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ARCHAEOLOGICAL EVIDENCE FOR SNUFFING IN PREHISPANIC MEXICO

BY
PETER T. FURST

The various hallucinogenic or psychoactive plants the extensive religious and divinatory use of which by Mexican Indians both fascinated and appalled the Spanish colonial clergy of the sixteenth and seventeenth centuries were smoked, chewed, sucked, brewed or macerated into beverages and otherwise ingested in liquid, solid or incinerated form. Tobacco, most commonly smoked, was also ground into a fine green powder that was not taken internally but was rather applied externally to the patient's body in shamanistic curing practices.

All these customary uses of "mind-altering" substances are well described for both prehispanic and post-Conquest Mexico by such writers as Sahagún, Durán, Hernández and, somewhat later, Jacinto de la Serna and Ruíz de Alarcón. In contrast, there is no mention whatever of hallucinogenic snuffs, taken through tubes or through "nose pipes", a common practice in the West Indies and in Central and South America. Since these and other chroniclers of indigenous practices and beliefs were usually careful observers, and since the Church was engaged in a vigorous—albeit ultimately unsuccessful—campaign to discover and suppress the indigenous use of intoxicants of all forms, we must assume that, trade and

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other contacts with Caribbean and Central American snuff-using cultures notwithstanding, the Indians of Late Post-Classic Mexico seem not to have assimilated these practices into their own extensive complex of ritual intoxicants.

Nevertheless, there is a growing corpus of data, in the form of archaeological art, to suggest that snuffing was once known and practiced in several parts of Mesoamerica as early as 1500–1200 B.C. and at least as late as the first centuries A.D. Before we examine some of the evidence, we need briefly to consider the problem of potential indigenous Mexican sources for hallucinogenic snuffs.

Thanks to prodigious research in the field, the laboratory and the historical sources, especially by such investigators as Richard Evans Schultes, S. Henry Wassén, Siri von Reis Altschul, and Bo Holmstedt, the various kinds of South American snuffs are botanically and chemically rather well understood. For Mexico, however, the botanical data are inadequate, and chemical information is wholly or largely lacking. Nevertheless, there are indications of the direction that future research might fruitfully take.

First, one cannot rule out one or more species of *Nicotiana*. These native tobaccos have a much greater nicotine content than do the hybrid species from which cigarette or pipe tobaccos are made. Wilbert (1972: 55–73) recently documented the use of tobacco as the sole psychotomimetic employed by the shamans of the Warao Indians of Venezuela, who smoke themselves into ecstatic trance states that are phenomenologically indistinguishable from those elsewhere triggered with such botanical hallucinogens as *ayahuasca*, the sacred mushrooms, morning-glory seeds, or *Anadenanthera* and *Virola* snuffs. Several species of *Nicotiana* are in fact employed

for psychotomimetic snuff in South America, either alone or in combination with other psychoactive plants. The shamans of some indigenous cultures—e.g., the Tacana of Bolivia—use pulverized tobacco as a magical repellent against hostile demons (Hissink and Hahn, 1961). Furthermore, it is not impossible that the use of tobacco powder as a magical external medicine by Mexican *curanderos* had its ultimate origin in an earlier use of powdered tobacco as snuff.

Secondly, there appears to be no reason why some of the better known Mesoamerican plant hallucinogens should not be as psychotomimetically effective when taken as snuff through the nasal membranes as when assimilated through the stomach. By way of illustration, I am informed by Dr. Schultes that, in South America, the bark of *Banisteriopsis Caapi*, which is usually macerated or brewed into the potent hallucinogenic beverage known by such names as *yajé*, *ayahuasca*, etc., is reputedly sometimes pulverized and inhaled as snuff. Even *Ilex Guayusa*, a caffeine-rich holly widely utilized as a stimulating tea, along with its sister species, e.g. *maté*, *Ilex paraguariensis*), has served as snuff, at least in prehispanic highland Bolivia, where Ilex snuff and snuffing paraphernalia were recently discovered in a Tihuanacoid shaman's grave, dated ca. A.D. 500. The shaman's kit also included clysters, suggesting that the same plant might even have been employed for stimulating enemas (Schultes, 1972b).

Whether or not peyote (*Lophophora Williamsii*), *ololiuhqui* (*Rivea corymbosa*) or other hallucinogens native to Mesoamerica were ever used in the form of snuff, there exist extensive Mexican populations of shrubs and trees of the Leguminosae that should be investigated for possible psychoactive properties. Included are two Mexican species of *Piptadenia*, a genus closely related to the

psychoactive genus *Anadenanthera* of South America, which may well possess the same or similar psychotomimetic constituents. Two of these Mexican species are *Piptadenia flava*, found also in Central America and Colombia, and *Piptadenia constricta*. Both are found along the Pacific coast, from Sinaloa and Jalisco in the north to Guerrero in the south. To my knowledge, neither have been tested for hallucinogenic alkaloids. There are in addition more than sixty species each of the allied genera *Mimosa* and *Acacia* in Mexico, and some of these may, like certain South American species, contain psychoactive principles. This might be found to apply especially to those species credited with sacred, magical, or "dangerous" qualities by local Indians or rural mestizos and should be chemically studied from the point of view of possible hallucinogenic alkaloids.

Finally, there appear two other possible candidates as potential sources of hallucinogenic snuff in southeastern Mexico, both with significant South American ties. These are species of *Psychotria* and *Justicia*. The former is a well known additive in hallucinogenic potions prepared basically from the *Banisteriopsis Caapi* vine in Ecuador, Colombia, Peru and Brazil, while the latter is added to *Virola* snuff or is said even to be employed alone as a source of psychotomimetic snuff (Schultes, 1972a: 45–46, 52). These possibilities emerge from a comment by Wassén (1972: 37–38) on a suggestion of mine (1968: 160–164) that snuffing might have been practiced by the Gulf Coast Olmec. In support of this comment, Wassén cites the following excerpt from a letter to him by Schultes, dated February, 1969:

> We are finding so many plants with tryptamines—the active principle of many of the snuffs of South America—that it is very possible that in the Mexican Gulf Coast area the Indians could have found a plant which, prepared in the form of a snuff, could intoxicate as does the snuff of the Waikas. One of these is *Psy-*

chotria, a species of which in South America has now been found to have N,N-dimethyltryptamine.
Psychotria occurs up as far as Vera Cruz and it is possible that other species have this principle. Furthermore, Holmstedt believes that he has found this same chemical in our species of *Justicia* which is added to *Virola* snuff by the Waikas. Other species of *Justicia* occur as far north as Vera Cruz and may possibly also have this chemical constituent.

While the botanical sources for hallucinogenic snuff in Mesoamerica must, for the present, remain conjectural, the evidence for snuffing in archaeological art is, as we shall see, beyond question. Moreover, on the earliest level of the proposed Mesoamerican snuffing complex—that is, the Early to Middle Formative—the evidence points persuasively southward, at least to Central America, if not actually to northwestern South America.

We owe much of our knowledge of Central and South American snuffing paraphernalia—prehistoric as well as recent—to Wassén's several studies, and I would here like to acknowledge my own debt to our Swedish colleague in this area of research. It was a paper by Wassén, published in 1967, that first set me on the track of a possible snuffing complex in Mexico. Specifically, my attention was drawn to the so called Brazilian *litos*, small effigy stone carvings, usually bird-like, with carved, shallow, oval or circular depressions that made them appear like receptacles. A number of these were found in the last century in the shell middens of Santa Catarina, Brazil. Wassén thought it likely that these bird-effigy *litos* might have served as tablets for hallucinogenic snuff, rather like the archaeological wooden snuff tablets found in the Chilean and Peruvian desert, or more recent snuff tablets from Amazonia.

Subsequently, I raised the question of the use of hallucinogens by the Olmec, suggesting that the well known jade artifacts called "spoons", might, like the Brazilian

litos, have served as snuff tablets (Furst, 1968: 162). At least some of the Olmec "spoons" seemed to represent long-tailed birds in flight, seen in profile. In any event, like some South American snuff tablets, certain Olmec jade spoons are decorated with bird-jaguar motifs, a common symbolic theme in South American ritual intoxication.

At the time, this was still highly speculative. No direct evidence existed to show that the Olmec had used snuff or other hallucinogens; for that matter, there was no proof that the ritual use of psychoactive substances in Mesoamerica was any older than the oldest of the so-called mushroom stones, i.e., from the end of the Middle to the Late Formative. All that could be said was that it would be surprising if the Olmec had used no hallucinogens, considering what was already known of the antiquity and wide distribution of the hallucinogenic phenomenon in the New World. To mention only snuffing: the earliest known archaeological snuffing implements are a whalebone tablet and associated birdbone snuffing tube which Junius Bird of the American Museum of Natural History excavated at Huaca Prieta, Peru. These are dated at ca. 1500–1700 B.C. The evidence was thus conclusive for a time depth of some 3,500 years for the use of hallucinogenic snuffs in South America.

The first evidence that snuffing was in fact known at one time also in Mesoamerica came to my attention in the form of a hollow, redware effigy figurine from Colima, representing a seated man with a horn on his head and a small, gourd-shaped nose pipe held to one nostril (Plate I). Subsequently, I was to come across a second, considerably larger, Colima effigy (Plate II), of burnished brown clay, sculpturally far more sophisticated, again depicting a man in the act of snuffing from a gourd-

Plate I



Small, hollow terracotta effigy of seated man, holding a gourd-shaped snuffing pipe to his nose. Colima, shaft-and-chamber tomb phase, ca. 100 B.C.–A.D. 200. Anon. private collection. H. $7\frac{1}{2}''$.

Plate II



Effigy figurine of burnished brown clay depicted in the act of inhaling snuff from a bottle gourd-shaped nose pipe. Colima, shaft-and-chamber tomb phase, ca. 100 B.C.–A.D. 200. Kurt Stavenhagen Collection, Mexico City. H. 11″.

shaped nose pipe. Both of these figurines belong to the larger West Mexican shaft-and-chamber tomb art complex and can, therefore, be dated between 100 B.C. and A.D. 100–200.

In addition to the effigies, we were able to identify, in several collections, a number of pottery snuffers or nose pipes from West Mexico that closely resemble the well known Costa Rican snuffing pipes illustrated by Wassén in several publications. Especially interesting is a red-slipped snuffer with bifurcated stems, one for each nostril, from the Ixtlán del Río area of southern Nayarit (Plate III). The Ixtlán snuffer is actually a conventionalized bird effigy, with nubs at the side of the bowl to indicate wings, and a projection at the front for the head or beak. Such abbreviated bird symbolism is common on Costa Rican pottery snuffers as well. That this is hardly fortuitous was recognized by Wassén: birds and bird spirits are widely connected with the ecstatic trance experience and with shamanism.

For a time, these West Mexican specimens seemed to be all that there was. Snuffing, therefore, appeared to be an isolated phenomenon in time and space, associated with the shaft-and-chamber tomb cultures of the West Coast. Their funerary art indicates that these same cultures also employed the peyote cactus and, possibly, mushrooms. The close similarity of the West Coast pottery snuffers to those of Central America, and their restricted distribution close to the Pacific coast, suggested a somewhat short-lived trait, introduced possibly from a southerly source, that eventually failed to take hold alongside established cults involving such well known indigenous Mexican hallucinogens as peyote and the sacred mushrooms.

However, West Coast snuffing was not to remain the isolated and short-lived phenomenon that it appeared at

Plate III



Bifurcated bird effigy snuffer from Ixtlán del Rio, Nayarit, shaft-and-chamber tomb phase, ca. 100 B.C.–A.D. 200–300. Coll. Mr. and Mrs. William Kaplan, New York. L. $2\frac{1}{2}''$.

first. New evidence has come to light in the form of effigy and undecorated snuffing pipes from the Early to Middle Formative, from Xochipala, Guerrero. The dating of Xochipala is still somewhat uncertain: there have been suggestions that it represents the very "origin" of Olmec art, predating the San Lorenzo Phase in Veracruz (Gay 1972). However, the reported and confirmed associations of the extraordinarily sophisticated and sometimes astonishingly naturalistic figurines from Xochipala with typically Olmec incised bowls and other Olmec artifacts characteristic of the Late Early to Early Middle Formative, including "spoons" and beads of blue-green translucent jade, suggests dates equivalent to San Lorenzo and contemporaneous sites in Morelos and elsewhere in Central Mexico—i.e., between 1300 and 1000 B.C. On the other hand, a recent series of thermoluminescence tests tend to support an earlier date at least for the beginning of realistic Xochipala art, possibly as early as 1500–1600 B.C. (Robert Stroessner, pers. comm.).

