inated. An exception to this is the conflict in the views on dextrinization expressed in Chapters XII and XIII. In some of the treatment of the more controversial subject-matter, the vague speculation and non-conclusive experimental detail characteristic of older texts still persist. These deviations from the clear description of industrial operations and concise presentation of certain phases of the scientific literature detract from the general objectivity of the book.

The book is timely and a contribution to both the scientific and the technological literature.

R. M. HIXON

REPORTS

THE BOTANICAL WORK OF THE CINCHONA MISSIONS IN SOUTH AMERICA

WHEN the Japanese invaded the Dutch East Indies in the late winter of 1942, our primary source of quinine was suddenly and unexpectedly cut off. Since our stock piles of this essential drug were inadequate for the urgent needs of a long war, the critical problem was placed in the hands of the Board of Economic Warfare (now the Office of Foreign Economic Administration). Negotiations were gotten under way almost at once with the several Andean republics which a century earlier had produced the world's quinine supply. Although the cinchona agreements consisted essentially of our guarantee to buy all bark above a certain minimum alkaloid content, to furnish technical aid to the bark harvesters and dealers and to establish a plantation program, in exchange for sole buying privileges, such negotiations are traditionally slow, and it was October, 1942, before the first field party was able to leave Washington.

Dr. F. R. Fosberg and myself, the first two botanists of the cinchona program, arranged to stop off in Guatemala in order to study briefly the cinchona plantations there before starting our search for wild species in Colombia. Our first surveys were in the Santander provinces of northern Colombia, in the Eastern Andes near Pamplona, since small lots of bark from this region were already appearing on the market. In the months which followed we laboriously studied the forests of the three ranges of the Colombian Andes and came to know in a general way the basic distribution of cinchona species there. *Cinchona pubescens,* an inferior species, was found to occur throughout all three ranges, although it is relatively richer in alkaloids in the eastern range. *Cinchona officinalis,* which usually produces bark of high quality, occurs in Colombia only in the eastern range. This range was found to possess still another source of quinine, quite unsuspected when our work was originally planned. In December, 1942, it had been my good luck to run into large stands of a race of *Remijia pedunculata* on the west slopes of the Eastern Andes north of Bucaramanga. We were astonished to find that the bark of this non-cinchona gave up to 3 per cent. of quinine sulfate with very little admixture of other alkaloids. This same species extends along the eastern foothills of the Colombian Andes from Florencia to Villavicencio, near the type locality where its alkaloid production is very low. The low percentage of quinine may be due to the very sterile, sandy soil, since the high-quality variety grows on deep rich clay in Santander. Another piece of good fortune not foreseen in our original plans was the rediscovery of *Cinchona pitayensis* in the Central Andes, in Cauca province, both by Dr. Fosberg and myself. This little known species had been supposed to be a botanical rarity with very limited geographical distribution. Nevertheless, it turned out not only to be relatively abundant in southern Colombia, but also to be the species richest in alkaloids, with an average of 3 per cent. of quinine sulfate and 5 to 6 per cent. of total crystallizable alkaloids.

In July, 1943, I went to Ecuador to inaugurate exploratory work in the northern provinces, where no cinchona species had ever been collected. My first expedition had as its aim the discovery of *C. pitayensis,* unreported in Ecuador, and in August, 1943, the first-known Ecuadorian stands of this high-quality species were found on the west slope of the Western Andes in the province of Carchi. It occurs in a zone between altitudes of 8,500 and 10,000 feet, and had been overlooked previously because of the tradition in Ecuador that the best races of cinchona occur between 3,000 and 5,000 feet. Explorations were continued and during the next twelve months the belt of *C. pitayensis* was followed southward through the provinces of Carchi, Imbabura, Pichincha and León, more than a hundred miles and well into the southern hemisphere. *Cinchona officinalis,* on the other hand, which had been known previously only in Loja and Azuay provinces of southernmost Ecuador, was followed northward to the Colombian frontier. *Cinchona pubescens* was found to occur throughout the Ecuadorian Andes, and although its bark is generally low in alkaloids, especially quinine, it occasionally produces local races which are surprisingly rich. Several other species were found in the course of survey work, but are of more botanical interest than economic importance. The importance of botanical surveys was demonstrated early in our program, as can be seen from the foregoing, but it was only during the winter of 1943–1944, a full year later, that the Colombian and Ecuadorian cinchona

