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THE WIDENING PANORAMA IN MEDICAL BOTANY[1]

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> "And as there are discouvered new Regions, new Kingdoms, and new Prouinces by our Spaniards, so they have brought unto us new Medicines, and newe Remedies, wherewith they do cure many informities, which, if we did lacke them, would bee incurible, and without any remedie . . . for which cause I did pretend to treate, and to write of all things that they bring from our Indias, apperteyning to the Arte and Use of Medicine, and the remedie of hurtes and diseases that we doo suffer and endure . . ."
> Nicholas Monardes [transl. John Frampton] "Joyfull Newes out of the New-found Worlde" (1956)

I. *Introduction*

From an Andean mountain top overlooking the endless forest of the Amazon, dawn can be beautiful. One sees — one feels — the tropical panorama widen as the solid blanket of morning mist below first breaks into little openings, then, as the sun climbs higher, slowly lifts to bring the foreground into detailed view and the distance into clearer perspective.

I have often experienced such a widening panorama during my years of work in South America. And I have just as often thought of how similar has been our recent experience in medical botany. The widening panorama of the Plant Kingdom as a field of exploration for new physiologically active substances — this panorama has already started to bring the foreground into detailed view and the distance into clearer perspective. For the first time perhaps in all history

[1]Lecture given at the Medical Center Lecture Series, University of West Virginia, Morgantown, West Virginia, October 29, 1962.

we know in a small way where we are going in our search for plants of promise in man's fight against the ills of his mind and body.

At the Botanical Museum of Harvard University, we have a course entitled "Plants and human affairs", the oldest course in economic botany in this country — going back to 1876. When I was a student in this course in 1935, Professor Oakes Ames spoke somewhat nostalgically when he took up the medicinal plants, because, one by one, the old plant medicines were being synthesized or replaced by coal-tar products. Professor Paul C. Mangelsdorf, who took over the teaching of the course in 1941, felt that, in the future, he might have to discuss plant drugs solely from the historical point of view. Now, in this same course, I divide my lectures on medical botany into *Medicines of the Past, Medicines of the Present* and *Medicines of the Future.*

Such an amazing turn-about has taken place in a quarter of a century that it is not easy for us fully to comprehend the far-reaching implications of the change. Perhaps it is even more difficult for the scientist who is close to the Plant Kingdom — especially a botanist who was fortunate enough to spend many years in the field in intimate association with rich tropical floras. He cannot help being thoroughly overwhelmed with the vastness, the boundless variation, the intricate adaptations, the potentialities of undiscovered constituents of the Plant Kingdom. Familiarity with such a welter of complexity can, of itself, relegate into a truly minor place the relationship between man's ills and the grandeur and universality of the vegetal world.

When I was a graduate student, seeking material for my doctoral thesis amongst Indians isolated in the mountains of Oaxaca, Mexico, I could find no pharmaceutical house in the United States with the time or interest to investigate witch-doctors' plants, and I was forced to send my material to Sweden to the late Dr. C. G. Santesson who, since he was retired, could study whatever it pleased him to investigate.

Now every pharmaceutical house of any size and seriousness has become newly conscious of the Plant Kingdom.

Colleges of pharmacy turn to the vegetal world for problems for doctoral students. Government agencies keep an alert eye on promising openings for research into plant drugs. And this forward step has opened up almost limitless vistas for both academic and practical research programmes.

Yet everything indicates that we are still far from grasping the potentialities which lie before us. We are hesitant to grasp the reality, perchance, just because we can see no bounds. It is this opportunity — never before given to man and fraught with such imponderable promise — that I want to consider.

Perhaps it may be interesting in the beginning to review a few simple figures to bring into higher relief this great opportunity of which I speak. I looked back into my college notes the other day and found that, in 1935, of the ten drugs then in most common use, only two (digitalis and codeine) were of vegetal derivation. The percentage of drugs of plant origin recognized by the United States Pharmacopoeia was steadily declining, whilst that of chemical drugs was steadily increasing. In 1820, our first Pharmacopoeia listed 223 plant drugs; a century and a quarter later, in 1946, the Pharmacopoeia and National Formulary enumerated 244. This would seem to indicate a slight increase, but it is not an indication of their relative importance. For, in 1820, 82% of the medicines listed were of plant origin, 15% of chemical, 3% of animal; in 1946, 38% were vegetal, 56% chemical, 6% animal. To-day, only about 100 of the original 223 are still in use, but these include the "blue-chips" that have paid good dividends in health since earliest times. Perhaps, in passing, it might be interesting to compare this total of 100 plant drugs now in use with the 3800 species recommended medicinally by John Parkinson, the last British herbalist, in his "Theatrum Botanicum" of 1640.[2]