The uncontrolled looting of Xochipala, with its remarkable assemblage of some of the finest Formative ceramic figurines to be found anywhere in the New World, is a scientific tragedy of major proportions. We can only guess at the evidence that has forever been lost; nevertheless, it has been possible to study and verify the authenticity of a number of Xochipala pieces now in private hands or museum collections (interestingly enough, although the accidental discovery of the Xochipala site by local farmers dates from the mid-nineteen sixties, a typical Xochipala figurine has been in the extensive pre-Columbian collection of the Peabody Museum of Harvard University for more than seventy years). Among recently discovered Xochipala artifacts are several unmistakable snuffing instruments or "nose pipes", dating far earlier than those of the West Coast

Plate IV



Terracotta bowl snuffer, Xochipala, Guerrero, Early Formative, ca. 1500–1200 B.C. Anon. private collection. L. $2\frac{1}{2}''$.

shaft-and-chamber tomb phase and approaching in antiquity the earliest South American paraphernalia found on the Peruvian coast.

The first of these to be examined and identified as a nose pipe was a small, round, undecorated bowl with a horizontal perforated stem (Plate IV). If one compares this pottery snuffer with examples from Central America, it is clear that, except for its characteristic local paste and the lime encrustation typical of ceramics from the Xochipala burials, the little Mexican snuffing pipe is virtually identical to similar instruments from Guanacaste or Linea Vieja, Costa Rica (Wassén, 1965: 25). As in the case of the Nayarit snuffer, it is difficult not to postulate a genetic connection between them, although the known Central American pottery snuffers, and also that from Nayarit, are appreciably later than this Early Formative pipe.

A second Xochipala nose pipe which I was able to study in detail is much more complex (Plate V). It is an effigy pipe, measuring $4\frac{3}{4}''$ in length, representing a human figure on its back, with knees drawn up—a position somewhat resembling the post-Classic "Chacmool" stone sculptures. On the basis of the wrap-around loincloth, the figure can be identified as male. In a recent museum catalogue, the piece was erroneously described as an effigy bowl in the form of a kneeling person (Gay 1972). But that would place the nosepiece at the top and the bowl opening facing vertically toward the front, which seems hardly likely. Once the piece is recognized for what it is—a nose pipe used for snuffing—the location and inclination of the nosepiece alone dictate a supine position for the figurine, as does the opening of the bowl itself. Indeed, in handling the piece, its real purpose suggests itself almost spontaneously.

While it is certainly the finest example known to me,



Effigy snuffer representing a man lying on his back. The burnished nosepiece emerges hornlike from the top of his head. From Xochipala, Early Formative, ca. 1500–1200 B.C. Anon. private collection. L. $4\frac{3}{4}$″.

this effigy pipe is by no means unique in form. Several similar nose pipes have come to light, including one (Plate VI) of a man with animal characteristics lying on his stomach, with the bowl in the back and a horn-like nosepiece on top of the head. Here again the sex of the effigy is male; indeed, there are indications of a phallus on the underside.

On the basis of the evidence, then, we can postulate a snuffing complex of appreciable duration and antiquity along the west coast of Mexico, with the earliest evidence dating to 1500–1200 B.C., and the latest approximately to the beginning of the Christian era.

A recent re-examination of early pottery artifacts from Oaxaca as well as from Central Mexico shows, however, that divine inebriation with psychotropic snuff was not limited to the Guerrero Formative or the shaft-and-chamber tomb phase of coastal northwestern Mesoamerica. I have only just begun checking through collections and the literature on Monte Alban ceramics, but already it appears that the evidence for snuffing from the Late Formative at least into the Early Classic is substantial. Thus far, we have been able to identify more than a dozen spouted "miniature effigy vessels", including a group in the Museo Frissell de Arte Zapoteca in Mitla, Oaxaca, as probable nose pipes, dating from Monte Alban I and II. Some of these appear very similar in construction, if not in style and paste, to those from Xochipala. In addition, I have located at least one probable Early to Middle Formative animal effigy nose pipe, in the form of a turtle, from Tlatilco, in the collections of the Museum of Ethnology in Vienna, Austria. This relates stylistically to black effigy ceramics of Olmec derivation or origin from Tlatilco and Las Bocas, Puebla.

One interesting little polished black snuffing pipe, possibly transitional from Monte Alban I to II (i.e. ca.

Plate VI



Effigy bowl snuffer in the form of a person with human head and animal-like body, from Xochipala, Guerrero, Early Formative, 1500–1200 B.C. As in Plate V, the nosepiece is on top of the head. Anon. private collection. L. 4″.

200 B.C.), appears to symbolize transformation, in this instance from human into a duck-like bird with rounded body and flipper-like feet (Plate VII). The frontal half is human, with hands held palms together to the chin; the rest of the body is that of a duck. A conical perforated horn on the head forms the nosepiece, as in some of the effigy pipes from Xochipala.

Space limitations preclude detailed discussion of duck symbolism, but it should be noted that chimereal or anthropomorphic ducks are not uncommon in prehispanic art, especially on the west coast. Ducks are present also in the art of Tlatilco and other Early to Middle Formative sites. A study of Pueblo duck mythology and beliefs about the duck as supernatural among the Cora and Huichol of West Mexico may throw some light on the problem; a Duck Person is a prominent figure in Huichol origin myths, as it is also among the Zuni and other Southwestern Indians; ducks seem to be messengers of the gods or else a form that the gods assume when they travel. Also, ducks are associated with shamanism, perhaps because, as wide-ranging water birds, they appear to inhabit several planes at once.

Of even greater interest is a Monte Alban effigy snuffing pipe of grey clay, representing a deer resting on its stomach, with legs drawn up and head turned to the right (Plate VIII). Cloven hooves leave no doubt about the zoological identification. What makes this piece especially fascinating is that it holds an unmistakable peyote cactus in its mouth (I am greatly indebted to Miss Julie Jones of the Museum of Primitive Art, who recognized the significance of the deer-peyote association here in relation to the Huichol conceptualization of peyote as deer, and vice versa, and who, on that account, drew my attention to the artifact).

While anthromorphic pipes from Oaxaca and Xochi-

Plate VII



Black-slipped, burnished terracotta effigy snuffer in the form of a duck-bodied man, from Monte Alban, Oaxaca, Late Formative, Monte Alban IA–II (?), ca. 300–100 B.C. L. $3\frac{1}{2}''$. Anon. private collection. A number of similar snuffers combining head and animal characteristics, with the nose piece either in the tail or forming a horn on the head, are in the Museo del Arte Zapoteca, Mitla, Oaxaca.

pala have the nosepiece in the form of a horn on the head, it is the tail that forms the nosepiece in the deer effigy snuffer from Oaxaca. Such choices on the part of the prehistoric pipe makers cannot be considered to be arbitrary. If one may venture some guesses, the horn atop the head as nosepiece may relate to the well known and widespread concept of horns—both single and double—as a symbol and even a source of shamanic or supernatural power (Furst 1965). Single horns on the forehead are a characteristic especially of a certain class of Colima figurines, but they also occur elsewhere in Mesoamerica (e.g. at Tlatilco, Tlapacoya, Chalcatzingo, Xochipala, Monte Alban, etc.) and even in Peru, especially in Nazca art. As for the nosepiece of the deer effigy pipe, this might have to do with the concept of the deertail as magical power object in some North American shamantic practices and beliefs. Among the Huichol, for example, the deertail is an important element in the shaman's equipment, as it is in Papago shamanism. Likewise, it is hardly insignificant that the name of one of the principal Huichol supernaturals is *Tamátsi Máxa Kwaxí*, Elder Brother Deer Tail.

The association of deer, divine inebriant and shaman which we perceive archaeologically in the Monte Alban snuffing pipe and ethnographically in Huichol and Cora religion, is itself an important culture-historical problem that remains to be seriously explored. Andean art dating to the fifth or sixth century A.D. suggests that there was something very like these Mesoamerican associations also in Peru. A common theme on Moche IV painted ceramics is a ritual deer hunt, in which the hunter is clearly not meant to be an ordinary man but a god, culture hero, or great shaman (Plate IX). Moche painters consistently depict the deer in association with a shrub or tree which, though to some degree conventionalized,

Plate VIII



Effigy snuffing pipe of burnished grey clay in the form of a deer holding a peyote cactus in his mouth, from Monte Alban, Oaxaca, Late Formative, Monte Albán I–II, ca. 300–100 B.C. The erect tail of the animal forms the nosepiece. Anon. private collection. L. $4\frac{1}{2}''$.

is identifiable botanically as *Anadenanthera colubrina*, with the long, bean-like seed pods characteristic of the hallucinogenically rich family Leguminosae. The seeds of this tree, called *vilca* or *willka* in the Andes, are made into a potent psychotomimetic snuff; they are also ingested in a beverage and, in some highland Quechua villages, play an important role in the making of *llampu*, a sacred substance used in cattle increase ceremonies and other rituals the origins of which lie far back in Andean prehistory (Billie Jean Isbell, personal communication).

In any event, the deer is often a semi-divine celestial animal for American Indians, connected with Sun, Fire, sky beings, and shamans. Among the Warao of the Orinoco Delta, its flesh is still strictly taboo for shamans, suggesting at least a former sacred relationship (Johannes Wilbert, personal communication). Among the Huichol, it is the shaman's spirit helper and companion: a pair of feathered ceremonial arrows that he wears on his head in certain ritual contexts symbolize deer antlers; the oblong basket of shamanic power objects (*takwátsi*) is identified with the divine Deer Person, *Káuyumarie;* certain deities are deer and vice versa; the deer is mount, guardian and guide on the shaman's celestial quests and flights, especially on the peyote hunt; the "Principal Deer", Elder Brother *Wawatsári*, is peyote, and vice versa, etc.

Such concepts remind one at once of the role of the deer in Paleo-Asiatic or Siberian shamanism. In Siberia, too, the deer is the celestial mount that carries the shaman to the Upperworld and its spirit rulers. In parts of Siberia, moreover, there is direct association between deer—in this case the reindeer—and the divine inebriant used by shamans to attain the ecstatic trance states in which they embark on their supernatural journeys—the *Amanita muscaria*, or fly agaric mushroom, for which

Plate IX



Supernatural deer hunting scene on a Mochica IV terracotta vessel, northern Peru, ca. A.D. 500. Drawn from the original by Alan Sawyer. Here, as in similar Mochica deer hunting scenes, the animal is shown in association with a tree or shrub almost certainly to be identified by its characteristic seed pods as *Anadenanthera colubrina*, whose seeds were, and still are, ground into a potent psychotomimetic snuff, widely known as *vilca* or *willka*. In some Andean communities *vilca* seeds are also used in an intoxicating ceremonial drink; elsewhere, as in Chile, the pods may be burned and the smoke inhaled to achieve ritual intoxication.

the reindeer is said to have an inordinate predeliction (Wasson 1972:204) and which some scholars regard as the Paleolithic or Mesolithic prototype for the Mesoamerican mushroom cults.

It is difficult to escape the conclusion that the esteem, not to say veneration, with which some American Indians regarded the deer represents a survival from an ancient, archaic, shamanistic substratum—a substratum that forms the underlying basis of American Indian ideology, including that of Mesoamerican civilization, and the ultimate roots of which lie in the religion of Eurasian Paleolithic and Mesolithic hunting and gathering culture. The curious association of deer as celestial mount on the shaman's ecstatic journeys and the sacred hallucinogens that are employed as aids in such mystical quests in parts of northern Asia as well as in America might well be a part of this very ancient belief system.

In this connection, a new series of radiocarbon dates from rock shelter sites in Trans-Pecos Texas and northern Mexico is of special significance. These dates, for which I am indebted to J. M. Adovisio of the University of Pittsburgh[1], confirm a time depth of over ten thousand years for the use of the potent hallucinogenic red seeds of the *Sophora secundiflora* shrub by Desert Culture hunters and food collectors as well as historic tribes in the same area. More than that, one important and well studied Texas site, known as Bonfire Shelter, yielded *Sophora secundiflora* from the lowest occupational stratum—Bone Bed II, with a C^{14} age of 8440 to 8120 B.C., in direct association with Folsom and Plainview projectile points and the bones of extinct bison. The same

[1] A short paper on the topic by J. M. Adovisio and G. F. Fry was presented at the 71st Annual Meeting of the American Anthropological Association, Toronto, Canada, November 1972. A fuller treatment by the authors is in preparation.

seeds also occurred in the topmost occupational level, dated A.D. 420 to 1040, and in all of the intervening cultural deposits. A related rock shelter site in northern Mexico, Frightful Cave, similarly yielded *Sophora secundiflora* beans from its lowest level, dated at 7500 B.C., through all subsequent cultural deposits. Interestingly enough, here, as in many other Desert Culture rock shelter sites, *Sophora secundiflora* was invariably associated with *Ungnadia speciosa*, in contexts strongly suggesting, according to Adovisio, ritual use.

