledge of chemical medicine in the cause of clinical practice. The interdependence of chemistry and medicine is so great that physicians are turning to chemistry, and chemists to medicine, in order to understand the underlying basis of life processes in health and disease. Once chemical truths, proofs, and convictions become sound foundations for clinical phenomena, key hybrid investigators clarify the bewildering panorama of biochemical progress for application in everyday practice, stimulation of experimental research, and extension of postgraduate instruction. Each of our monographs thus unravels the chemical mechanisms and clinical management of many diseases that have remained relatively static in the minds of medical men for three thousand years. Our series is charged with the *nisus élan* of chemical wisdom, supreme in choice of international authors, optimal in standards of chemical scholarship, provocative in imagination for experimental research, comprehensive in discussions of scientific medicine, and authoritative in chemical perspective of human disorders.

Dr. Schultes of Cambridge, Massachusetts, and Dr. Hofmann of Basel, Switzerland, combine their botanical and chemical knowledge to integrate interdisciplinary knowledge and international wisdom about powerful alkaloids from primitive cultures to modern times. There are only 120 species of hallucinogens out of about 600,000 plant species with an unexplained concentration in the New World, with many hallucinogenic plants in both hemispheres never used as narcotics. And so the authors conduct the reader through the classic edifice of clinical alkaloids into world areas where probing is now in progress, to temper the customary severity of the sciences insofar as is compatible with clarity of thought. They know how to put what they have to say as if it had never been said before. It is not a textbook, a *table*

*d'hôte* to which one may sit down and satisfy his hunger for drug information with no thought of the agricultural processes which gave rise to the raw materials, nor of the laboratory procedures which converted them into drugs. It is an authoritative work designed as an introduction to research and as a guide to doctors to use hallucinogens effectively. Once chemical understanding is clear, clinical application is usually easy.

Naturally occurring hallucinogens have been used in religious practices for centuries and in psychiatric practice since the beginning of the century; artificial hallucinogens have come into use during this generation. They produce extraordinary disturbances of perception—disordered sense of time, visual hallucinations, mystical experiences, and even transcendental sensations—all disrupting the function of the ego. Unlike barbiturates, none depresses brain functions. Hallucinogenic drugs alter human consciousness in man's groping toward memory control, reshaping behavior patterns through reinforcement schedules paralleling man's vertical extension into outer and inner space. The results of this inward exploration may be infinitely more powerful than voyages to planets or to the bottom of the Challenger Deep. The territory is virtually unexplored. But do the construction potentials of hallucinogens outweigh their admitted hazards? There are really no safe hallucinogens; there are only safe physicians. Even in treating patients, doctors will have to be extremely cautious not to transgress the rule of *primum non nocere*.

*But words are things, and a small drip of ink,  
Falling like dew upon a thought, produces  
That which makes thousands, perhaps millions, think.*

I. NEWTON KUGELMASS, M.D., Ph.D., Sc.D.

## FOREWORD

I FEEL GREATLY HONOURED by the request of the authors to furnish a few preliminary remarks of introduction to this book. At the same time, I should confess, I am somewhat reluctant to undertake such a task since the subject of hallucinogens is related to one of the most complex and difficult subjects—the world of hallucinations and other subjective phenomena. In trying to cope with this “hallucinatory” world, previous investigators have left us with categories and terms such as *positive* and *negative hallucinations*, *pseudohallucinations*, *déjà vu phenomena*, *derealization phenomena*, *illusions*, *visualizations*, *dreams*, *dreamy states*, *eidetic images*, *eidetic images with reality character*, *hypnagogic images*, *memory-images*, *projected memory-images*, *memory-after-images*, *pseudo-memory-images*, “*phantastic visual phenomena*,” *re-perceptions*, and *Sinnengedächtnis*, to name only a few of the technical terms used in these researches. Raoul Mourgue, after analyzing some 7,000 publications on the subject of hallucinations, was forced to conclude in 1932, in his *Neurobiologie de l'Hallucination*, that all the facts and observations then available could not furnish an adequate basis for a *theory* of hallucinations. Fortunately, the reader of the present volume, *The Botany and Chemistry of Hallucinogens*, will readily see that it is not the aim of the authors to deal with and attempt a resolution of such psychological intricacies; their aim is obviously a more important one: to start at the beginnings by furnishing a detailed presentation of such botanical and chemical facts and considerations as are essential for a scientific study of hallucinogens. Certainly, such a point of departure will ultimately be essential also for an understanding of the mechanisms of hallucinations.