Now, since we are using but 100 of the original 223 drugs of plant origin, how can we be sure that we should delve so deeply and with such great hopes into the Plant Kingdom

[2]Parkinson, John: "Theatrum Botanicum. The theatre of plantes" (1640).

for new medicines? And when we realize that from 1900 to 1940 only about five new plant drugs were added to our list: Strophanthus, agar, chaulmoogra, Ephedra and Psyllium — what should we think then?

But from 1940 to 1960, a minor miracle has come to pass. As the result of new methods of analysis and refined techniques, many new drugs have been discovered and new uses have been found for some of the older drugs. To-day, 75 to 80% of the drugs most frequently prescribed are recent additions to our pharmacopoeias; most of them, in fact, were unknown in 1940. As a direct result of this rash of discovery, our tempo of research has been steadily accelerated, yet the frontiers for discovery have hardly been touched.

The organic chemist might differ with our predictions, since he may believe that it is only a question of time before everything will be synthetic and that chemistry alone will dominate the field of new drug discovery. No one can deny that great strides have been made in organic synthesis. Many plant drugs have been produced synthetically (witness camphor and quinine) or closely allied substances, sometimes more effective and efficient, have been made (such as aspirin vs. oil of wintergreen, novocaine vs. cocaine). Alkaloids, the active principles of so many drugs, have long baffled the chemist. It took 134 years to synthesize morphine, and production is still in the pilot-plant stage. Fifty-eight years elapsed after atropine was first synthesized before it could be done on a large scale. All of this means that the opium poppy and the belladonna plant are still very much with us.

Yet it is not that we would look to the Plant Kingdom as a commercial supply of our drug compounds, unless it be more economical to isolate them from plants than to produce them synthetically. We should look upon the Plant Kingdom as an almost untapped arsenal of ready-made compounds which, once isolated and understood, can serve us in at least three ways: 1) directly as medicinal agents; 2) as starting points for the elaboration of more complex compounds of therapeutic value; and 3) as academically interesting or stimulating exercises.

II. *The Plant Kingdom*

Since the vegetal world does present this widening panorama, let us start at the beginning and take an appraising look at the Plant Kingdom. Just what does the Plant Kingdom offer?

The most diverse of organisms make up the Plant Kingdom: the Bacteria, Algae, Fungi, Bryophytes, Pteridophytes and Spermatophytes. All told, there may be as many as 800,000 species in the Plant Kingdom. It is hard to appreciate how extensive a field this represents, but it is easy to realize how truly marginal our phytochemical knowledge of this vast assemblage must be.

Estimates, naturally, are subject to appreciable variation, and calculations of the number of species can, of course, be made with greater precision in groups of plants which have been thoroughly studied taxonomically. This means that we are in a better position to calculate how many species of spermatophytes there are than bacteria. Estimates vary, again, with the outlook of the taxonomist, but when we consider the Plant Kingdom as a whole, the personal equation — what sundry taxonomists accept as species limitations — is more or less balanced out.

We do not have a clear idea of how many species of Bacteria there are. This is partly because they have been less thoroughly studied than most other groups of plants and partly because they are often known more from their physiological effects than from structural characteristics. Modern estimates[3] give approximately 1500 species in about 200 genera. The bacteria are, of course, of intense importance in medicine as the causative agents of many ills, but a disappointingly small number of therapeutically promising compounds have been isolated from them.

Estimates for the Fungi have varied from approximately 30,000 to 85,000 species. One of the most recent workers[4],

[3]Thimann, K. V.: "The life of bacteria — their growth, metabolism and relationships" (1955).