It was Weston La Barre who suggested on several occasions (e.g. 1972:270–278) that the origins of the American Indian hallucinogenic complex had to be sought ultimately in ecstatic, vision-seeking Paleoasiatic shamanism, the fundamental religion of the pre-agricultural Paleolithic and Mesolithic hunting peoples of Siberia who presumably constituted the ancestral pool from which flowed the Late Pleistocene migrations into North America. La Barre's contention, which came to be increasingly shared by some of his colleagues in the study of aboriginal American religion and the botany and anthropology of hallucinogens, thus appears to be confirmed: the historic shamanistic "red bean" cult of the Southern Plains is at least as old as the big-game hunting phase of the terminal Pleistocene and thus appears to reach back toward a time when the peopling of North America across the Bering land bridge might still have been in progress. If knowledge of ritual or divine inebriation with plant hallucinogens was part and parcel of the intellectual baggage of these early migrants, it implies at least equal antiquity, if not a much greater one, for such practices in Eurasia.

Just when or where in prehistoric antiquity the technology and chemistry of snuffing might have arisen is unknown. The concentration of these variants on the

common theme of divine inebriation especially in the Amazon suggest that area as its ultimate source. If it did indeed diffuse from the tropical lowlands, its age would have to be at least three and a half thousand years, since, as mentioned above, the earliest known snuffing implements date to the mid-second millenium B.C.

The fact that in addition to its numerous other psychotomimetics prehispanic Mesoamerica can now be shown to have shared in a wider pan-American complex involving the use of snuff opens up a host of new possibilities for culture-historical and ethnobotanical research. Obviously, multidisciplinary study of what now appears to have been a Mesoamerican snuffing complex of substantial distribution and duration is important in and of itself. At the same time, it might provide answers to questions of external relationships, especially with South America, at roughly that crucial moment in time when Neolithic-type farming communities became transformed, by some as yet little understood processes, into the first great Mesoamerican civilization—that of the Olmec.

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A STUDY OF SYSTEMATIC WOOD ANATOMY IN CANNABIS

BY
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Cannabis has been associated with man since very early times (Ash, 1948), yet, surprisingly, little is known about its comparative wood anatomy. The reasons are due probably to the tendencies for (1) anatomists to select wood from trees and woody shrubs rather than from herbs for study and for (2) researchers often to disregard or slight plants associated with man, either as crops or weeds, in basic scientific enquiries.

Tippo (1938) offered a few general comments on the wood of *C. sativa* L. in his extensive study on the anatomy of the Moraceae and its allies. Stem shape and leaf-trace number in transections were stressed by Nassonov (1940) in a report on geographical races of hemp. Hayward (1948) devoted a chapter in his textbook to *C. sativa*. The general morphology of that species was given, but details of seedling anatomy and floral structure were emphasized; wood anatomy was scarcely mentioned. Metcalfe and Chalk (1950) summarized anatomical data on Cannabaceae to that date. Shimomura *et al.* (1967) emphasized trichomes in their study of leaf and bract anatomy in *Cannabis;* they found differences between *C. sativa* and *C. indica.*

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Some features of *Cannabis* anatomy are relatively well known, such as the economically important phloem (bast) fibres. These aspects have been reviewed by Hayward, 1948; Metcalfe and Chalk, 1950. Considerable attention has also been given to cystolithic hairs (Pireyre, 1961) and laticifers in *Cannabis*.

With the recent attention devoted to taxonomic problems in *Cannabis* (Schultes *et al.*, 1974; Stearn, 1974), I am pleased to present this introductory account on comparative wood anatomy. It includes apparently the first technical description of wood identified with vouchered material as *C. indica* Lam.

Methods and Materials

All materials were collected fresh and preserved in formalin-propriono-alcohol (FPA). Woods were sectioned on a sliding microtome at 20 μ. Some sections of each sample were stained in safranin O and counterstained with fast green FCF and orange G; others were stained only with safranin. Tissues were mounted in Permount.

Xylem features were microscopically measured with a calibrated ocular micrometer; a minimum of 50 measurements were made for each feature reported in Table 1. Polarizing filters aided study of cell wall structure and crystals. Statistical analyses were made on a Wang 600 computer with the assistance of Dr. M. P. Johnson.

The material of *C. indica* came from a wild population at Pashimool, west of Kandahar, Afghanistan, *R. E. Schultes 26505* (Econ. Herb. Oakes Ames); that of *C. sativa* came from a naturalized population in Pottawatomie County, Kansas, United States, *L. C. Anderson 3663* (Fla. State Univ.).

Results

Details of wood anatomy are illustrated in Figs. 1–6.

The woods of *C. indica* and *C. sativa* differ significantly in each feature listed in Table 1.

Vessels in *C. indica* tend to occur in radial chains; whereas those of *C. sativa* usually occur singly (as illustrated in Hayward, 1948). That difference in distribution can be seen in Figs. 1–2. Vessel members are angular to round in transection. They have simple perforation plates, and the end walls are slightly oblique. Pits are alternate with elliptic borders. Pit apertures are elongate; they are 6–9 μ long in *C. indica* and 4–8 μ in *C. sativa*.

Vessel members and wood fibres differ between the two samples in average width, length and cell wall thickness (Table 1). In *C. indica*, both cell types are wider, have thicker walls, but are shorter in length compared to those of *C. sativa*.

Fibres in the secondary xylem must not be confused with the hemp fibres of commerce, which are phloem or bast fibres. Wood fibres of *C. indica* are typical, lignified libriform fibres. Fibres in *C. sativa* differ in two respects. They are dimorphic, with successive tangential bands of

TABLE 1. Averaged measurements on wood anatomy in *Cannabis*.

Feature	*C. indica*	*C. sativa*	Significance level[a]
vessel number per group	3.05	1.39	*
vessel member width, μ	68.52	62.16	*
vessel member wall thickness, μ	3.50	2.30	**
vessel member length, μ	209.71	244.54	**
fibre width, μ	18.41	14.28	**
fibre wall thickness, μ	3.44	0.68	*
fibre length, μ	281.10	443.47	**
ray width (cell number)	2.23	1.63	**
ray height, mm	0.87	0.68	*

[a]Analysis of variance (F test): * = $p < .05$, ** = $p < .001$

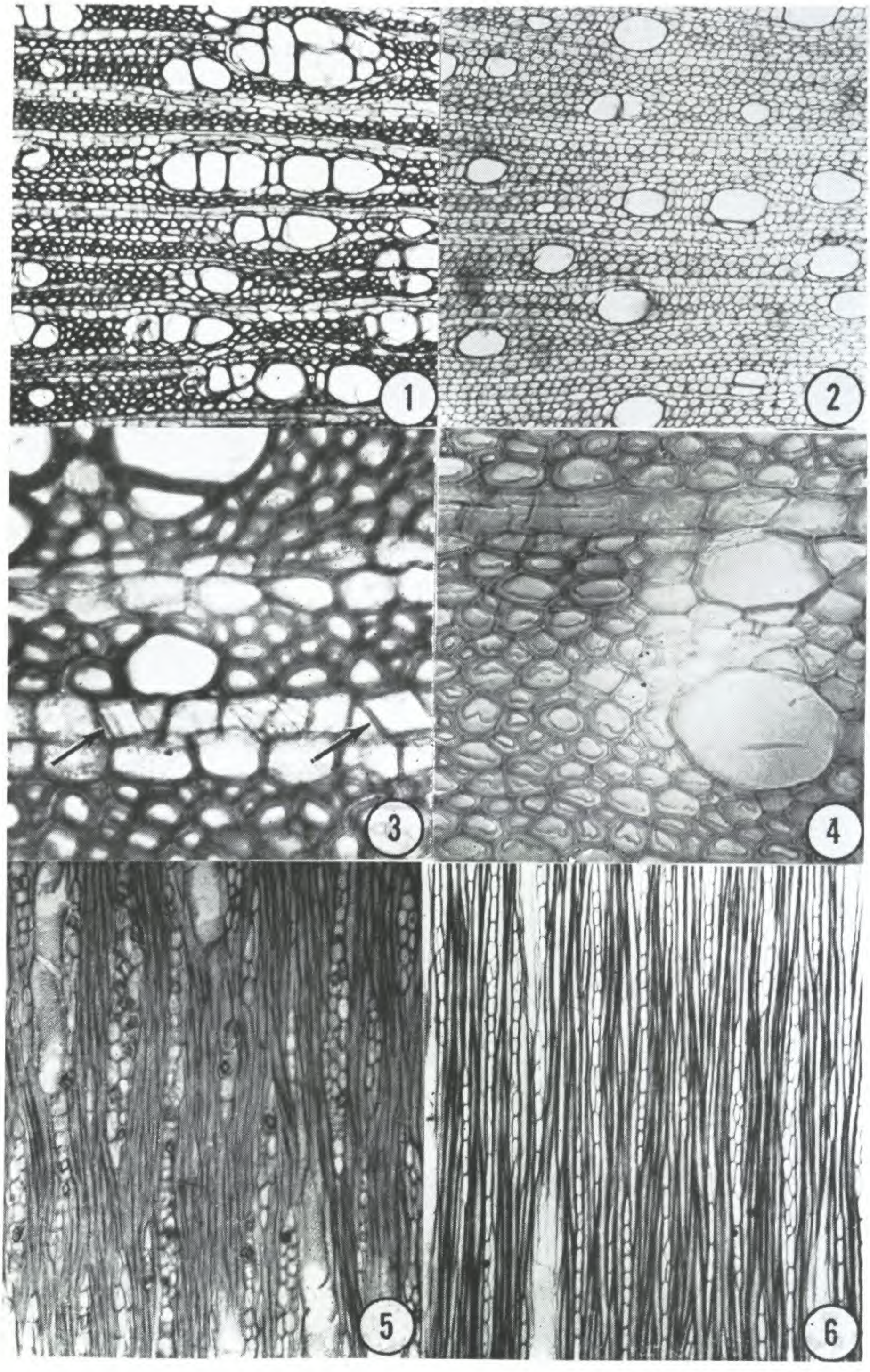
EXPLANATION OF PLATE X

Figs. 1–6. *Cannabis* wood sections. Figs. 1, 3, 5 are *C. indica*, and 2, 4, 6 are *C. sativa*. Fig. 1, transection showing radial chains of vessels, libriform fibres, and procumbent ray parenchyma. Fig. 2, transection showing tendency for solitary vessels, fibre dimorphism, and ray parenchyma shorter radially (erect). Fig. 3, transection showing thick walls of vessel members and libriform fibres; note cuboidal crystals in ray cells (arrows). Fig. 4, transection showing relatively thin cell walls; note shrunken secondary walls of gelatinous fibres. Fig. 5, tangential section showing wood rays with numerous crystals; photographed with partially polarized light. Fig. 6, tangential section showing relatively narrower wood rays with erect cells; crystals absent. Figs. 1–2, 5–6, × 71. Figs. 3–4, × 308.

PLATE X

C. indica

C. sativa



thick-walled fibres alternating with bands of thin-walled fibres. They have irregularly shrunken secondary walls (more pronounced in the thick-walled fibres) and are termed gelatinous (Fig. 4). Their staining reaction (note lighter tones in Figs. 2, 4, 6) and absence of birefringence under polarized light are similar to that of gelatinous fibres in other species that I have studied (Anderson, 1963, 1972).

Axial parenchyma is paratracheal. It is very scanty in *C. indica* and scanty to vasicentric in *C. sativa*.

Wood rays are classed as heterogeneous I: *i.e.*, both multiseriates and uniseriates occur, and they are composed of procumbent and erect ray cells. Those of *C. indica* are predominantly square to procumbent; whereas ray cells in *C. sativa* are mostly erect with very few square or procumbent ones. The differences in cell shape are suggested in Figs. 5–6, but they are best viewed in radial sections. A qualitative difference in wood rays is the presence of numerous cuboidal or prismatic crystals of calcium oxalate in *C. indica*. They can be seen in all sections under normal light but are more obvious with partial polarization of light (Fig. 5). No crystals were found in *C. sativa* ray cells (although both species have druses in their phloem and ground tissues).

Discussion

Many American botanists have thought *Cannabis* to be monotypic, possibly because only hemp, *C. sativa*, has been cultivated in this country. Most taxonomists who have studied the genus closely, however, recognize three species: *C. indica* Lam., *C. ruderalis* Janisch., and *C. sativa* L. (see Schultes *et al.*, 1974, for a review of the taxonomic history of the genus).

Data from wood anatomy have not hitherto been utilized in the taxonomy of *Cannabis*. Such data might

help resolve the question of species recognition in the genus. Nassonov's study (1940) is of little use, as he mentioned no binomials. He primarily studied variation in crop plants (all *C. sativa?*), where he identified three basic types of stem structure. He did note that wild and cultivated forms of hemp could not be distinguished clearly on the basis of anatomy of stem and bast fibres.

Wood features of *C. indica* and *C. sativa* listed in Table 1 are those commonly measured in comparative studies. They are all significantly different between the species with four at the 5% level and five at the 0.1% level! Additional differences in the axial and radial parenchyma systems are noted in the text. Woods of the two species are qualitatively distinct for libriform fibres versus gelatinous fibres and for presence of crystals in wood rays. Many examples of the taxonomic significance of crystals in woods have been noted (Bailey, 1961; Chattaway, 1955–56).