No one will doubt that the two authors are particularly well qualified to write this particular book. Only experts in both botanical and chemical matters could deal with all the ramifications and complexities of the problems presented here. Personally,

I merely claim a long-continuing and deep interest in the various problems so competently discussed in this volume. This interest of mine has been greatly strengthened by my belief that the authors of this book are unique in the annals of science: the one, Richard Evans Schultes, for remaining in the jungle for some twelve years to acquire the tools of his trade and his facts; the other, Albert Hofmann, for constantly following the trail he discovered on April 16, 1942, a day that was destined to launch, not 1,000 but several, perhaps even 10,000, publications on LSD.

At a time when drugs and drug-produced experiences have become a national and international problem, the reader may easily forget that not so long ago, during the first decades of this century, only a few investigators in various countries were interested in a scientific study of hallucinogens. As it happened, on an October day in 1925, I introduced myself to the world of hallucinogens by consuming some mescal buttons in one of the laboratory buildings of the University of Minnesota, not for the sake of consciousness expansion or other unique experiences, but to test a new tool possibly useful in studying various problems of the psychology and pathology of perception. For some years, I had been engaged in the study of certain types of pseudohallucinations (now generally referred to as *eidetic phenomena* or *eidetic imagery*), studies which had taken me into different geographic districts in California, New York, West Virginia, Ohio, and Louisiana. It was a remark found by chance in the literature that *Lophophora williamsii* would provide the possibility of producing eidetic phenomena in noneidetic individuals (I happen to be such an individual) that led me to the use of peyote in my 1925 experiment and to the results which I subsequently reported in the literature (*Am. J. Psychol.*, 37:502-515, 1926). It also led, somewhat unexpectedly, to a stream of visitors ranging from organic chemists to psychiatrists and anthropologists who appeared in my laboratory or home: visitors who for one reason or other had become interested in the world of mescaline-produced phenomena.

Thus, I recall with pleasure the long and profitable discussions with researchers such as Gordon Alles, Paul Radin, J. S. Slotkin, W. Mayer-Gross, A. Hoffer, and H. Osmond. I also recall that in



one of these discussions, Paul Radin, who had made a special study of the peyote cult, offered to send "Crashing Thunder" for some psychological testing to my laboratory (Crashing Thunder being the Winnebago Indian whose autobiography he had edited). I declined his kind offer for various "psychological" reasons, believing that my Culver Hall laboratory at the University of Chicago would not provide the proper background for psychologically examining a Winnebago Indian.

Some fifty years ago there seemed to be relatively few investigators who were concerned with scientific approaches to the study of hallucinogens or who were using drugs in exploring mechanisms of normal and abnormal behavior. Consequently, I could optimistically assume that it would be relatively easy to contact at least the most important of these researchers and visit their laboratories and institutions. In pursuit of such an idea, I made, for instance, a pilgrimage to the Maison Nationale de Charenton, an institution associated with such famous names as Esquirol and Moreau de Tours. My host was Henri Baruk who, in his drug researches, happened to be a collaborator of H. de Jong in Holland (whom I subsequently visited in his laboratory in Amsterdam). Incidentally, it was Henri Baruk who, in 1958, founded the Société Moreau-de-Tours and who, in 1962, played a leading role in publishing the *Annales Moreau de Tours*. It was on the same European trip that I had the pleasure of spending a day in Freiburg i.B. with Kurt Beringer, whose book, *Der Meskalinrausch*, in the opinion of Bo Holmstedt, is to mescaline what Moreau's book, *Du Hachisch et de l'Aliénation Mentale*, is to hasheesh.

As to American investigators in the 1920s, I like to recall that, during my years at Columbia University (1926-1928), I managed to discover the whereabouts of William J. A. M. Maloney who, together with A. Knauer, had studied the "psychic action" of mescaline with special reference to "the mechanisms of visual hallucinations" in Kraepelin's clinic in Munich. This was no doubt the most thorough experimental study of mescaline effects carried out before World War I, and it was carried out with the methods of experimental psychology, methods with which Kraepelin had become familiar in the Leipzig laboratory of

Wundt. It is probably not generally known that Kraepelin, who became famous for initiating a new era in psychiatry, thought most highly of his contributions to experimental psychology; his "deepest love" belonged to this field. When I discovered that Maloney was practicing clinical neurology in New York City, I called on him but unfortunately found his waiting room full of patients. However, when he heard from the nurse that I wanted to talk about mescaline, he took me immediately into his office and talked for at least an hour about "the happiest year" in his life, namely, the year he and Knauer had spent in Kraepelin's clinic studying the psychological effects of mescaline poisoning. He also explained to me the sad reason that a detailed report of these remarkable pre-World War I experiments, aside from a preliminary report in 1913, would never be published (and to my knowledge has never been published).