[4]Martin, G. W.: "The numbers of fungi" in Proc. Iowa Acad. Sci. 58 (1951) 175.

however, has written that 100,000 may be highly conservative and that the total may well be over 200,000. Another contemporary worker[5] states that "it seems reasonable to predict that, as more facts are accumulated . . . the fungi will eventually be recognized as bearing the same relationship to the Plant Kingdom (on the basis of numbers of species) as insects bear to the Animal Kingdom." Now the fungi are extraordinarily important to man; but, as sources of medically active compounds, they have, until recently, been of strangely minor significance. The ergot alkaloids come immediately to mind as very old fungal medicines. But the rise of the antibiotics, beginning with the development of penicillin in the early 1940's, has brought into sharp relief as a source of new drugs not only the fungi but the related actinomycetes. The very recent work with hallucinogenic mushrooms and the isolation from them of phosphylated indole derivatives never known to occur in plants has turned our eyes towards this much neglected section of the fungi and may, one day soon, produce spectacular and highly practical medical results. Furthermore, the study of fungi as allergens is still in its infancy and promises many new avenues of approach in research. I cannot tell you how many species of fungi have as yet never been subjected to chemical study; but, if we accept the estimate of 100,000 species for this group of plants, we can easily appreciate the widening panorama here awaiting the attention of our research scientists.

That most varied of plant groups, the Algae, numbers about 19,000 species[6]. Here is a vast and hardly touched field for phytochemical investigation. Since most of the algae are aquatic, many of them marine, the problems as well as the opportunities awaiting us must be both numerous and unique. Only a beginning has been made in the search for medically promising chemicals from the algae.

When we come to that interesting symbiotic group, the Lichens, we find that startling advances have likewise been

[5]Gray, William D.: "The relation of fungi to human affairs" (1959).
[6]Bold, H. C.: "The plant kingdom" (1960).

registered in recent years. The newest estimates give the lichens some 450 genera and 20,000 species[7]. Since 1944, the bacteria-inhibiting properties of a number of lichens have been noted. In fact, about one-half of the temperate zone lichens have this property, due to lichen acids which can inhibit gram-positive bacteria and even the tuberculosis bacilli and some fungi. Lichen antibiotics are now used commercially in medicinal salves in northern Europe, especially in Finland, Russia and Germany, and there is every reason to believe that the lichens may supply more as well as more diverse antibiotics as research continues. The Japanese are extremely active at the present time in the investigation of chemical components of the lichens.

The Bryophyta, characterized as "a constellation of divergent groups rather than as a homogeneous division or phylum",[8] has been severely neglected in phytochemical investigation. Comprising some 14,000 species and being world-wide in distribution, the bryophytes promise interesting results from a concerted study of their chemical constituency.

When we come to the so-called "higher" plants, the Pteridophyta and the Spermatophyta, we see again the potentialities of a widening panorama, for here we have a significantly large and diversified group of plants.

The pteridophytes — ferns and fern allies — have given us a few folk remedies, but they have been disappointingly parsimonious in contributing to modern medicine. Here is a field, however, which, since it has not been granted the intensive phytochemical efforts that have characterized other groups of the higher plants, may hold hidden surprises. The 250 genera and nearly 10,000 species of ferns and fern allies[9] deserve closer chemical scrutiny, especially those which are known to have outstanding folk uses in primitive societies.

We come now to the seed plants or Spermatophyta, the

[7]Lamb, I. M.: Personal communication.

[8]Steere, W. C.: "Bryophyta" in "The encyclopedia of the biological sciences" [Ed. P. Gray] (1961) 177-179.

[9]Tryon, R.: Personal communication.

dominant land flora of our present geological epoch. The two Spermatophyte groups, the gymnosperms and the angiopserms, show extreme disparity both in their size and in what they have given to medicine.

There are some 65 genera and 700 species of gymnosperms,[10] from which, in the United States, we use only about two dozen official and unofficial drugs[11] — and these mainly for their volatile oils or resins. Would not a renewed phytochemical attack, utilizing improved techniques, upon this ancient group of spermatophytes seem to be warranted?

It is the angiosperms, above all other groups of plants, which have occupied man's attention from earliest times in his search for medicines. This is easy to understand. The angiosperms are not only numerous, but they are conspicuous and, even to-day, take a position of primacy in the popular concept of the Plant Kingdom. Most of our plant remedies of the past and a very substantial number of the newer advances in medical botany have been made from the angiosperms. Since it is my belief that the potentialities have only been superficially explored, even in this best known part of the Plant Kingdom, I shall discuss somewhat more fully the width of the panorama which the angiosperms present.

It may surprise those who are not taxonomic botanists to hear that no one knows really how many angiosperms there are. Even though the angiosperms are better understood than other groups of plants, estimates vary significantly, and one sometimes wonders: May not even our highest estimates be seriously deficient? Estimates vary greatly, but the figure usually accepted is in the neighbourhood of 200,000 species[10, 12] in some 300 families and some 10,500 genera. The monocotyledons usually are credited as comprising about one quarter as many species as the dicotyledons.