Although only one sample of each species is discussed here, the magnitude of differences between the two is impressive in a system as conservative as wood. In his exhaustive review on many aspects of wood science, Jane (1963) stated the following regarding taxonomic wood anatomy:

> Wood structure is probably more conservative than floral structure, and specific differences, as determined by floral characters, are often not reflected in the secondary xylem. Indeed, it may be said that in general the distinguishing features of wood are at generic, rather than specific, level.

Certainly, the plants used in this study are of the same genus, but it is my opinion that they represent different species.

Examination of woods from three additional collections of North American *C. sativa* shows they are also distinct from the *C. indica* wood sample. All vary from

C. indica in the features listed in Table 1, with the exception of vessel member width. All three samples have gelatinous fibres. Crystals are absent in wood rays in two; only a few were found in the rays of the third sample. Complete data on these samples will be presented in the future as part of an expanded study on the wood anatomy of *Cannabis*.

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TWO NEW BRAZILIAN SPECIES OF BRUNFELSIA

BY

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In anticipation of my forthcoming revision of the South American species of *Brunfelsia* (Solanaceae) based on a doctoral dissertation at Harvard University (Plowman, 1973), I herewith offer the description of two previously unrecognized species.

I would like to express my thanks to the curators of the several herbaria who have graciously loaned specimens cited in this paper. Abbreviations of herbaria are taken from Index Herbariorum (Lanjouw and Stafleu, 1964). Special thanks are due also to Dr. Leslie Garay for checking the Latin descriptions and to Lynda Bates for preparing the line drawings which accompany the text.

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Brunfelsia Martiana *Plowman sp. nov.*

Frutex. Folia subsessilia, oblonga, plerumque elliptico-oblonga vel oblongo-lanceolata, apice acuminata, basi late cuneata vel obtusa, utrinque glabra, nervis lateralibus 8–12, petiolo brevissimo. Inflorescentia terminalis vel

axillaris annotinis ramulis, pauciflora, glabra. Flores 1–7, albidi vel albo-virescentes. Pedicellus erectus, gracilis, glaber. Calyx tubulosus vel tubuloso-campanulatus, glaber, dentibus subaequalibus, triangulari-ovatis vel ovato-lanceolatis, apice acutis vel acuminatis. Corollae tubus quam calyx duplo longior, rectus, apice parum inflatus, glaber, limbo patenti, lobis subaequalibus, oblongo-obovatis, apice rotundatis vel subtruncatis, marginibus lateralibus abrupte reflexis. Stamina inclusa in tubi parte superiori. Ovarium oblongo-ovoideum. Fructus ignotus.

A Brunfelsia guianense foliis oblongis, longioribus, nervis lateralis pluribus (8–12), calyce tubuloso-campanulato et corollae tubo quam calyce duplo longiori et a B. amazonica foliis majoribus et pedicellis multo brevioribus differt.

Type: Brazil: Amazonas: "Provinciae Rio Negro, habitat in sylvis ad flum. Japurá, prope São João do Principe," Dec. 1819, *Martius* [*3247*] (holotype, M; isotypes, M).

Shrub to 1 m. tall. Branches few, naked below, somewhat knobby at nodes, glabrous. Bark cracked longitudinally, dark reddish brown, shiny, furnished with lenticels. Leaves scattered along branchlets, subsessile, mostly oblong, sometimes elliptic-oblong or oblong-obovate, acuminate at apex, broadly cuneate to blunt at base, blade 10–25 cm. long, 4–8 cm. wide, glabrous on both surfaces, firmly membranaceous to subcoriaceous, upper surface dark green, dull or shiny, lower surface paler green, sometimes shiny, midrib dark reddish brown, lateral nerves 8–12 pairs, spreading, straight; petiole short, 1–4 (12) mm. long, glabrous, becoming cracked, rugose. Inflorescence terminal or axillary in the upper leaf axils, glabrous, axis 2–10 (15) mm. long. Flowers 1–7 per inflorescence, sometimes with short peduncle which articulates with pedicel, greenish white to white. Bracts 1–3 per flower, linear-lanceolate, concave, 1–10



Photograph of holotype of *Brunfelsia Martiana* Plowman, *K.F.P. von Martius* [*3247*].

mm. long, ciliolate at margin, caducous. Pedicel short, slender, 3–6 (10) mm. long, glabrous. Calyx tubular to tubular-campanulate, 8–12 mm. long, 3–8 mm. in diameter, glabrous, rarely striately veined, teeth subequal, triangular-ovate to ovate-lanceolate, 2–6 mm. long, acute to acuminate at apex. Corolla tube twice as long as calyx, straight, cylindric, inflated at apex, 20–24 mm. long, 1–3 mm. in diameter, glabrous; limb spreading, somewhat undulate, 15–22 mm. across, lobes subequal, oblong-obovate, abruptly reflexed at lateral margins, rounded-truncate at apex, 5–10 mm. long. Stamens included within upper part of tube; filaments subligulate, longer anterior pair 4 mm. long, shorter posterior pair 3 mm. long; anthers orbicular-reniform, slightly unequal, the upper pair somewhat smaller, about 1 mm. in diameter. Ovary oblong-ovoid, 2 mm. long; style filamentous, a little broader and curved at apex, about 15 mm. long; stigma briefly bifid, upper lobe slightly larger, 1 mm. long. Fruit and seed unknown.

Distribution. Brazil (Amazonas, Pará, Bahia); Guyana.

Additional specimens. Brazil: Pará: Faro, 22 Jan. 1910, *Ducke s.n.* (MG); Bella Vista, Rio Tapajóz, matta das immediações do Campina do Perdido, 12 Feb. 1917, *Ducke s.n.* (MG); Região do Jutahy de Almeirim. Palhal, 16 Apr. 1923, *Ducke s.n.* (RB); Gurupá, 25 Feb. 1923, *Ducke s.n.* (RB); Pará, May 1819, *Martius 3300* (M). Amazonas: Manáus and vicinity, road Manáus-Caracaraí, km. 22, 21 Mar. 1967, *Prance et al., 4704* (WIS), Rio Negro, Cachoeira Baixa de Tarumã, 11–14 Apr. 1973, *Schultes & Rodrigues 26132-A* (ECON), *26133 A* (ECON). Bahia: Distrito Ileus, Ferradas, Dec. 1818, *Martius s.n.* (M); Feira de Santana, Apr. 1850, collector unknown (G).

Guyana: Essequibo-Demarara River, Madray-Bubu Trail, Topy Trysil Forest, 8 Feb. 1944, *Forest Department 422* (K).

Brunfelsia Martiana is named for K. F. P. von Martius who first collected the plant in the year 1818. This new specific concept has proven difficult to define, not through its lack of distinctive characters, but due to the scarcity of specimens which are scattered in Brazilian and European herbaria.



BRUNFELSIA martiana *Plowman*

Brunfelsia Martiana Plowman. 1, flowering branch, one third natural size. 2, corolla limb from beneath, approximately natural size. 3, calyx showing attachment to stem and bracts, approximately natural size. 4, excised corolla tube showing stamens and pistil, one and one-half times natural size.

This interesting shrub grows in the understory of lowland tropical forests from Guyana throughout the lower Amazon basin and with disjunct populations in the coastal forests of the State of Bahia. The species has been collected only twice in the last fifty years, and no collections of it are known from Bahia since 1850.

Brunfelsia Martiana is closely related to *B. amazonica* Morton and *B. guianensis* Benth., which also have rather small, greenish white flowers and occur sympatrically with *B. Martiana* in the middle Amazon. *B. Martiana* differs from *B. amazonica* in having larger leaves (10–25 cm. vs. 6–12 cm.) with more lateral nerves (8–12 pairs vs. 5–8 pairs) and much shorter pedicels (3–6 mm. vs. 13–20 mm.). It differs from *B. guianensis* in having larger (10–25 cm. vs. 6–15 cm.) oblong leaves with more lateral nerves (8–12 pairs vs. 4–5 pairs), a calyx which is usually narrow-tubular, not ovoid-campanulate, and a corolla tube which is rarely more than twice as long as the calyx. In *B. guianensis*, the tube is frequently $2\frac{1}{2}$ to 3 times as long as the calyx.

Brunfelsia pilosa *Plowman sp. nov.*

Frutex. Ramuli graciles, pilosi vel villosi. Folia breve petiolata, anguste elliptica, oblongo-lanceolata vel obovata, apice acuminata, basi cuneata, utrinque ad costam pilosa, nervis lateralibus 6–9. Inflorescentia terminalis, sessilis. Flores 1–3, speciosi. Pedicellus brevissimus, apicem versus incrassatus, pilosus. Calyx tubuloso-ventricosus, in exsiccatione campanulatus, sparse vel dense pilosus, raro glaber, membranaceus, dentibus subaequalibus, lanceolatis, acuminatis; calyx in fructu persistens, quam capsula fere aequans. Corollae tubus quam calyx duplo longior, glaber, limbo patenti, lobis subaequalibus, rotundatis, lobo superiori posteriori parum majori. Stamina et stigma in tubi parte superiori in-

Plate XIII



Photograph of holotype of *Brunfelsia pilosa* Plowman, *L. B. Smith & Pe. R. Reitz 12777*.

clusa. Ovarium conico-ovoideum. Capsula ovoidea vel subglobosa, apice apiculata, laevis, atroviridis. Semina ellipsoides, reticulato-foveata.

A Brunfelsia cuneifolia calyce tereti pubescentia pilosa et corollae tubo longiori, a B. uniflora calycis dentibus longioribus, pubescentia pilosa et corollae tubo longiori, et a B. australe foliis apice acuminatis, pubescentibus angustioribus differt.

Type. Brazil: Santa Catarina: Municipio São Miguel d'Oeste, forest above Rio Reperi-guaçú, Peperi, ca. 26°32′ S., 53°44′ W., 300–400 m., 21 Oct. 1964, *L.B. Smith & Pe. R. Reitz 12777* (holotype, GH; isotypes, MO, R, UC).

Shrub 0.5–2 m. tall, diffusely branched from near base. Branches spreading and arching, terete. Bark rough, longitudinally cracked, shedding in thin, chartaceous flakes, yellowish brown. Branchlets slender, pilose to villous, greyish green, dark purple when young. Leaves appearing two-ranked, scattered on branchlets, narrowly elliptic, oblong-lanceolate or obovate, acuminate at apex, cuneate at base, blade 3–7.5 cm. long, 1.3–3 cm. wide, pilose on both surfaces, primarily at midrib, firmly membranaceous, dull, dark green above, pale green beneath, the young leaves dark purple, lateral nerves 6–9 pairs, straight, often prominulous above; petiole short, 1–4 mm. long, pilose to villous. Inflorescence terminal, sessile, usually with one flower, rarely 2–3. Flowers showy, deep violet fading to pure white with age, odorless. Bracts 1–3, linear-lanceolate, 1–8 mm. long, pilose to villous, caducous. Pedicel short, stout, 1–3 mm. long, pilose; in fruit becoming corky, rugose-verrucose toward apex. Calyx tubular-ventricose, appearing campanulate in pressed specimens, terete in cross-section, 12–19 mm. long, sparsely to densely pilose with long weak hairs, rarely glabrous, membranaceous, purplish, drying reddish brown, teeth subequal, lanceo-



Brunfelsia pilosa Plowman. 1, flowering and fruiting branch, one-half natural size. 2, corolla limb from above, approximately natural size. Drawn from living plant in cultivation at Miami, Florida, *Plowman 2963* (ECON).

late, 4–10 mm. long, acuminate; calyx in fruit persistent, partially enclosing capsule, becoming subcoriaceous, light green, the sinuses becoming more deeply cut. Corolla tube twice as long as calyx, 25–32 mm. long, 1.5–3 mm. in diameter, glabrous; limb spreading, 30–47 mm. in diameter, thickening at mouth prominent, round and white, lobes subequal, the uppermost posterior lobe slightly larger, broadly rounded, 10–15 mm. long. Stamens included in uppermost part of corolla tube; filaments slender, upper pair 3–4 mm. long, lower pair 3–5 mm. long, glabrous; anthers orbicular-reniform, 1–1.5 mm. in diameter. Ovary conical-ovoid, 2–2.5 mm. long, 1 mm. in diameter; style slender, 22–26 mm. long; stigma briefly bifid, in the form of a forceps, 1 mm. long. Capsule ovoid to subglobose, apiculate at apex, 12 mm. long, 10 mm. in diameter, smooth, dark green, shiny, pericarp thin-walled, dry at maturity, tardily dehiscent. Seeds ca. 10, ellipsoid, 5–6 mm. long, 2.5–4 mm. in diameter, reticulate-pitted.

Distribution. Brazil: (São Paulo, Paranä, Santa Catarina, Rio Grande do Sul); Paraguay; Argentina (Misiones).