It was at the time of my visit to Maloney that I found another New York investigator who had also been concerned with hallucinogens and had, in fact, written a handbook article on mescal buttons. This was Henry Hurd Rusby (1855-1940), who was associated with the Department of Pharmacy at Columbia University. His interests were wide-ranging—from the morphology and histology of plants to the properties and uses of drugs; his work had brought him many medals and honors. When I called on him one late afternoon, I found him in his office surrounded by half a dozen black dogs. In the course of the conversation, he soon warned me (and any other scientist) against studying unknown drugs by experimenting on oneself. Finally, he took me into the next room filled with large boxes containing materials which he had brought home from various expeditions. He would probably never unpack them, he said, nor work up their contents; in fact, he was now raising dogs and asked me to join him in giving his dogs an airing on Broadway (which I did).

When, many years later, I did some reminiscing about my hallucinogenic and psychotomimetic past with the man who introduced LSD-25 for medical use into this country and who was slated to be one of the presidents of the Society of Biological Psychiatry, namely, my friend, the late Max Rinkel, and when I mentioned some of the scientists I had visited here and abroad

or who had come to the doors of my home or laboratory, he said: "But you have not met the most interesting and most remarkable of them—and that man is right here in Boston." "And who is he?" I asked. "I am speaking of Richard Evans Schultes—and on your next trip to Boston I shall see to it that you will meet Dick Schultes." I shall always be thankful to Rinkel for arranging this meeting: It was about ten years ago, on March 18, 1961, at one of those unforgettable social gatherings in the evening that only a Max Rinkel could arrange, that I finally met Dick Schultes and his charming wife, Dorothy. It is true that the social occasion offered little opportunity for discussing hallucinogens or investigators interested in hallucinogens, but it was the starting point for more meetings and for an exchange of letters and publications over the last ten years. Through these exchanges I became, of course, readily aware that Schultes was and is a world authority on the botany of hallucinogens, but I also learned, quite unexpectedly, that I had played a role in shaping his career and changing, as he said, his entire scientific life. In his very first letter to me (written in 1961) I find the lines: "As I told you, it was your book on mescal intoxication, read (of all places) in a botany course, that first veered me on to the study of narcotic plants. It has been a field that has brought me unlimited happiness and much satisfaction, and so much of it I owe to your beautifully written book." I should note that Schultes refers here to my little monograph *Mescal: The "Divine" Plant and Its Psychological Effects*, published in 1928 in London (out of print for many years but recently reprinted, with some additions, by the University of Chicago Press under the title *Mescal and Mechanisms of Hallucinations*).

No doubt, it will be of interest not only to the readers of *The Botany and Chemistry of Hallucinogens* but also to the historian of science to learn how a little book came to change the scientific life of Dick Schultes and to hear what the life that resulted from such a change was like. The information I elicited in the course of years is, I believe, best expressed in his own words:

In 1936, when I was taking the course at Harvard which I am now teaching—"Plants and Human Affairs"—one of the weekly reading assignments (in the week devoted to narcotics) was your little

book *Mescal: The "Divine" Plant and Its Psychological Effects*. I was so enthralled with peyote, of which I had never heard, that I decided to write my senior honors thesis on the plant. Professor Ames found me finances to visit Oklahoma and partake of peyote in Indian ceremonies. That started my whole career. I was a premedical student but switched to economic botany and did my graduate work on the materia medica of Indians of Oaxaca, Mexico, in the meanwhile rediscovering the sacred morning glories (ololiuqui) and one of the sacred mushrooms (teonanacatl) that had been reported among the Aztecs by the early chronicles and not collected for identification since. When I got my Ph.D. in 1941, I went to Colombia—to the northwest Amazon—for a year, to study arrow poison plants, and I remained 12 more years, living permanently there. I was thus able to ferret out many medicinal and narcotic plants in use. Since this region is one of the richest in plant hallucinogens, I concentrated my work there and was able to identify six new narcotics and stimulants and make ethnobotanical studies on about 15 more that had previously been known. During these years in the Amazon—naturally before I was married—I lived off the country, with Indian tribes, learned many of their customs (e.g. I chewed coca for over 8 years daily), learned several languages and travelled in an 18-foot aluminum canoe. I collected over 24,000 plants which I am now studying, a significant number of them with notes on their uses as medicines, poisons, narcotics, foods, etc.