Having spent more than a decade in field work in the Amazon basin and in the northern Andes — one of the richest floristic areas of the world — I have now for some time

[10]Lawrence, G. H. M.: "Taxonomy of vascular plants" (1951).
[11]Youngken, H. W.: "A text book of pharmacognosy", Ed. 4 (1936).
[12]Ames, O.: "Economic annuals and human cultures" (1939).

given serious thought to this estimate. I am led to the conclusion that we are greatly underestimating the species-wealth of the angiosperms.

I once began to formulate my ideas about the number of species in the flora of the Republic of Colombia. After marshalling many facts and opinions and screening the results of past and current plant exploration, I was obliged to place my census of Colombia's flora in the neighbourhood of 50,000 species of higher plants. Even though Colombia is recognized as one of the two or three richest phytogeographic areas of the world, this calculation at first frightened me. Nevertheless, I published it, together with my reasons for arriving at such a figure.[13] The reaction from botanists was, in general, very favourable.

Now, if we hold to a figure of only 200,000 species of angiosperms, Colombia would then have one quarter of all the world's flowering plants. As rich an area as Colombia is, it cannot be that rich. Then, let us look at it from another vantage point: the Orchidaceae is the largest phanerogamic family, with an estimated 25,000 to 30,000 species; and the next largest family is the Compositae with some 20,000 species. If two of the 300 angiosperm families add up to about 50,000 species, must we not alter our estimate of the total number of flowering plant species? In other words, do these two families comprise one quarter of all the angiosperms? And let us not forget that every exploration beings back species new to science. I have, for myself at least, made the indicated statistical alteration and have felt for a long while that we must allow somewhere near half a million species, instead of 200,000 for the flowering plants. The future — and the very near future, I believe — will justify this point of view.

III. *Plant Constituents*

Perhaps the alkaloids are, to medicine, the most impor-

[13] Schultes, Richard Evans, "La riqueza de la flora comombiana" in Rev. Acad. Col. Cienc. Exact. Físico-Quím. Nat. 8 (1951) 230. — "Hacía un censo de la flora de Colombia" in Univ. Nac. Col., no. 23 (1958) 77.

tant constituents — and certainly they are one of the most widespread — in the plant world, even though we cannot forget the glycosides, essential oils, gums, mucilages, tannins, fatty oils, colouring matters, resins and other types of chemical substances which man has sometimes found useful therapeutically. There is no question that the Plant Kingdom has yielded an amazing variety of products in this field and, as chemical methods and laboratory techniques become more sophisticated, we can see no end to the useful materials available from the thousands of species as yet untouched.

Notwithstanding the vast amount of research that remains to be done, perhaps more chemical and medical work has been carried out on alkaloids than on any other kind of plant constituent. A recent and most thorough compilation of alkaloids[14] enumerates 3671 species of plants (including cryptogams) in which alkaloids have been found. Not all of these have been structurally identified. Some of them are undoubtedly "duplicates" — alkaloids which may be shown to be identical to others. In the flowering plants, certain families are known to be rich in alkaloids, but even in these families the figures indicate only partial study. Two good examples are the Leguminosae, a family of at least 15,000 species, in which 1525, or about 10%, are listed as having alkaloids; and the Solanaceae, with upwards of 2500 species, where 252, or again only 10%, are alkaloid-bearing. About 10% of the known alkaloids have been recorded from one family, the Apocynaceae, as a result of the effort initiated by Rauwolfia investigations during the past ten years. From the chemist's point of view, there are other families in which a concentration of work, if it could be justified on other than purely academic grounds, would likewise yield large numbers of compounds. And probably an equally large variety of structures would appear as well.

The potentialities are obvious. To-day our techniques of alkaloidal detection — as well as tests for other types of constituents — are greatly improved. A recently perfected

[14] Williams, J. J. and Bernice G. Schubert: "Alkaloid-bearing plants and their contained alkaloids", U. S. D. A. Techn. Bull. no. 1234 (1961).

spot test for alkaloids,[15] which can be applied to fresh plant material in the field or to fragments from herbarium specimens, promises rapidly and widely to extend our knowledge of the distribution of alkaloids in the higher plants. It will not, of course, tell us what kind of alkaloid is present; that must await more detailed examination. But it will tell us whether or not an alkaloid is present. The potentialities offered by this simple spot test can hardly be over-emphasized, for it opens up for quick and easy preliminary study all the spermatophytes and some other plant groups.