Additional specimens. Brazil: São Paulo: Itapetininga, 17 Nov. 1887, *Löfgren 389* (C, R, SP, US); Ypiranga, Nov. 1910, *Lüderwaldt 2117* (RB, SP); Campinas, Jundiahy, Mar. 1900, *Campos Novaes 216* (US); Villa de Serra Branca, 1 Nov. 1897, *Puttemans 4328* (SP); Carandirú, Dec. 1912, *Tamandaré 244* (RB); Mandaquil, 23 Nov. 1906, *Usteri s.n.* (G). Paraná: Curitibá, Bairro São Niolau, 18 Nov. 1966, *Caprilioni 1659* (US); Itaperussú, 17 Nov. 1908, *Dusén 7077* (GH, S); Jaguariahyva, 25 Oct. 1910, *Dusén 10443* (GH, MICH, NY, S); Tamandaré, 4 Oct. 1914, *Fönssen 1054a* (F, GH, NY, S); São Matheus, 27 Feb. 1929, *Gurgel s.n.* (RB); Municipio Rio Branco do Sul, São Vicente, 27 Oct. 1967, *Hatschbach 17610* (C, UC); Ponta Grossa, 2 Nov. 1928, *Hoehne 23309* (SP, US); Foz do Iguaçú, Parque Nacional de Iguaçú, 8 Oct. 1946, *J.G. Kuhlmann s.n.* (RB); Ypiranga, 15 Sept. 1934, *Reiss 99* (GH, NY). Santa Catarina: Municipio Caçador, Fazenda dos Carneiros, 1100 m., 7 Dec. 1962, *Klein 3518* (US); Municipio Campos Novos, Palmares, 950 m., 28 Oct. 1963, *Klein 4102* (US); Bituruna, Fazenda Etienne, 11 Feb. 1948, *Mello Filho 793* (R); Nova Teutonia, 25 Oct. 1943, *Plaumann 164* (RB);

Municipio Ararauja, Rodeio da Areia, 22 Nov. 1943, *Reitz C-171* (RB); Santa Cecilia, 1100 m., *Reitz & Klein 14136* (NY); Municipio São Miguel d'Oeste, Canela Gaucha, 8 km. northwest of São Miguel d'Oeste, ca. 26°40′ S., 53°34′ W., 700–750 m., *Smith & Reitz 12757* (NY, R, US); Municipio Abelardo Luz, north bank of Rio Chapeco at Abelardo Luz, ca. 26°35′ S., 52°20′ W., 900-1000 m., 23 Oct. 1964, *Smith & Reitz 12870* (C, F, LE, R); Tubarao, Nov. 1889, *Ule 1521* (P). Rio Grande do Sul: São Leopoldo, 10 Sept. 1946, *Henz 27246* (MO, NY), 20 m., 17 Sept. 1946, *Henz 35305* (S); Municipio Rio Pardo, Fazenda Horticola, 70 m., Oct. 1923, *Jürgens 19* (B); Colonia Santo Angelo, 4 Feb. 1893, *Lindman A-597-b* (S), Sept. 1900, *Schwarzer 50* (L, S); Silveira Martins, 20 Mar. 1893, *Lindmann A-597-c* (S); Rio dos Sinos, 8 Nov. 1949, *Rambo 44295* (BR, L); Bütterberg prope Montenegro, 13 Nov. 1950, *Rambo 49144* (GH, P, W).

Paraguay: In regione fluminis Alto Paraná, Yaguarazapa, 1909–1910, *Fiebrig 5460* (G, GH, US).

Argentina: Misiones: Departamento de San Javier, Acaragua, 220 m., 30 Sept. 1947, *Bertoni 2974* (B, W); Departamento de Candelaria; Bompland, 4 Oct. 1909, *Jorgenson s.n.* (BAB), Nov. 1910, *Jorgenson s.n.* (BAB); Santa Ana, Aug. 1901, *Llamas 1530* (BAB, G). Departamento de Iguazú, Cataratas de Iguazu, 13 May 1969, *Plowman 2735* (GH); Delicia, camino a El Dorado, 4 Nov. 1949, *Schwindt 2270* (C, LD, NY); Puerto Aguirre, Río Iguazú, 19 Sept. 1922, *I.N.T.A. 4435* (B).

Brunfelsia pilosa is a distinct species which has been consistently confused with several other plants of southern Brazil, especially ***B.*** *uniflora* (Pohl) Benth. and ***B.*** *australis* Benth. An early collection of ***B.*** *pilosa* (*Sellow 1573*) with atypically glabrous leaves and calyces was cited by Bentham as a syntype of his concept of ***B.*** *australis* (Bentham, 1846).

A small shrub with showy flowers, ***Brunfelsia pilosa*** occurs primarily in the understory of primary and secondary woods, as well as in thickets and along water courses. Flowering takes place from October to December with fruits appearing from February to May. It has a fairly wide altitudinal range, occurring from near sea level to 1100 m. The species ranges from the Brazilian State of São Paulo south to Rio Grande do Sul and extreme

northeastern Argentina (Misiones). In the central part of its range, where it occurs most commonly, this species seems to be associated with the formerly extensive *Araucaria* forests of the south Brazilian planalto.

Owing to its attractive flowers, this plant is cultivated in tropical gardens, although not so extensively as *Brunfelsia australis*. Recently, *B. pilosa* has appeared in the Florida nursery trade and is increasing in importance as an ornamental.

Brunfelsia pilosa may be distinguished from related species by its very short (1–3 mm. long), stout pedicels and an inflated tubular calyx with deeply cut teeth (4–10 mm. long). The twigs, leaves and calyx characteristically contain few to many long, weak trichomes. The flowers are large and showy with a corolla limb nearly 5 cm. in diameter.

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ARCHAEOLOGICAL MAIZE FROM NORTHERN CHILE

BY

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INTRODUCTION

Now that the modern races of maize of the countries of this hemisphere have been classified and described in a series of eleven publications issued by the National Academy of Sciences-National Research Council, it has become a common procedure for botanists analyzing collections of prehistoric remains of corn of a particular country to relate the ancient specimens, so far as is possible, to the living races of that country. The modern maize of Chile has been described by Timothy *et al.* (1961), who recognized nineteen more or less distinct races.

As part of a study of prehispanic cultural development in the Atacama Desert of northern Chile, the junior author of this report obtained several collections of maize cobs from archaeological sites found near the town of Chiu Chiu, which lies beside the middle section of the Loa River. The vicinity of Chiu Chiu, at an elevation of 2500 meters, is a small oasis along the river which supports a narrow band of vegetation in the extreme

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desert environment. The region around the town has a long and almost unbroken archaeological sequence beginning at least 10,000 B.C. and lasting until post-Conquest times. A summary of the cultural sequence since the introduction of ceramic technology (ca. 500 B.C.) is found in Pollard (1971). The appearance of maize cultivation in the archaeological record (ca. A.D. 100) is associated with artificial irrigation technology.

Maize from the Earliest Site

The earliest site found with associated maize is designated RAnL 100. Although no prehispanic structures are preserved, the site is believed to be the earliest agricultural village settlement along the middle Loa River. Sections of the site include a small intact refuse mound, a looted cemetery, ancient agricultural terraces and irrigation canals, and ruins of a historic-period house. A 1.0 × 2.5 m. cut was excavated in the refuse mound, revealing five well separated, but culturally homogeneous layers, the deepest of which (layer 5) was as much as 55 cm. below ground surface. Each layer yielded an abundance of sherds, various lithic artifacts, and sizeable quantities of *Lama* sp. bones. Layers 2–5 each contained varying amounts of *Lama* sp. wool and mesquite seeds (*Prosopis chilensis*). Layers 3 and 5 also contained several gourd fragments (*Lagenaria* sp.). Twenty maize cobs and several fragments were recovered from layers 2–5. Radiocarbon analysis of a sample of *Lama* sp. wool and skin from layer 5 resulted in a date of A.D. 105 ± 105 (GX-1644). At present, this is the earliest date for maize agriculture in northern Chile.

Of the nineteen races of maize described by Timothy *et al.* (1961), we recognize three in the collection from site 100. Descriptions of these follow:

Capio Chico Chileno

Twenty of the oldest cobs are considered to be related to this modern race; their characteristics are set forth in Table 1. All of the cobs represented in this table came from the test excavation described above. Layer provenience is represented by the last number in the code, except that layer 2 is represented by two code numbers, 2 and 7. There is no clear relationship between the depth of the layer and the characteristics of the cobs. Within each layer the cobs are arranged in order of their lengths, for identification purposes.

We call particular attention to the last cob listed in Table 1. This was very small with a length of 2.6 cm., a diameter of 1.6 cm., and 12 kernel rows. The senior author, having shortly before studying the Chilean speci-

TABLE 1

Characteristics of the cobs from the earliest site (RAnL 100), dated at A.D. 105.

code no.	length (cm)	diameter (cm)	diam/length ratio	kernel-row no.
100–2	3.7	1.8	.49	22
100–3	3.6	1.1	.31	14
"	3.1	1.3	.42	18
"	3.4	1.4	.41	16
"	2.1	1.5	.72	16
100–7	6.3	1.8	.29	18
"	6.2	1.6	.26	12
"	6.1	1.7	.28	18
"	5.3	1.1	.21	12
100–4	5.6	2.1	.37	18
"	5.4	1.3	.24	16
"	5.7	1.6	.28	16
"	5.1	1.5	.29	16
100–5	7.0	2.8	.40	30
"	5.2	2.0	.38	18
"	4.2	1.6	.38	16
"	4.1	1.9	.46	22
"	3.6	2.0	.56	18
"	3.6	1.5	.42	16
"	2.6	0.8	.31	12
average	4.6	1.6	.35	17.2

mens been engaged in studies of the prehistoric wild corn of the Tehuacán Valley in Mexico, saw in this specimen some resemblance to the Mexican corn; this raised in his mind the question of whether there could once have been a wild corn in Chile. Subsequent correspondence with the junior author made it clear that this part of Chile could scarcely have provided a suitable habitat for wild corn, and we concluded that this specimen is probably that of a stunted ear, borne on a depauperate plant.

Except for their smaller size, these earlier Chilean cobs (see Plate XV, fig. A) are quite similar in their characteristics to cobs of the modern race Capio Chico. The average data for their lengths, diameters, diameter/length ratios, and kernel-row numbers are 4.6, 1.6, 0.35, and 17.2 respectively. For their modern counterparts, the corresponding averages, published by Timothy *et al.*, are 8.6, 2.3, 0.27, and 17.2 respectively. The similarity in kernel-row numbers is especially significant.

In their dimensions, the Chilean cobs resemble even more closely the prehistoric ears excavated by Dr. Dwight Wallace from the Los Cerillos site in the Ica Valley on the south coast of Peru, some 1100 km. north of the Chilean site. This corn, estimated to be 2300–2500 years old, has been briefly described by Grobman *et al.* (1961) as a prehistoric race, Confite Iqueño; three ears of this race are illustrated in their figure 19.

The specimens from the Los Cerillos site are unusually well preserved, the kernels still being attached to their cobs. To obtain estimates of the diameters of the cobs, we subtracted from the diameters of the ears 9/10 of the length of two average kernels, assuming that 1/10 of their length, on the average, was embedded in the cob; this figure is based on the data published by Timothy *et al.* for Capio Chico.

Estimates obtained in this manner from the Los Ceril-

los maize produced the following averages: 5.6, 1.8, 0.32, and 17.8. These are so similar to those set forth above for the prehistoric Chilean cobs that we may conclude, with some degree of confidence, that the two collections represent essentially the same race, Confite Iqueño. By the same token, we can assume that if the Chilean cobs had retained their kernels, the intact ears would have been similar in their general appearance to those of the Los Cerillos maize, illustrated by Grobman *et al.* in their figure 19.

Polulo

This race is represented among the oldest cobs by a single specimen which is so different from the remaining ones that it must be considered as that of a different race. This specimen is 3.4 cm. long, but it is probably not intact with respect to length, since it lacks a peduncle. Also, since it comprises only the rachis, the central stem of the cob, the floral bracts having been lost, its diameter/length is not comparable with other cobs in this collection. The kernel-row number is 10; the cupules are distinct, slightly longer than wide and are hairy; stumps of the rachillae are prominent.

We might not have been able to identify this single specimen had not we found counterparts of it in a collection from site RAnL 337-1. Cobs of that lot, illustrated in Plate XV, fig. B, were derived from the shallow fill within the foundation of an isolated house dating to the late prehispanic period.