When I inquired whether he had ever been seriously sick during all those years in the jungle, he reported:

I was very fortunately not ill, except for repeated malaria attacks and one period with beriberi. I do recall one close call—and only one. That was in 1944. Before antibiotics were easily available, I developed a swelling of the right arm from a wound. My luck was with me in that I was able to get to one of the provisional airstrips built to take wild rubber out during the war shortage. This plane left me in Villavicencio, a small town at the base of the Andes but, since the road to Bogotá was closed because of landslides, I checked into a hotel and looked up a doctor for my arm. The doctor injected something, after telling me that I had advanced septicemia—and I fainted away to wake up in bed in the home of Nancy and Marston Bates, Rockefeller people who lived in Villavicencio. The doctor called them, knowing that I was American. Nancy kept my arm in hot wet towels for a week and fed me—I was somewhat emaciated from malaria and six months of hard exploration in the Rio Apaporis. I owe my arm, if not my life, to the Bates's—and I shall never forget their kindness.

By way of summing up his years in the jungle, Schultes had this to say:

These years were happy ones—always running into plants new to science and delving into folk uses of the Plant Kingdom. I never worked with white assistants, always travelled with Indians or mestizo helpers. We never had trouble of any kind with Indians, and now, when I return on short trips to localities where I formerly spent months or even years, it is like an Old Home Sunday Reunion. I realize how fortunate I have been in being able to spend, like Richard Spruce and some of the earlier naturalist-explorers of the Amazon, long periods in the field, for that is the only way that ethnobotanical investigations can be carried out in tropical jungle areas with any assurance of success.

When turning from the world of hallucinogens botanically viewed to the world of hallucinogens chemically viewed, I share Albert Hofmann's regret (expressed in 1967, when he could not attend a meeting in this country) that psychoactive drugs, while spanning time and space psychically, cannot yet do so physically by transporting us on a "flying carpet" from one region of the globe to another. Indeed, I have often wished for such a flying carpet to take me to the Sandoz Laboratories overlooking the Rhine and to hear from Albert himself some of the fascinating details of the most unusual cycle of chemical research pursued there. It is a kind of "magic circle" that started with the synthesis of various lysergic acid amides and the discovery of the extraordinary psychotomimetic potency of LSD, then led to an investigation of the sacred Mexican mushrooms and the isolation of psilocybin from *teonanacatl*, ending finally with *ololiuqui* where, again, lysergic acid amides were encountered—thus closing the magic circle.

But in pursuing this magic circle of research, Hofmann, unusual amongst chemists, insisted on field work in regions where natives were employing the hallucinogenic plants that he was analyzing. Consequently, we find him accompanying R. Gordon Wasson, the famous American student of ethnomycology, into the far-off Mazatec Indian country of Oaxaca, Mexico, to study the use of the sacred mushrooms, the psychoactive morning glories, the intoxicating *Salvia*, and other plants. This aspect of Hofmann's

work—this interdisciplinary thoroughness—is merely one of the many characteristics which I have long admired in his work. It is a characteristic which shows in the present volume.

In considering the remarkable researches involved in this magic circle, it is easy to understand why LSD should have been called (by A. E. Caldwell) a one-man drug and its discoverer, Albert Hofmann, “a multihallucinogenic man.” It is now generally recognized and needs no further emphasis that the LSD phase of this work was the starting point for numerous lines of investigation in practically every psychiatric research centre. As Hoffer and Osmond have insisted, it initiated “a revolution in psychiatric thought which still has not completed its course.” No doubt, this revolution has spread, or will spread, far beyond the confines of psychiatry to many other fields of scientific or therapeutic endeavour. This spread was vividly brought home to me on the occasion of some visits from the late Max Knoll who, at that time, was Professor of Technical Electronics at the Technische Hochschule in Munich. He had established a laboratory for “medical electronics,” the chief object of which was the study of subjective visual phenomena resulting from electrical and magnetic stimulation or produced by LSD, psilocybin, and other hallucinogens. Little did I realize at the time of his visits that the man who was so eager to discuss the structure of the subjective world was the same Max Knoll who, together with Ernst Ruska, had built and publicly demonstrated the first electron microscope! There is no doubt that during the last ten years of his scientific life (Knoll died on November 6, 1969), he was much more interested in “the world of inner light sensations,” to quote the title of his 1967 monograph, than in the world of the electron microscope. In looking back to the April days of 1942, that is, to Albert Hofmann’s discovery of LSD, Irvine H. Page remarked that this discovery would certainly have “fascinated investigators and clinicians alike” if they had known about it at that time. At the present time, the historian will have to record that interest in psychochemistry has spread to fields far removed from medicine and biology. The scientific activities carried on by a man like Max Knoll during the last decade of his scientific career strik-