One American pharmaceutical house has tested some 15,000 to 20,000 species for alkaloids.[16] On a random basis, about 15% would have been found to be alkaloid positive, but, since certain families (Solanaceae, Papaveraceae, Amaryllidaceae, etc.) with alkaloids of well known structure were eliminated, the percentage would run probably about seven or eight of positives. In any case, about half of the 15% are suspected of possessing alkaloids in such minute amounts as to preclude a practical study of their chemistry or pharmacology. About half of the remainder contain some previously recorded alkaloid. Thus, we are left with about 4% of the species examined with possibly new alkaloids, hence potentially new medicinal agents. This means at least 8000 new alkaloids, more than three times the number now known, remain to be discovered.

I have stressed the alkaloids, but we must bear in mind that alkaloids are not the only plant compounds of interest to medicine. There are another 3000 non-alkaloidal plant principles of known structure, many of which have or have had some application in or bearing upon medical problems. These include about 150 cardiac glycosides of the types which have been used as starting material for modern syntheses of the steroid hormones.

IV. *Methods of Investigation*

Now, this brings us face to face with the question: How

[15]Raffauf, Robert F.: "A simple field test for alkaloid-containing plants" in Econ. Bot. 16 (1962) 171.

[16]Raffauf, Robert F.: Personal communication.

can we take fullest advantage of this widening panorama? There is only one answear: *Exploration.*

Exploration to hasten the widening of our panorama in medical botany may be done in the literature, both the ancient and the modern; in the herbarium; and in the field. And exploration for our present purposes had best be done along all three lines simultaneously.

The literature of the ancients, the herbals of mediaeval Europe and the writings of modern anthropologists, travellers and missionaries must still be treated as repositories of much uninvestigated information. We should never pass quick judgment on statements in any of this literature concerning plant uses simply because they seem to be ridiculous. To do so might cause the loss to science, at least for many years, of plant medicines of supreme importance. This has happened frequently. Had we seriously studied the Egyptian papyri, we might many years ago have found a hint to the anti-bacterial activity of certain actinomycetes or fungi. And, had the ethnobotanical references in the chroniclers of post-conquest Mexico been seriously studied, we would not have had to wait until this past quarter century for a knowledge of the hallucinogenic mushrooms and morning glories. It is, nonetheless, true that this literature must be employed with wise restraint, since much of it may be scientifically unsound. To base an entire programme of research on literature alone, as some pharmaceutical houses are doing, appears to me to be a highly suspect *modus operandi.*

Recently, our herbaria have come into their own as sources of ethnobotanical observations made in the field by plant collectors of the past. These reports have several advantages. Unlike much of the literature, they are, in great part, firsthand; they are attached to an actual plant specimen, and there can be, therefore, no problem concerning the proper identification of the plant; the ethnobotanical data are anchored down, through the information on the specimen label, to a definite locality and oftentimes to specific peoples who employ the plant. The vastness of our herbarium resources has hitherto not fully been recognized. The Harvard

University Herbarium, for example, has a total of some 2,200,000 sheets. There is now underway a project consisting of a sheet by sheet search for records of medicinal uses amongst primitive peoples.[17] It appears probable, on the basis of the first six families studied, that we may find in the entire collection in the neighbourhood of some 3700 notes of interest. If we vouchsafe that about half of these may be unpublished or new to science, there remain for investigation about 1800 reports. We know that about 40% of the notes — or about 720 — are specifically medical. And we may be justified in assuming that about half of these — or 360— might prove to be of some real interest to pharmaceutical science. This may give us some inkling into the panorama as seen from the point of view of our herbarium resources.

The herbarium may assume an even greater "exploratory" importance with the application of the spot test for alkaloids which can be made upon very small fragments. Here we have assembled in dried form material of most of the higher plants and from the farthest corners of the globe, and a drop of reagent on a few scraps can, in a few minutes and in the quiet of our own laboratories, tell us whether or not there are alkaloids in a tree from the Tibetan Himalayas, a shrub from driest Australia or a liana from the muddy banks of the Amazon.

But field work still offers our very best opportunity of discovering new physiologically active substances.