Anticipating a description of this lot, to be set forth later, we can say that of the 115 cobs of site 337-1, thirty-five are of a very distinctive type. These have slender rachises and peduncles of about the same diameter as the rachises. The floral bracts that remain attached to the rachises are relatively long; both lower and upper

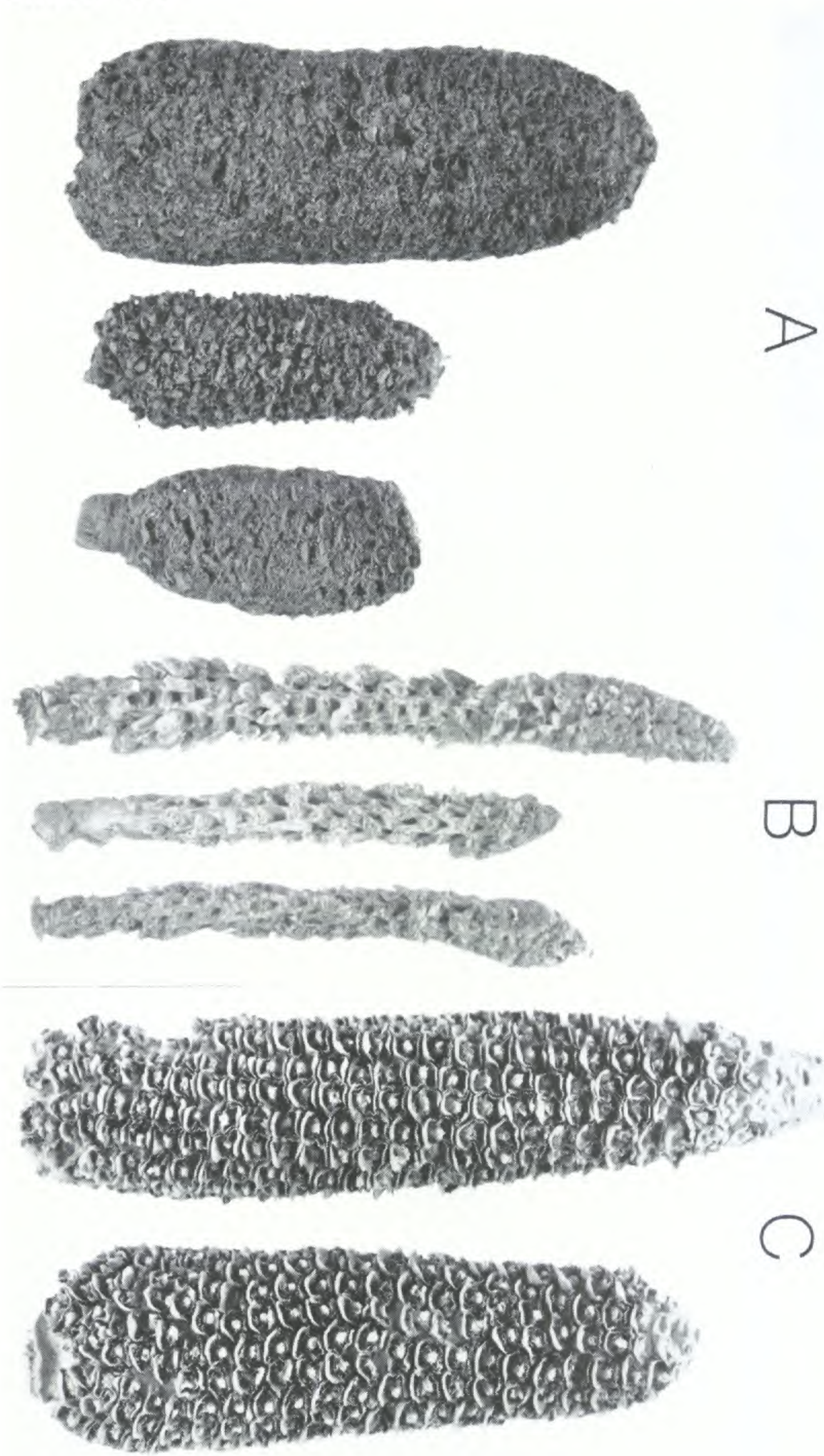
EXPLANATION OF THE PLATE

FIG. A. Three of the larger cobs from lot 100, dated at ca. A.D. 100. These are quite similar in the average dimensions to the prehistoric Peruvian race Confite Iqueño, and are related to the modern Chilean race Capio Chico Chileno. (Actual size.)

FIG. B. Three of the more slender cobs from lot 337-1, dated at ca. A.D. 1250. These are related to the modern Chilean race Polulo, which may in turn be related to the Peruvian popcorn Confite Morocho. (Actual size.)

FIG. C. Two cobs from lot 290, dating to the late prehispanic period. These are prehistoric counterparts of the modern Chilean race Chutucuno Chico, which may be related to the Peruvian race Confite Puntiagudo. Note the stiff, curved lower glumes, a characteristic which may have been derived from one of corn's relatives, teosinte or *Tripsacum*. (Actual size.)

PLATE XV



glumes are herbaceous and not at all indurated. They are typical of certain types of pod-corn involving lower alleles at the pod-corn locus in combination with *Ti*, a major tunicate-inhibiting gene (see Mangelsdorf 1974).

There is only one known modern Chilean race, Polulo, to which these slender cobs can be assigned. This is a finger-shaped popcorn with 10–16 kernel rows, grown at approximately 2700 meters. Its glumes are soft, the rachillae long and slender.

Timothy *et al.* state that the race Polulo seems not to be duplicated among collections made in other South American countries, but there seems to us a possibility that it is related to the Peruvian popcorn race Confite Morocho. Indeed one of the ears of Polulo illustrated in figure 5 of Timothy *et al.* resembles rather closely one of the ears of Confite Morocho illustrated in figure 48 of Grobman *et al.* (1961). Both have about the same length, 9.1 and 8.5 cm. respectively; both have 10 kernel rows and their rows are slightly irregular. One of the most distinctive characteristics of the archaeological specimens is their peduncles, which have about the same diameters as the rachises. The data of Grobman *et al.* show that this is true of Confite Morocho.

Galinat (1969) has isolated from the Peruvian race Confite Morocho types with cobs so slender that he calls them "string cobs." These slender cobs are found also in the Peruvian race Rabo de Zorro, which Grobman *et al.* regard as a hybrid derivative of Confite Morocho. Moulds thought to represent ears of Rabo de Zorro occur on a number of ceramic vessels of the Moche culture (Early Intermediate Period); several of these are illustrated in Grobman *et al.* (figs. 31 and 32), and one in Mangelsdorf (1974, fig. 17.13). These show that this slender-cob trait in South American races is an ancient one. The fact that it is not known in Mexican races may

lend some support to the hypothesis (Mangelsdorf 1974) that there may have been an independent domestication of maize in South America. It is in this connection that the slender-cobbed Chilean specimens are of particular interest.

Galinat (1972) has recently published a brief description of the archaeological maize turned up by MacNeish in a site in Ayacucho, Peru. He states that some of the cobs resemble those of the race Confite Morocho, but these are not among the earliest cobs from this site. They are tentatively dated at 3000 B.P.

Chutucuno Chico

This race, described by Timothy *et al.*, appears to be represented by one specimen obtained from near the top of looters' backdirt adjacent to the cemetery on site 100. This single cob is 7.6 cm. long; its most prominent feature is the stiff indurated lower glumes.

This specimen could be a precursor of cobs with stiff indurated lower glumes occurring in lots from sites RAnL 186, 268B, and 290, described briefly below. These in turn appear to be related to the living Chilean race Chutucuno Chico which is grown at altitudes of 2260 to 2500 meters. Timothy *et al.* describe this race as a small yellow popcorn with large cobs having 16–22 or more kernel rows. Both red and white cobs occur in the modern as well as the late prehistoric collections.

Chutucuno is in some respects similar to the fasciated form of the Peruvian primitive race Confite Puntiagudo described by Grobman *et al.* and illustrated in their fig. 56. These authors attribute the indurated tissues of the rachis and lower glumes to hybridization with corn's relative *Tripsacum*.

Maize from Later Sites

This site is a cemetery of more than 100 niche and pit graves at the locality of Chiu Chiu, and appears to have been utilized ca. A.D. 800. All the burials were found to have been looted, with broken artifacts and organic remains, including maize cobs, strewn on the ground surface.

Fifty intact or almost intact cobs and six fragments were collected from the surface scatter. Of the intact cobs, twenty-nine are red and twenty-one white. Many are quite tripsacoid in having indurated tissues of the rachis and glumes. These cobs are quite similar to those of the lot from site RAnL 290 except that they are smaller. In shape they are tapered and rounded at the butts. The shanks are intermediate in thickness; the lower glumes are stiff, and the rachillae long. Measurements of five red and five white cobs show no significant differences in the two types except perhaps in kernel row numbers. The averages for lengths, diameters, and kernel row numbers are 7.6 cm., 1.7 cm., and 18.0 for the red cobs, and 7.5 cm., 1.6 cm., and 15.6 for the white.

RAnL 1

This is a village site located at the present dispersed settlement of Lasana beside the Loa River, and may have been occupied from ca. A.D. 800 until Spanish arrival in the early 16th century. Maize cobs were collected from scattered surface refuse, and comprise eleven intact or almost intact specimens and six fragments.

Three of the specimens resemble the slender cobs in the lot from site 337-1, and three resemble the thicker cobs from that same site. Five cobs are quite tripsacoid, with their tissues highly indurated either naturally or hardened through some kind of impregnation. One of the cobs has several single spikelets, a characteristic of corn's relatives teosinte and *Tripsacum;* both of the lat-

ter differ from corn in having solitary instead of paired pistillate spikelets. Three of the cobs have stumps of what may have been staminate spikes.

RAnL 290

This is a small burial site of niche and shaft graves near Chiu Chiu, dating to the late prehispanic period. All graves were found looted, but a collection of maize cobs was made from the surface of the burial chambers.

Thirty-seven cobs were collected, of which eighteen are red or pink, seven variegated, and twelve white. The predominating shape is tapering with rounded butts; the shanks are intermediate in thickness. The lower glumes are stiff, indurated and glabrous. On several of the cobs some of the lower glumes have spots of brown pigmentation characteristic of maize-teosinte or maize-*Tripsacum* hybrids. The rachillae are prominent and in some specimens protrude beyond the lower glumes.

There are no marked differences between the red cobs and the white. Averages for lengths, diameters, and kernel row numbers for eight red cobs are 9.0, 2.4, and 18.3; for six white cobs these measurements are 8.9, 2.6, and 18.3. Two of the red cobs from this site are illustrated in Plate XV, fig. C. Most of the cobs appear to be related to the modern race Chutucuno Chico, which still occurs in Antofagasta Province.

RAnL 186

Dating to the late prehispanic period, this site consists of a single isolated shelter/dwelling situated on barren terrain 2 km. from the Loa River. A cache of between 400 and 500 maize cobs was found in the earth floor of the structure.

The cobs are quite variable in shape and other characteristics. Some are tapering at both ends; others are

more slender and more nearly cylindrical. With respect to diameter/length ratios, the cobs in a selected sample of twenty specimens vary from 0.13 to 0.86. In kernel-row numbers these same specimens vary from ten to twenty-six. Many of the cobs are twisted and contorted, and some are fused into conglomerate masses. They must have been somewhat soft and pliable at one time, perhaps as the result of some chemical action in the soil.

With respect to race, these cobs appear to represent a kind of "melting pot" in which the principal participants were the races Capio Chico and Polulo; a minor component may have been Chutucuno Chico.

RAnL 268B

This is another small, looted cemetery of niche graves near Chiu Chiu, dating to the late prehispanic period. A cache of fifty-three cobs was found within one of the burial chambers.

The specimens are similar to the cobs from site 290 with respect to color; twenty-nine are red or pink, six variegated, and eighteen white, but are brighter due to better preservation. Another similarity is the stiff lower glumes, which in some specimens are curved like the teeth of a wood rasp. Most of the cobs appear to be related to the modern Chilean race Chutucuno Chico.

RAnL 337-1

This isolated house site is located beside the Loa River among scrub vegetation, and is at least 12 km. from the nearest prehispanic settlement. The remains consist of a surface scatter of artifacts and a 3.0 by 3.5 meter house foundation which contained a maximum of 28 cm. of unstratified refuse. A sample of wood from the excavation yielded a radiocarbon date of A.D. 1250 ± 90 years (I-5399), thus placing the site within the late prehispanic period.

In one respect, the maize from the refuse is the most interesting of all of the lots recovered because it contains cobs of a slender type not previously described in the archaeological record of South America.

The lot comprises 115 cobs, of which fifty are rather thick, tapering at both ends. The diameter/length ratios of these vary from 0.25 to 0.32 in five typical cobs that were measured; the kernel-row number varied from fourteen to eighteen. These cobs appear to be related to the modern Chilean race Capio Chico Chileno.

The slender cobs (see Plate XV, fig. B) are thirty-five in number. In five cobs measured, diameter/length ratios varied from 0.09 to 0.14, and kernel row numbers from twelve to sixteen. Both upper and lower glumes are herbaceous, quite different from the stiff, indurated glumes of Chutucuno Chico, and they probably represent a form of pod-corn. As mentioned earlier in this report, they appear to be related to the Chilean race Polulo, which in turn may be a descendant of the primitive popcorn race Confite Morocho.