ingly exemplify and illustrate such developments. A psychologist or psychiatrist may even argue that the exploration of the "psycho" in psychochemistry or psychopharmacology has not kept pace with advances along chemical and pharmacological lines, not to mention the progress in electronics or physics. Furthermore, it is apparent that the well nigh frenetic research activities in the field of psychoactive drugs have frequently been pursued without considering recent advances along ethnopharmacological and ethnobotanical lines.

Fortunately, researchers of the future ready to explore further the world of psychotomimetics and hallucinogens will now have a chance of avoiding the sad discovery at the end that they have ignored relevant facts or concepts and having to cry "peccavi" for such a distressing or even fateful oversight. They may easily avoid, it might be suggested, such a course of events by studying *The Botany and Chemistry of Hallucinogens* by Richard Evans Schultes and Albert Hofmann before embarking on their researches! This is, I believe, sound advice.

HEINRICH KLÜVER





## PREFACE TO THE SECOND EDITION

**I**T MIGHT SEEM STRANGE that a book published in 1973 should need a second edition so soon. The longer we worked on this new edition, however, the more we were convinced of the wisdom of the publishers in requesting an update of the book.

Both the botany and the chemistry of the hallucinogens have progressed at a rapid rate since 1973. Several new hallucinogens have been discovered in this five-year period; many hints of possible hallucinogens have appeared; and additional information on some of the well known drugs has been accumulated through continued field work.

The chemistry of many of the hallucinogenic plants has, with the application of modern, sophisticated analytical methods, been elucidated or more thoroughly investigated; new compounds have been discovered; in some cases, chemical examination has clarified native uses.

We have, furthermore, decided to strengthen the historical background of studies in the chemistry and botany of the hallucinogens and have striven to amplify the information of an ethnopharmacological nature, realizing that this information is often a significant stimulus to botanical and chemical studies.

Several sections are substantially enlarged as a result of research during the past five years: *Cannabis* and *Lophophora* are good examples. The number of plants of possible or suspected hallucinogenic use is much larger than it was five years ago. The bibliography is—as expected—greatly enlarged as the result of recent intensive activity in both the botanical and the chemical investigations of these psychoactive plants in many parts of the world.

And we have, in conclusion, one further point to mention in our willingness to prepare a second edition. Since the principal hallucinogens are of vegetal origin, their study brings to the fore the almost untouched wealth of biodynamic constituents of potential

medical interest in the half million plant species. In recent years, botanical, phytochemical, and pharmacological research into this treasury has languished, partly because of the lack of discovery in the past two decades of a “wonder drug” of importance equal to the numerous new medicines—the curare alkaloids, cortisone, reserpine, and many others—which came to light mainly as a result of ethnopharmacological leads in the 1930s and 1940s.

Compounds discovered or synthesized in the course of chemical investigations into psychotomimetic plants have already gained acceptance in the pharmaceutical industry. But the plant kingdom remains a fertile and nearly virgin field for a search for new psychotropic compounds, not to mention other kinds of biologically active vegetal constituents. As has been indicated: “Can we afford to neglect any longer the hunting ground that until now has provided, mainly through folklore and serendipity, leads that the American pharmaceutical industry has turned into products having annual sales in excess of three billion dollars in the American prescription market alone?” (Schultes and Farnsworth, 1978).

R. E. S.

A. H.

## PREFACE TO THE FIRST EDITION

ANYONE MIGHT JUSTIFIABLY ASK, "Why another book on the hallucinogens?" The past decade has witnessed a steady procession of volumes in the many disciplines touched upon by these most remarkable narcotics, not to mention the thousands of articles in learned journals. Some of these works have been good, some mediocre, some poor; there have been specific and there have been comprehensive treatments; a few have been impartial scientific treatises, many have been emotional "potboilers." The 1960s will most certainly be remembered as a period in which hallucinogens have called forth in both technical and popular literature a plethora of productions. Why, then, still another book?