Because I am emphasizing the ethnobotanical aspects of field work, I must mention the rather generalized tendency in both popular and scientific circles to over-emphasize the importance of folk medicines. Notwithstanding the fact that primitive peoples *do* possess valuable understanding of plant properties, their knowledge has been optimistically exaggerated in the past and is far from being complete. It, therefore, behooves us to carry out our own phytochemical studies of the flora in general in the field, and this is probably best done

[17] von Reis, S.: "Herbaria: sources of medicinal folklore" in Econ. Bot. 16 (1962) 283.

along two paths: 1) intensive examination of families and genera known to be rich in active principles and 2) a systematic examination, species by species, of a random sampling of floras. I cannot take up this most interesting and promising type of exploration for lack of space but I do want to keep its fundamental importance in mind throughout our consideration of other aspects of the medico-botanical panorama.

Perhaps the most satisfying way of advancing our knowledge of medicinal plants is direct investigation amongst primitive peoples, and I shall discuss this aspect of our research, endeavouring the while to avoid exaggeration of its importance or of suggesting that it has any special exclusivity or primacy in ethnobotanical research.

The discovery of some drug plants has been attended by exciting adventure. Knowledge of others was gained from travel incidental to "conquest, colonization or religious conversion".[18] Still others have been found through the efforts of individuals or groups specifically sent out to learn of their identity and use.

There is a tendency now to send out expeditions exclusively to discover new drug plants. There is historical precedence for this procedure. Shortly after the conquest of Mexico, Philip II of Spain sent his personal physician, Dr. Francisco Hernández, to the new realm to study its medicinal plants, animals and minerals. After field work from 1570 to 1575, he had finished 16 folio volumes containing an unbelievable wealth of native medical lore. What has been published of his work is still replete with uninvestigated opportunities for modern scientists.[19] This represents undoubtedly the first *official* purely scientific expedition in history, and it was sent out for the sole purpose of trying to capitalize on the medical knowledge of the conquered peoples of a country rich in natural history.

In 1714, Peter the Great ordered the establishment of the Apothecaries' Garden in Russia and commissioned the Ger-

[18]Cheney, Ralph H. and B. L. Milana: "Medicine and plant exploration" in Am. Journ. Pharm. 119 (1947) 323.

[19]Hernández, Francisco: "Rerum medicarum Novae Hispaniae thesaurus . . ." (1651).

man botanist Messerschmidt to collect the medicinal flora of Russia between 1720 and 1727. We could cite other examples in historic times where the search for drug plants was the unique purpose of an expedition.

There were other expeditions, however, which set out to study the flora in general, the useful plants as well as those which were not employed. Most of the truly outstanding explorations were of this kind. The work of the 17th Century Dutch botanist, Rumphius, basic to natural history research in the East Indies, could be cited,[20] for he wrote about the native uses of more than 700 plants. We could mention the three botanical expeditions sent out in the late 1700's by the King of Spain: Sessé & Mociño to Mexico; Mutis to Colombia; Ruíz & Pavón to Peru. All of these expeditions gave very special attention to folk-medicines while studying general floristics.

Although we have returned to the custom of sending out expeditions exclusively to search for new drug plants, I am not at all convinced that this is usually the most efficient way of working in the field. It may be the quickest and most direct way, when we are after a specific drug, the identity of which we know and about which we have a large fund of ethnobotanical knowledge. But to visit an area in the hope that a brief sojourn amongst natives will uncover their plant remedies — no; we should not be so sanguine.

Many of our official drugs have come incidental to the work of individual botanists busy with some larger project, and I am convinced that most of the new discoveries will be made by botanists, ethnobotanists or anthropologists engaged in leisurely fashion in their own research rather than by expeditions sent out "to find new drugs". And we must not minimize or overlook the role which the layman has played in this work, both in the past and in the present.

Perhaps because my own expeditions were carried out in this way, I hold out greater hope for success for resident work amongst native peoples, which does not unduly emphasize the search for drug plants. Few botanists, I realize, are

[20] See De Wit, H. C. D. [Ed.]: "Rumphius memorial volume" (1959).

fortunate enough to spend an almost uninterrupted twelve years in the field. Long residence in one region most certainly enhances opportunity for ethnobotanical discovery through the creation of a rapprochement with natives, a familiarity with their languages and customs and an intimate knowledge of the flora itself. Few botanists, I realize further, are fortunate enough to work in such an ethnobotanically rich and untouched area as the northwest Amazon. And I realize, finally, that, in such a virgin area as the northwest Amazon, any naturalist of long residence could not but uncover both botanical and ethnobotanical rarities and novelties.

Like most primitive peoples, the Amazon Indian cannot comprehend any purely academic interest in plants. His only understanding is of their utilitarian or magical value. The botanist who works amongst them is easily accepted, for here is a man who spends all of his time collecting plant specimens. The native lives intimately with his plant environment. Consequently, from the start, the botanist has a common interest with the native.