Four kernels were found in this collection. All are popcorn: three are yellow in color and one is brown.

Discussion

The cobs of these collections, the earliest as well as the more recent, appear to be related to three still living Chilean races: Capio Chico Chileno, Polulo, and Chutucuno Chico. These in turn are related respectively to three prehistoric Peruvian races: Confite Iqueño, the popcorn race Confite Morocho, and the popcorn race Confite Puntiagudo. The last-named race resembles in a number of characteristics the Mexican popcorn Polomero Toluqueño, but the remaining two races have no close counterparts in Mexican maize, either prehistoric or modern. This fact is consistent with the suggestion

(see Mangelsdorf 1974) that there may have been an independent domestication of corn in South America.

Acknowledgments

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THE CONTRIBUTION OF LINNAEUS TO ORCHIDOLOGY[1]

BY

WILLIAM T. STEARN[2]

The presentation to the Botanical Museum, Harvard University of a collection of works by Carl Linnaeus (1707–1778), which formed part of the library of Oakes Ames (1874–1950), provides a fitting occasion on which to review concisely Linnaeus's pioneer contribution to orchidology. Orchids were Ames's life-study and, while himself contributing much new knowledge, he was too wise and well-informed to ignore the historic background of modern work; the scholarly essays gathered together in his *Orchids in Retrospect* (1948) manifest the range of his orchidological learning and contain many references to earlier literature.

Orchidology is the study of orchids as a special group within the Plant Kingdom. Its existence necessarily depends upon recognition of them as a definable group worthy of particular study, and that implies a high degree of botanical sophistication. A group embracing plants so

[1] This paper embodies a lecture given at the Botanical Museum of Harvard University on September 18, 1969 when the heirs of Mrs. Blanche Ames presented Professor Oakes Ames's collection of Linnaeana to the Botanical Museum. It includes part of an earlier lecture, 'Two thousand years of orchidology', printed in *Proc. Third World Orchid Conf. 1960*, 26–42 (1960).

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distinct in habit as *Eria microphylla*, with leaves only 1 cm. long, creeping over the bark of tropical trees, and the tall erect terrestrial savanna herbs of the genus *Eulophia*, as well as the saprophytes exemplified by *Aphyllorchis*, *Corallorhiza*, *Didymoplexis*, *Epipogium*, *Gastrodia* and *Neottia*, which spend most of their lives hidden in subterranean darkness, can be held together in a single botanical family, the *Orchidaceae*, only by emphasis on a common basic floral pattern by no means obvious to the uninitiated. The existence of such a ground plan of floral organization tends to be masked by fantastic variations upon it in size, shape and colour associated with pollination mechanisms so complex as to be unbelievable were they not so well attested. Consequently, the concept of the *Orchidaceae* as a group of petaloid monocotyledons technically distinguished by such associated characters as a perigon of six segments zygomorphically developed, stamens reduced to one, two or three, ovary inferior and usually twisted (the whole flower then upside down) a stigma modified into a peculiar organ, the rostellum, seeds very numerous, minute and lacking endosperm—this concept has been long in the making.

The orchids lack a single marked feature comparable to the umbel of *Umbelliferae* (*Apiaceae*), which led to the early recognition of that aromatic economically important family. Nevertheless, they now present themselves to us as a natural group without conscious reference to their individual technical features. This recognition is the result of familiarity. The firm waxy texture of their flowers, in shape generally unlike those of other plants, their frequent use in floristry and their former association with wealth have established orchids as a generally known and popular group. They continually provide botanists with new problems and gardeners with new joys unparalleled in any other botanical family.

When discussing the evolution of the orchid flower in *Amer. Orchid Soc. Bull.* 15: 18–19 (1946), Ames remarked, with light-hearted scholarship, that 'certain floral structures and the story of their probable evolution intensify the belief that orchids possess qualities which set them apart from other plants. Therefore (in the bosom of the family, with no botanists present) it is delightful to regard orchids as beings which have shaped their own destiny and to speak of their floral structures, of the rostellum, for example, as organs purposefully developed to serve special and fantastic functions'. In the 18th century, Linnaeus recognized most of their distinctive features as a group, although he knew only a few species. He thus provided a base upon which, in the 19th century, other botanists, John Lindley their chief, built modern orchidology.

The words *orchis* (ὀρχις) 'testicle' and *lŏgŏs* (Λογος) 'discourse' are Greek, but the distinctive technical details of the family *Orchidaceae* if made known to a learned and intelligent Ancient Greek herbalist, even Dioscorides himself, in the 1st century A.D. would have had little or no meaning or interest. To people whose interest in plants was primarily utilitarian, the division of the Plant Kingdom into major groups defined by inconspicuous and apparently trivial features such as these floral subtleties of organization—groups which Magnol called *familiae* and Linnaeus *ordines naturales*—would have seemed pointless. The Ancient Greeks and Romans, like their successors in Europe down to the 17th century, knew nothing about the functions of the different parts of the flower; they lacked lenses suitable for supplementing and training the naked eye in observation; consequently, they gave little attention to the floral structure on which the concept of the *Orchidaceae* rests. For them the word *orchiologos* would have suggested either a medical treatise or an obscene comedy.

To survive the long, dry, fiercely hot Mediterranean summer, plants must either have features enabling them to withstand dessication, such as small, hard or woolly leaves, or else disappear underground, having stored during the relatively mild moist winter and spring enough food in bulbs or tubers to give them a quick start into growth when the rains come. The storage organs of a number of Mediterranean orchids such as *Orchis* and *Ophrys* are paired rounded tubers which suggested testicles to the far from prudish Greeks, and they named these plants *orchis* (ὀρχις) and *cynosorchis* (κυνοσορχις) 'dog's testicle' accordingly, a matter discussed by Ames in his little essay on the 'Origin of the term Orchis' in *Amer. Orchid Soc. Bull.* 11: 146–147 (1942). Dioscorides described the root as bulbous, with paired swellings, one full and solid, the other wrinkled and soft, and mentioned as a folk-tale the belief that men should eat the full one to beget sons but women the soft one to conceive daughters, presumably avoiding synchronisation! The extension of the word *orchis* and cognate words to tropical plants with long slender dangling roots would have seemed an absurdity for them, a contradiction in terms. The extension of the concept of 'orchid' to cover such plants owes much to Carl Linnaeus (after 1762 Carl von Linné) but did not originate with him. It developed out of the studies of his predecessors who had a feeling for affinities between plants as expressed in overall resemblance.

Thus Gaspard (or Caspar) Bauhin (1560–1624), who attempted in his *Pinax* (1623) to regulate the names of all the plants then known, devoted section 6 of his book II mainly to orchids, with headings now unfamiliar such as *Cynosorchis seu Testiculus canis*, *Orchis Serapias*, etc., although somewhat spoiling the picture by associating *Dens canis* (i.e. *Erythronium*) and *Orobanche* with them.

Plate XVI



Orchis morio L., illustrating the paired tubers which suggested the generic name. Reproduced from Leonhard Fuchs, *De historia stirpium*, page 559, 1542, Basel.

Towards the end of the 17th century came the huge works of John Ray (1628–1705) and Robert Morison (1620–1683). Ray's account occupies pages 1212–1233 of volume 2 of his *Historia Plantarum* (1688), the species being listed under the names *Orchis*, *Tragorchis*, *Cynosorchis*, *Chamaeorchis*, *Monorchis*, *Triorchis*, *Palmata*, *Pseudo-Orchis*, *Nidus-avis*, *Pseudo-limodoron*, *Helleborine* and *Bifolium*. He possessed a good knowledge of these plants derived from his extensive travels in Britain and on the Continent of Europe, and his descriptions give significant details as regards the species but no formal generic characters. His comments on the great difficulty of studying orchids on account of the numerous allied species and the inadequate descriptions by botanists, of which one description can apply to several species and several different descriptions to one species, has unfortunately not ceased to be true: 'Caeterum cum Orchidum historia magna confusione et obscuritate laboret, partim ob multitudinem specierum, et nonnullarum etiam similitudinem, partim ob earum apud botanicos descriptiones, adeo breves interdum et generales ut et una pluribus, et plures uni alicui speciei accommodari possint: unde perspicacissimum quemque et in his studiis versatissimum torqueant et perplexum reddant necesse est' (*Hist.* 2: 1212; 1685). This was a state of affairs which Linnaeus set out to remedy.

In the third volume (1699) of Morison's *Plantarum Historia universalis Oxoniensis*, which was completed by Jacob Bobart after Morison's death, 103 kinds of *Orchidaceae* are listed together, though associated with other plants having minute seeds such as *Orobanche* and *Pyrola*. These are put in six genera: *Helleborine*, *Bifolium sive Ophris*, *Triorchis et Monorchis*, *Orchis palmata*, *Pseud-orchis*.

Joseph Pitton de Tournefort (1656–1708) in his *In-*

stitutiones Rei Herbariae 1: 431–438 (1701) dealt with them as a special group under the heading 'De Herbis, flore polypetalo, anomalo', this including *Orchis*, *Helleborine*, *Calceolus* (i.e. *Cypripedium*), *Ophris* (i.e. *Listera*), *Limodorum* and *Nidus avis* (i.e. *Neottia*). Unlike his predecessors, he provided concise generic descriptions. Within *Orchis* he included plants with flowers resembling 'nunc Hominem nudum, modo Papilionem, Fucum, Columbam, Simiam, Lacertam, Psittacum, Muscam, caeterave repraesentante' now put in *Orchis*, *Dactylorhiza*, *Ophrys*, *Himantoglossum*, *Accras*, etc. This extraordinary mimicry of animal forms by the flowers of orchids had already excited the admiration of Jacob Breyne (1637–1697) in his *Exoticarum aliorumque minus cognitarum Plantarum*, 94 (1678) as Ames noted in his essay, 'Orchids in retrospect' (in *Amer. Orchid Soc. Bull.* 11: 102–106; 1942). The orchids known to these early authors were north-temperate species. Of the astonishing richness of the tropics in orchids they knew nothing.

In 1703, H.A. van Rheede tot Draakestein (1635–1691) posthumously recorded six orchids from Malabar, southern India, in his *Hortus Indicus Malabaricus*, these being now known as *Rhynchostylis retusa*, *Vanda spathulata*, *Acampe Wightiana*, *Sarcanthus peninsularis*, *Dendrobium ovatum* and *Cymbidium aloifolium*.

On his visit to Jamaica in 1687 to 1689, Sir Hans Sloane (1660–1753) found a number of epiphytic orchids. Those recorded in his *Voyage to the Islands Madera* xxx *and Jamaica* (1707–25) as species of *Viscum*, *Cardamon*, etc. are now known as *Brassavola cordata*, *Oncidium guttatum*, *Broughtonia sanguinea*, *Vanilla claviculata*, *Stenorrhynchus speciosus* and *Erythrodes plantaginea*.

About the same time, another doctor, Engelbert Kaempfer (1651–1716), was becoming acquainted with a few of the many orchids of Java and Japan. He illus-

trated three of these in his *Amoenitatum Exoticarum Fasciculi V* (1712), the species now known as *Dendrobium moniliforme*, *Vanilla domestica* and *Arachnis flos-aeris*.

Such was the state of knowledge of orchids at and after the birth of Carl Linnaeus in 1707. His career has been sketched in so many publications, notably B.D. Jackson, *Linnaeus (afterwards Carl von Linné), the Story of his Life* (1923), K. Hagberg, *Carl Linnaeus* (1952), N. Gourlie, *The Prince of Botanists* (1953), and W. Blunt and W.T. Stearn, *The Compleat Naturalist* (1971), that a bare outline will suffice here. He was born in 1707 at Råshult, Skåne, southern Sweden, entered the University of Lund in 1727, changed next year to the University of Uppsala, made an important journey to Lapland in 1732, left Sweden for Holland in 1735 and returned in 1738, having acquired a doctor's degree at Harderwijk and published his *Systema Naturae* (1735), *Fundamenta botanica* (1736), *Genera Plantarum* (1737), *Flora Lapponica* (1737), *Critica botanica* (1737), *Hortus Cliffortianus* (1738). He was appointed a professor at the University of Uppsala in 1741 and that year visited the Baltic islands of Öland and Gotland. His *Species Plantarum*, the starting point of modern botanical nomenclature, appeared in 1753, and his *Systema Naturae*, 10th ed., vol. 1, the starting point of modern zoological nomenclature, in 1758. He died at the age of 70 in 1778.

On his journey to Lapland in 1732, Linnaeus became acquainted with seven species now known as *Dactylorhiza maculata*, *Coeloglossum viride*, *Goodyera repens*, *Corallorhiza trifida*, *Listera cordata*, *Herminium monorchis* and *Cypripedium calceolus*, admittedly but not surprisingly few, considering their remoteness from the tropics, and also atypical of this essentially tropical family. He knew *Calypso bulbosa* only from a coloured drawing made in Lapland by Rudbeck the Younger.