We believe that there is great need—nay, even a vital urgency—for a simple treatment that starts the study of hallucinogens at the very basics. A survey of the vast literature indicates a conspicuous dearth of books which start at the beginning of any serious effort to understand hallucinogens and their impact on human affairs—in primitive cultures of hinterland regions or in sophisticated societies of the western world.

Most hallucinogens are of vegetal origin. Consequently, the first step in any consideration of hallucinogens must be botanical. Even though specialists know it, they sometimes tend not to realize that hallucinogens are by and large plant products (that means natural products) and have been available since long before the mind of man was capable of recognizing their utility. Consequently, a sound understanding of their value and effectiveness, their danger or innocuousness, lies in an evaluation of their botanical identity and, concomitantly, a clear and thorough knowledge of their chemical composition. These two phases of technical appreciation of hallucinogens must be clarified before any studies in such fields as psychopharmacology, physiology, and

the behavioural sciences can be expected to yield significant results.

Consequently, we—a botanist and a chemist, both of whom have worked with hallucinogens for long periods—have sought to present a brief, straightforward book oriented primarily towards the botany and chemistry of hallucinogens. It most certainly will fall far short of an ideal, inclusive text on these two basic fields of hallucinogenic research. We trust, however, that here specialists not only in botany and phytochemistry, but also in the many other disciplines that impinge upon the growing study of the hallucinogens, may find basic information simply set forth, free from the encumbrances of extraneous discussion and all-embracing discourse, and may use this information for the furtherance of their own scientific endeavours.

R. E. S.

A. H.

## INTRODUCTION

**W**E HAVE TRIED to keep the plan of our book simple. Oftentimes the information available does not permit us to assert positively that a toxic or narcotic plant employed in a primitive society is used because of hallucinatory effects. In other instances, the data at hand seem to indicate that the use is for the purpose of inducing hallucinations, yet we know of no psychotomimetic constituent in the plant. In a few cases, both the utilization of a plant for psychoactive effects and its chemical composition are equally doubtful or uncertain.

Believing that the purposes of future investigations are better served by including rather than excluding these borderline examples, we have set them apart in a section of the book separate from the well known, adequately understood hallucinogenic plants, the use of which is based definitely upon the search for visual and/or other types of hallucinations.

In the section of this book dealing with plants of doubtful hallucinogenic properties, no chemical formulae are given. The constituents of such plants are mentioned only by their names, while reference to their chemistry is made in bibliography. Chemical compounds with nonspecific hallucinogenic activity (e.g. ibogaine), of which the hallucinogenic property is only a side effect of other main pharmacological activities, are characterized by their structural formulae, but without description of their synthesis, which is referred to only in the bibliography. Detailed chemistry will be reported only for the specific hallucinogens.

Throughout the book, we have employed the term *hallucinogen* or *psychotomimetic* to mean either the active chemical principles or the plant containing them, or crude extracts of such plants. Our reason for not reserving these terms merely for chemical compounds is simply that, in primitive societies especially, where these psychoactive agents find their primary use, rarely if ever are the responsible chemical constituents isolated from the plant

and taken as such. The normal procedure amongst aborigines is the employment of the crude plant in its natural state or, at best, as a crude decoction, infusion, or powder of the vegetal material. It is only rarely and in sophisticated western cultures that purified chemical compounds are isolated and taken for hallucinogenic purposes.

In order to provide the reader with an understanding of the botanical interrelationship, we have, in discussing the major hallucinogenic plants, felt constrained to present very briefly basic information on each family and genus considered and a rather detailed description of the species involved. Sometimes—as with the sacred hallucinogenic mushrooms of Mexico and the myristicaceous snuffs of the Amazon—a number of closely related species are employed, and in these cases we have offered a description of only one species, choosing what appears to be the most important species.

We would like to emphasize that, although occasionally we have included material of pharmacological orientation, it is not the aim of this book to present nor evaluate what is pharmacologically or psychopharmacologically known about the plant hallucinogens.

One of the contributions of our book which, we believe, many colleagues may find most useful is the bibliography. Consequently, we have aimed towards a rather comprehensive and inclusive list of references. It remains, however, perfectly obvious that a complete bibliography of such a fast moving field is not possible. We have, therefore, had occasionally to exercise our judgment as to what to include and what to exclude in accordance with the aim of our book.