missions began to receive reinforcements in the form of a number of competent botanists. The survey work in the trackless and precipitous Andean forests of Ecuador just outlined would never have been possible without the help of W. H. Camp, W. B. Drew, G. W. Prescott and Ira L. Wiggins.

Although the best wild cinchona ever known, from which came the cultivated "Ledger" varieties, was discovered in Bolivia, the delicate diplomatic situation prevented the establishment of an official cinchona mission there. However, the best Bolivian barks, like those of the classic Loja region of southern Ecuador and northern Peru, had been exterminated through a destructive exploitation lasting two centuries. The highest quality bark still remaining in Bolivia and much of Peru is so inaccessible that its exploitation in any quantity is almost impossible. Consequently, the great volume of cinchona bark resulting from our work during more than two years has originated primarily in Colombia and Ecuador, even though it is of somewhat inferior quality.

The single factor of greatest importance in our work, to which I should attribute much of its success, has been our ability to obtain prompt and accurate analyses of our field samples of bark. No praise can be too high for the chemists who pioneered the cinchona mission laboratories now operating in Bogotá, Quito, Lima and La Paz. In cinchona "booms" of previous centuries, analyses could be made only after the shipment reached Europe, months after the bark had been bought and the proceeds spent. This situation led not only to fantastic speculation on good bark, but to excessive traffic in worthless barks, and one still hears reminiscences of fortunes made or lost overnight in the "quina" or "cascarilla" business. Through prompt analyses we were able to stop the harvest of poor barks and to encourage the production of good ones. Many species of Remijia, Ladenbergia and other rubiaceous genera closely resemble cinchona to the untrained eye, and our technical aid, both botanical and chemical, has saved many thousands of dollars which dealers would otherwise have "invested."

The quotas of cinchona bark set up in 1942 (which I am not free to mention) have been greatly exceeded by the supplies already harvested, and the cinchona mission botanists are returning one by one to the United States. As a consequence, we may expect publication of extraordinarily important researches on cinchona and related genera, to augment the very few publications which have already appeared on current work.[1, 2, 3] The availability of analyses has brought to light physiological distinctions between species, varieties and forms not heretofore suspected, and has provided an important new approach to the interpretation of a complex and badly misunderstood genus. From Dr. W. H. Camp and Dr. F. R. Fosberg, especially, we may certainly anticipate much enlightenment on the taxonomy of this difficult group of plants.

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SPECIAL ARTICLES

ORAL ADMINISTRATION OF PENICILLIN IN OIL

IT has been generally accepted that the various salts of penicillin in an aqueous media can not be administered orally[1, 2, 3] due to its rapid inactivation by gastric acidity. However, all the penicillin activity is not lost in the stomach. This was demonstrated by some preliminary experiments in which mice were completely protected against a thousand or more lethal doses of a virulent culture of hemolytic streptococci by mixing the dry sodium salt of penicillin in their regular diet. Approximately five to ten times the equivalent of a dosage of 100,000 units of penicillin per day in human beings was required for complete protection. This as well as data[2, 4, 5] that have appeared in the literature indicates that penicillin can be absorbed from the small intestine.

It seemed reasonable to believe that if penicillin could be protected from the gastric acidity and yet be available for absorption from the small intestines it could be administered successfully by mouth. Accordingly a series of experiments was undertaken in this regard. Enteric coated penicillin tablets appeared to be one possible method of accomplishing this; however, it was found in agreement with others[6] that consistent blood levels of penicillin in dogs could not be obtained. This was probably due to the variability in the time and the location at which the enteric coating disintegrated in the gastro-intestinal tract. Next the

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