During my twelve years in the Amazon, I made some 24,000 collections of the Amazon flora. Only a small fraction were reputedly medicinal. If an Indian helper asked, during my collecting activities, why I wanted a certain plant, the only explanation which he could understand was that I needed it for a remedy. Now, the very fact that he asked about *that* particular plant, and no other at the moment, indicated that perhaps he had a medicinal use for it and wanted to see if his use and my reason for wanting it coincided. In such a case, I would contrive the next day or so to collect the same species farther up stream, followed a few days later with another collection — all the while saying nothing about the plant. If it were really a plant of utilitarian importance to the native, he would most certainly, after seeing me collect it several times, begin to discuss it. This "cat-and-mouse" technique uncovered many ethnobotanical facts which, had I pressed impatiently at the start, would not have been divulged.

When I first went into the Colombian Putumayo in 1941,

I was anxious to identify botanically "yoco", a plant employed by the Indians as the source of a strong stimulant known for years only by its vernacular name. Persistent research for nearly a year failed to uncover a flowering or fruiting specimen of the liana which clambers through the crowns of 100-foot jungle trees. I had alerted Indians far and wide of my need for flowers of yoco. Finally, after eight months, serious leg ulcers from work in inundated forests forced me to go to a small Colombian naval base on the Putumayo River to await a hydroplane to civilization. The clean accommodations offered me on a river gun-boat by the officers were so pleasant that when an Indian, who had paddled downstream in search of me, reported that he had seen the liana in flower, I was reluctant to leave. Yet intuition told me that I should, so back I went two days upstream and a day through flooded swamp-forest. Locating the liana, the ground under it strewn with minute white flowers, we had to fell seven trees to bring it down. But we were rewarded in being able to establish the identity of the elusive yoco, later shown to be rich in caffeine, as an undescribed species of the sapindaceous genus *Paullinia*.[21] This experience is indicative of the interest and loyalty which I found at all times amongst the Indians of the region. I cannot subscribe to the widespread belief that he regards his plant lore as something secret zealously to be guarded and that civilized man must pry it from him by ingenious duplicity.

A sympathetic understanding and tolerance of his beliefs and ways and a participation in his customs do more than anything else to win the Indian's respect and confidence. I naturally learned to chew his coca and, finding it to be not only a pleasant but a most helpful custom, used it for eight years myself. This may explain perhaps why certain Makunas of the Apaporis River, where I spent a total of some three years, told me of a remote and isolated group of Tanimukas which prepared a superior type of coca. Finally making a trip to investigate this report, I learned of a most

[21]Schultes, Richard Evans: "Plantae Colombianae II" in Bot. Mus. Leafl. Harvard Univ. 10 (1942) 301.

ingenious method of infusing into coca powder the acrid incense of the resin of the tacamahaca tree *(Protium heptaphyllum)*, one of the few variations ever found in the preparation of this widespread narcotic masticatory, the source of the alkaloid cocaine.[22]

Anthropological writings indicate (but we now know that they are in error) that the narcotic snuff yopo, prepared from the seeds of Piptadenia, is employed throughout the upper Orinoco and much of the Amazon basin. I was puzzled, however, by my failure to encounter a single tree of this plant in the northwest Amazon. Yet the witch-doctors employed a highly narcotic snuff which was not tobacco. What could it be? Had I been insistent, I might never have known. After nine years, one of my Puinave boys, himself the son of a medicine-man, suddenly said one day: "This is the tree that gives yakee snuff." Controlling my excitement, I showed only mild interest. We decided to prepare snuff from it. From strips of bark, the boy scraped off a reddish exudate, mixed it with water, boiled it down in four hours to a thick syrup which he allowed to sun-dry. The resulting solid, pulverized and mixed with bark-ashes of a wild cacao tree, gave us the snuff. Since I believe in experimenting with these plant products personally in the field, I took one-quarter the dose normally snuffed by a medicine-man to produce the psychotomimetic effects essential for his divination and diagnosis of disease. I was ill in my hammock for several days, so strong was the snuff. Strangely enough, the source of yakee snuff belongs to the myristicaceous Virola and is, therefore, related to our nutmeg, which has itself been employed as a narcotic.[23]

The moral from this experience is that patience will usually pay good dividends in this kind of work, but time for such patience is not to be had on the usual expedition set up with the purpose of looking for medicinals and nothing else.