R. E. S.

A. H.

## ACKNOWLEDGMENTS

SO MANY OF OUR COLLEAGUES and friends have freely contributed to the elaboration of both editions of this book—both in botanical and chemical aspects of it—that we find it difficult adequately to thank each of our helpers. Suffice to say that this book would be far less complete and probably far less useful without the assistance of so much willing research and bibliographic assistance.

To our numerous colleagues who have themselves worked on hallucinogenic plants or their chemical constituents, we owe our appreciation for many suggestions and favours. These friends include the following: Professors Roger Heim (Muséum d'Histoire Naturelle, Paris); Bo Holmstedt (Karolinska Institutet, Stockholm); Robert F. Raffa and John Neumayer (Northeastern University, Boston); Heinrich Klüver (University of Chicago, Chicago); Norman R. Farnsworth (University of Illinois School of Pharmacy, Chicago); Peter Waser (University of Zürich, Zürich); Raphael Mechoulam (Hebrew University, Jerusalem); Weston LaBarre (Duke University, Durham, North Carolina); Tony Swain (Boston University, Boston); Loran Anderson (Florida State University, Tallahassee, Florida); D. W. Fullerton (Oregon State University, Corvallis, Oregon); Carlton E. Turner (University of Mississippi, Oxford, Mississippi); William A. Emboden, Jr. (California State University, Northridge, California); Donald Pfizer (Harvard University); and H.-L. Li (University of Pennsylvania, Philadelphia).

We owe our gratitude equally to Dr. J. P. M. Brenan (Director, Royal Botanic Gardens, Kew); Dr. Olav Braenden (United Nations Division of Narcotics, Geneva); Dr. György-Miklós Oláh (University of Laval, Quebec); Dr. Nathan S. Kline (Rockland State Hospital, Orangeburg, New York); Dr. Stig Agurell and Dr. Jan-Erik Lindgren (Astra Läkemedel, AB, Södertälje, Sweden); Dr. Jan Bruhn (Karolinska Institutet, Stockholm); Dr. Laurent

Rivier (Université de Lausanne, Lausanne); Dr. Efrén del Pozo, Dr. José Luís Díaz and Prof. Gastón Guzmán (Universidad Nacional Autónoma de México); Dr. Irmgard Weitlaner de Johnson (Mexico City); Dr. Alexander T. Shulgin (Lafayette, California); and Mr. Frank Lipp (New York Botanical Gardens).

Dr. Siri von Reis Altschul, Dr. R. Gordon Wasson, Dr. Andrew T. Weil, Dr. Timothy C. Plowman, and Dr. Peter T. Furst (Botanical Museum, Harvard University) have been exceptionally helpful in assisting and in criticizing certain parts of the text. Professor Johannes Wilbert (also of the Botanical Museum) has been free with his suggestions for improvement of the content and text of this second edition.

The staffs of several libraries have been generous with their time, but we must especially thank Mrs. Lillian Hanscom, publications secretary, and Miss Esther Reynolds and Mr. Wesley Wong, librarians at the Botanical Museum of Harvard University, for many favours. Mrs. Leonore Dickinson, librarian of the Gray-Arnold Arboretum Library, Harvard University, has likewise been of help in sundry aspects of the botanical parts of this edition.

We thank Dr. Raffauf for his technical assistance in reading final page proof.

Many friends and colleagues have facilitated photographs and/or drawings, which are individually acknowledged. We deeply appreciate the kindness of Mr. Yando de Rios, Peruvian artist, for the drawing of an ayahuasca healing session which he executed especially for this edition. Several artists have enhanced the illustrative part of this edition by providing drawings of hallucinogenic plants: Mr. Gordon W. Dillon, Mr. Elmer W. Smith, Mr. Joshua Clark, Mrs. Irene Brady Kistler, Miss Lynda T. Bates, and Miss Judith Gronim, all of whom have worked at the Botanical Museum of Harvard University.

Finally, our appreciation goes to Miss Charlotte K. Hodsdon for her careful typing of pages altered from the original edition. Her interest and constancy have made our task substantially easier throughout the work.

R. E. S.  
A. H.



## CONTENTS

	<i>Page</i>
<i>Editor's Foreword</i> —I. Newton Kugelmass . . . . .	v
<i>Foreword</i> —Heinrich Klüver . . . . .	vii
<i>Preface to the Second Edition</i> . . . . .	xvii
<i>Preface to the First Edition</i> . . . . .	xix
<i>Introduction</i> . . . . .	xxi
<i>Acknowledgments</i> . . . . .	xxiii
<i>Chapter</i>	
I. HALLUCINOGENIC OR PSYCHOTOMIMETIC AGENTS: WHAT ARE THEY? . . . . .	3
II. THE BOTANICAL DISTRIBUTION OF HALLUCINOGENS . . . . .	19
III. THE STRUCTURAL TYPES OF THE PRINCIPAL PLANT HALLUCINO- GENS . . . . .	25
IV. PLANTS OF HALLUCINOGENIC USE . . . . .	32
V. PLANTS OF POSSIBLE OR SUSPECTED HALLUCINOGENIC USE . . . . .	317
VI. PLANTS WITH ALLEGED HALLUCINOGENIC EFFECTS . . . . .	366
<i>Bibliography</i> . . . . .	369
<i>Index</i> . . . . .	411



**The Botany and Chemistry  
of Hallucinogens**



(1) Top (distal portion) of male plant, in flower; (2) top (distal portion) of female plant, in fruit; (3) seedling; (4) leaflet from a large, 11-parted leaf, to show leaf variability; (5) portion of a staminate inflorescence, with buds and a mature male flower; (6) female (carpellate) flower, with stigmas protruding from enveloping hairy bract; (7) fruit enclosed in persistent hairy floral bract; (8) fruit, lateral view; (9) fruit, end view (sagittal plane); (10) glandular hair, with multicellular stalk; (11) glandular hair with short, one-celled, invisible stalk (sometimes called a sessile glandular hair); (12) rigid nonglandular hair containing a cystolith of calcium carbonate. Drawn by E. W. Smith.

## Chapter I

### HALLUCINOGENIC OR PSYCHOTOMIMETIC AGENTS: WHAT ARE THEY?

**A**GENTS THAT CAUSE VISUAL, auditory, tactile, taste, and olfactory hallucinations or that induce artificial psychoses have been known undoubtedly since earliest human experimentation with the vegetal environment.

Their use goes so far back into prehistory that it has been suggested that even the idea of the deity may have arisen as a result of their physiological effects (LaBarre, 1972; Wasson, 1958). Although man in all primitive cultures tried to find direct palliatives or cures for his ills, the psychic effects of drugs were often far more important to him than the purely physical. It is easy to understand, since in most, if not all, primitive cultures, sickness and death itself are usually attributed to supernatural forces entering the body. Witchcraft, aided by communion with spirit forces, was the principal tool in diagnosing and treating disease (Schultes, 1970c).

What easier way to contact the spirit world than by use of plants with strange, unearthly, psychic effects capable of freeing man from the prosaic confines of this mundane environment and carrying him temporarily to fascinating worlds of indescribably ethereal wonder? Primitive man sought after these plants and put an extraordinary value on them. Narcotics, especially those now called hallucinogens, were his medicine *par excellence* and became fast fixtures of his magic and religion, the bases of his medical practices (Söderblom, 1968).

How could this come to pass? Man saw, experimented with, and came to know the thousands of different plants in his surroundings. He tried ingesting them all. Most were innocuous; a few pleased his taste; some nourished him; a goodly number of them made him ill; sundry ones relieved pain and suffering; a few killed him outright; but a very few had weird and unearthly



Figure 1. Waiká Indian medicine man under the influence of epena, the narcotic snuff prepared from *Virola theiodora*. Rio Maturacá, Amazonas, Brazil. Photograph by R. E. Schultes.

effects on his body and mind. His only plausible explanation of such strangely unreal, psychic powers ascribed to these species a resident divinity or spirit. The plants were exalted to a highly sacred place and usually were reserved for a sacred role in magico-religious rites (LaBarre, 1964, 1970; Schultes, 1969c).

While some of these sacred hallucinogens have become more or less secularized and are on occasion employed by the general adult male populations without strict ritualistic control, most of them are still taken or administered by priests, shamans, medicine



Figure 2. Kamsá Indian witch doctor after having taken the preliminary draughts of a tea prepared from leaves of a species of the solanaceous *Brugmansia*. Sibundoy, Putumayo, Colombia. Photograph by R. E. Schultes.

men, or witch doctors in structured medico-religious control. As a consequence, field research by anthropologists and botanists must of necessity be carried out in collaboration with these usually powerful members of primitive societies.

Modern man now knows that these "resident divinities" are chemical substances. During the last eighty years—but more particularly during the last two decades—pharmaceutical research has uncovered an astonishing array of chemical compounds, many from plant sources, capable of extraordinarily af-