[22]Schultes, Richard Evans: "A new method of coca preparation in the Colombian Amazon" in Bot. Mus. Leafl. Harvard Univ. 17 (1957) 241.

[23]Schultes, R. E.: "A new narcotic snuff from the northwest Amazon" in Bot. Mus. Leafl. Harvard Univ. 16 (1954) 241.


VIROLA
calophylla
Warburg
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E.W. Smith

I might go on in such a vein, telling how, without prying or seeking to outwit the Indian, knowledge of folk-medicines accumulated along with my general botanical work. I could relate the unexpected circumstances which led me to information about plants employed as styptics, to treat conjunctivitis, as snake-bite remedies, in treating burns — not to mention the many everyday uses such as carminatives, febrifuges and purgatives. I could tell about the fascinating detective work with curares which uncovered for the first time the use as a basic arrow poison component a species of Thymelaeceae, *Schoenobiblus peruvianus*. Or I might relate how participation in native dances and rituals when hallucinogens are taken gave me a deeper understanding of the extensive use of the numerous vision-producing narcotics of the region, some hitherto botanically unknown. I might explain how there are still psychotomimetic agents lurking unidentified in these forests for future study. It might be interesting to discuss my work in Mexico on the sacred Mexican mushrooms and on the narcotic morning glory, *Rivea corymbosa*. It would be interesting to relate the circumstances which led me to identify three species of aroids used in different tribes in various parts of the Amazon of Colombia as oral contraceptives. I could occupy many pages discussing the many poisonous plants, some of them species new to science, known and used by these people. But the panorama is too vast to allow a discussion of all of its details.

V. *Final Considerations*

This widening panorama — can we avail ourselves of it? The answer, at the present time, is: "No". The reason is simple: we do not have the trained man-power for the effort. There is no reason why we cannot rectify this short-coming, and there are vaguely discernible signs that perhaps we are beginning to take steps in this direction.

There is an urgency to our training of the needed corps of investigators.[24] Civilization is on the march in many, if not

[24]Schultes, R. E.: Tapping our heritage of ethnobotanical lore" in Econ. Bot. 14 (1960) 257.


SCHOENOBIBLUS
peruvianus
Standl.

most, primitive regions. It has long been on the advance, but its pace is now accelerated as the result of world wars, extended commercial interests, increased missionary activity, widened tourism. The rapid divorcement of primitive peoples from dependence upon their immediate environment for the necessities and amenities of life has been set in motion, and nothing will check it now. One of the first aspects of primitive culture to fall before the onslaught of civilization is knowledge and use of plants for medicines. The rapidity of this disintegration is frightening. Our challenge is to salvage some of the native medico-botanical lore before it becomes forever entombed with the cultures that gave it birth.

Though it is by no means an insurmountable task, it will not be the easiest accomplishment to prepare enough men thoroughly to cope with all the ramifications of the widening panorama in medical botany. They may be basically anthropologists, botanists, medical or pharmaceutical scientists, but they must have an interdisciplinary training. Here is where all of us, as members of teaching and training institutions, must contribute to progress in medical botany. We should watch for the student keen for this kind of research, appraise him of the sundry needs in the field and counsel him as to the best type of preparation and where it may best be acquired. This will demand on our part continual alertness and an imaginative flexibility in our counselling. We cannot now fail medical science, for never before has history offered us similar opportunities.

The task before us is big, but never, I am certain, have we had the human material, scientific tools and financial support more adequate to a frontal attack and, cognizant as all of us must be of the virgin fields that lie ahead, we must utilize these resources conscientiously and efficiently.

I cannot close with words more appropriate than those written in 1754 by the great Linnaeus himself in the preface to a museum catalogue.[25] In expressing what has been aptly described as his creed, words most appropriate for us as we

[25]See Krutch, J. W.: "The gardener's world" (1959) 177.


GORDON W. DILLON
RIVEA
corymbosa (L.) Hall. f.

stand upon the threshold of great new advances, he said in part: "Man, ever desirous of knowledge, has already explored many things; but more and greater still remain concealed; perhaps reserved for far distant generations, who shall prosecute the examination of their Creator's work in remote countries, and make many discoveries for the pleasure and convenience of life. Posterity shall see its increasing Museums, and the knowledge of the Divine Wisdom, flourish together; and at the same time all the practical sciences . . . shall be enriched; for we cannot avoid thinking, that what we know of the Divine works are much fewer than those of which we are ignorant."

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