These species he enumerated in his *Flora Lapponica* (1737).

In 1738, Linnaeus published his *Classes Plantarum* which summarizes the earlier classifications of the Vegetable Kingdom by his predecessors, Cesalpino, Morison, Ray, Knaut, Hermann, Boerhaave, Rivinus, Rupp, Ludwig, Tournefort, Pontedera and Magnol, as well as his own artificial 'sexual system', wherein the genera now included in *Orchidaceae* form his class *Gynandria* order *Diandria*. He appended to this a 'Fragmenta methodi naturalis' which is an attempt at a more natural system of classification. Here again, as in his 'systema sexuale', the orchid genera, *Orchis*, *Satyrium*, *Serapias*, *Herminium*, *Neottia*, *Ophrys*, *Cypripedium* and *Epidendrum*, form a group distinct from other plants, his Ordo IV. Much later, in his *Genera Plantarum*, 6th ed. (1764), he published a modified version under the heading 'Ordines naturales'; this is reprinted, with a discussion by Stearn, in the Ray Society facsimile of Linnaeus, *Species Plantarum*, vol. 2, Appendix: 93–102 (1959). Here appears an Ordo VII *Orchidaceae* comprising the above genera. After his death, two former students, P. D. Giseke and J. C. Fabricius, published a detailed account of lectures on the natural system delivered by Linnaeus at Uppsala in 1764 and 1771 entitled *Caroli a Linne Praelectiones in Ordines naturales Plantarum* (1792). Here again the *Orchideae* from a distinct 'Ordo' (in modern terminology, family) of which Linnaeus stated the characters, the ecology and the cultivation, then so little understood that most tropical orchids died soon after their introduction. 'Omnium difficillime in hortis plantantur, et introductae vix per aliquot annos perennant', he said, 'E seminibus satis in hortis non proveniunt: certe si possent seri, nullus hortulus amoenioribus floribus superbiret'. Their successful cultivation

and raising from seed was not achieved until the 19th century; John Smith (1798–1888) provided in his *Records of the Royal Botanic Gardens, Kew*, 227–241 (1880) a first-hand account of progress in orchid-growing during his lifetime.

On his way back to Sweden from Holland in 1738, Linnaeus visited Paris and was conducted to Fontainbleau, where the wild orchids in particular delighted him. Before taking up his professorship at Uppsala in October 1741, Linnaeus with six young companions made an expedition to Öland and Gotland at the request of the Swedish Estates of the Realm. The purpose of this journey, which extended from May to August 1741, was primarily economic, to search for dye-yielding and medicinal plants and to make observations on soils, minerals, farming, manufacturing methods and general natural history. These islands, then scientifically almost unexplored, differ from mainland Sweden in being of limestone and having a relatively mild climate, so that they shelter many organisms rare or unknown on the mainland, among them various orchids. The two islands naturally excited Linnaeus's eager curiosity, and he described them in detail in his entertaining account of the journey entitled *Öländska och Gothländska Resa* (1745), of which an annotated English translation by Marie Åsberg and W.T. Stearn is now available in *Biol. J. Linnean Soc.* 5: 1–220 (1973). Their orchid flora includes 22 species. Linnaeus visited the islands when most of the orchids were in full flower. As soon as he and his companions touched the shore of Öland on June 12 (June 1, Old Style, of Linnaeus's journal) they realized that this was a land altogether different from the other Swedish provinces and they decided to make meticulous notes about everything. Their second day provided them with the joy of finding *Ophrys insectifera*, *Orchis militaris*, *Orchis*

ustulata, *Orchis morio*, *Gymnadenia conopsea*, *Dactylorhiza sambucina*, *Dactylorhiza maculata* and *Dactylorhiza incarnata* and caused Linnaeus to remark that, such plants having previously been unrecorded for Sweden, he had never expected when seeing them at Fontainbleau that he would ever see them again. These grew between Forjestaden and Bornholm. *Listera cordata* was found on June 15 (June 4, Old Style). Later (June 25, Old Style), he came across *Orchis mascula* in Lummeland parish north of Visby; he also found *Herminium monorchis* (July 5, Old Style), *Epipactis helleborine* (July 25, Old Style) and *Epipactis atrorubens* (July 3, Old Style).

These Baltic orchids inspired Linnaeus to give special attention to all of the species then known. Many had been described by earlier authors under a diversity of names. Linnaeus reduced them to 41 species in a survey entitled 'Species orchidum et affinium plantarum' in *Acta Soc. Regiae Sci. Upsal.* 1744: 1–37 (1744) cited by Linnaeus as 'Act. ups. 1740'. For each one he gave very detailed synonymy and a concise diagnosis. There are no generic descriptions here, as he had already provided them in his *Genera Plantarum*, 2nd edition (1742). His genera were few: *Orchis* (including *Dactylorhiza*), *Satyrium*, *Serapias*, *Herminium*, *Neottia*, *Ophrys*, *Cypripedium* and *Epidendrum*.

In 1745 Linnaeus published the account of his Öland and Gotland journey, *Öländska och Gothländska Resa*, already mentioned. An important feature of this interesting book is its index because it foreshadows Linnaeus's later introduction of consistent binomial nomenclature for all species of plants and animals. In the text he used diagnostic polynomials such as *Orchis bulbis indivisis, nectarii labio quinquefido punctis scabro, cornu obtuso, petalis conniventibus* and *Orchis bulbis palmatis, nectarii cornu setaceo germinibus longiore, labio crenato*, names

which indicate the distinguishing features of the species but are inconvenient to write and almost impossible to remember. In the index these are listed as *Orchis* 725 *militaris* and *Orchis* 727 *longicalcar*, the number referring to the numbered entry with diagnostic details in Linnaeus's *Flora Succica* (1745). The generic name and the added single epithet were easy to remember; the number took the place of the long descriptive phrase by serving as a concise reference to one in a standard work. These names thus provide an intermediate stage between the polynomial nomenclature of Linnaeus's *Flora Suecica* (1745) and the binomial nomenclature of his *Species Plantarum* (1753), where, for example, the two species mentioned above are simply designated *Orchis militaris* and *Orchis conopsea;* the last species, however, has long been removed from *Orchis* and is now known as *Gymnadenia conopsea.* Apart, therefore, from its interest as an 18th-century travel book replete with first hand observations on local customs and superstitions—plants, animals, minerals, quarrying, household remedies, vernacular names, runic inscriptions and much else— *Linnaeus's Öland and Gotland Journey 1741* is an important work in the history of biology.

Orchids for Linnaeus were only a small part of the Vegetable Kingdom which he had set himself the daunting task of classifying and naming. He accomplished this in his *Species Plantarum* (1753) and the associated fifth edition (1754) of his *Genera Plantarum.* Contrary to common belief, the introduction of consistent binomial nomenclature for species, i.e. the designation of each one by a two-word name, e.g. *Orchis ustulata*, consisting of the generic name, e.g. *Orchis*, followed a single specific epithet, e.g. *ustulata*, was not the primary intent of the *Species Plantarum*, although this nomenclatural innovation has given it outstanding importance. The addition

of specific epithets came almost as an after-thought; as late as 1748, Linnaeus had not added them to his manuscript draft now in the library of the Linnean Society of London. The main purpose of the *Species Plantarum* was to provide diagnostic phrase-names (polynomials), such as *Cypripedium radicibus fibrosis, foliis ovato-lanceolatis caulinis* and *Cypripedium bulbo subrotundo, folio subrotundo radicali*, which, taken together, functioned like the contrasts in a modern key and enabled the species to be distinguished from their congeners, with relevant synonyms cited as a guide to the existing literature about each. Hence, the material, either specimens or illustrations, supplying the information epitomised in the phrase-name, is of first importance for the typification of the associated specific epithet. Each phrase-name set out to give as concisely as possible a statement of the main distinguishing features. Thus, in his synopsis of the genus *Orchis* in the *Species Plantarum* (1 : 939–944), the phrase-names of species 1–10 begin with 'bulbis indivisis' ('with undivided root-tubers') and so distinguish them from species 11–14 with 'bulbis palmatis' ('with palmately lobed root-tubers') as well as from species 15–17 with 'bulbis fasciculatis' ('with bunched fibrous roots'). A number of species are further distinguished by the length of the spur in relation to the ovary, e.g. species 12 (*maculata*) with 'nectarii cornu germinibus breviore' ('with spur shorter than the ovary') being thereby distinguished from species 13 (*conopsea*) with 'nectarii cornu setaceo germinibus longiore' ('with spur setaceous longer than the ovary') and species 14 (*flava*) with 'nectarii cornu filiformi longitudine germinis' ('with spur filiform as long as the ovary'). A name such as that for species 5 (*pyramidalis*), *Orchis bulbis indivisis, nectarii labio trifido antice bidentato, cornu longo, petalis acuminatis* served to distinguish this species from all other orchids then known.

Descriptions of the genera were provided in the fifth edition of the *Genera Plantarum*. Here, Linnaeus recognized as distinct *Orchis* (which included Tournefort's *Limodorum*), *Ophrys*, *Serapias* (which included Tournefort's *Helleborine*), *Limodorum*, *Arethusa*, *Cypripedium* (which included Tournefort's *Calceolus*) and *Epidendrum* (which included Plumier's *Vanilla*). The content of these genera can be best illustrated by listing the species included in each genus by Linnaeus in the *Species Plantarum* and then giving the currently accepted name for each species and also the name which Oakes Ames adopted or would probably have adopted when dealing with the same species. This list, compiled with the help of Mr. Peter F. Hunt, is as follows:

Linnaeus, Species Plantarum 2: 939–954 (1752)

	Linnaean name	*Currently accepted name* (if different from Linnaean name)	*Probable name used by Ames* (if different from currently accepted name)
1	Orchis susannae	Pecteilis susannae (L.) Raf.	Habenaria susannae (L.) R.Br.
2	O. ciliaris	Blephariglottis ciliaris (L.) Rydb.	H. ciliaris (L.) R.Br.
3	O. bifolia	Platanthera bifolia (L.) L.C.Rich.	H. bifolia (L.) R.Br.
4	O. cucullata	Neottianthe cucullata (L.) Schltr.	H. cucullata (L.) Hoefft.
5	O. pyramidalis	Anacamptis pyramidalis (L.) L.C.Rich.	—
6	O. coriophora	—	—
7	O. cubitalis	Peristylus cubitalis (L.) Kraenzlin	H. cubitalis (L.) R.Br.
8	O. morio	—	—
9	O. ustulata	—	—
10	O. militaris	—	—
11	O. latifolia	Dactylorhiza latifolia (L.) Soó (D. majalis (Rchb.) P.F.Hunt & Summerh.)	O. latifolia L.
12	O. maculata	D. maculata (L.) Soó	O. maculata L.
13	O. conopsea	Gymnadenia conopsea (L.) R.Br.	Habenaria conopsea (L.) Benth. (non Rchb.f.)
14	O. flava	Tulotis flava (L.) Sengh.	H. flava (L.) R.Br.
15	O. fuscescens	Tulotis fuscescens (L.) Raf.	H. fuscescens (L.) Torr.
16	O. strateumatica	Zeuxine strateumatica (L.) Schltr.	—
17	O. abortiva	Limodorum abortivum (L.) Swartz	—

Linnaeus, Species Plantarum (cont.)

Linnaean name		*Currently accepted name* (if different from Linnaean name)	*Probable name used by Ames* (if different from currently accepted name)
18	O. psycodes	Blephariglottis psycodes (L.) Rydb.	H. psycodes (L.) Sprengel
19	O. spectabilis	Galearis spectabilis (L.) Raf.	Orchis spectabilis L.
1	Satyrium hircinum	Himantoglossum hircinum (L.) Koch	—
2	S. viride	Coeloglossum viride (L.) Hartman	H. viridis (L.) R.Br.
3	S. nigrum	Nigritella nigra (L.) Rchb.	—
4	S. albidum	Pseudorchis albida (L.) Löve & Löve	H. albida (L.) R.Br.
5	S. epipogium	Epipogium aphyllum Swartz	—
6	S. repens	Goodyera repens (L.) R.Br.	—
1	Ophrys nidus-avis	Neottia nidus-avis (L.) L.C.Rich.	—
2	O. corallorhiza	Corallorhiza trifida Chatelain	—
3	O. spiralis	Spiranthes spiralis (L.) Chevall.	—
4	O. cernua	S. cernua (L.) L.C.Rich.	—
5	O. ovata	Listera ovata (L.) R.Br.	—
6	O. cordata	L. cordata (L.) R.Br.	—
7	O. lilifolia	Liparis lilifolia (L.) L.C.Rich. ex Lindl.	—
8	O. loeselii	L. loeselii (L.) L.C.Rich.	—
9	O. paludosa	Malaxis paludosa (L.) Swartz	—
10	O. monophyllos	M. monophyllos (L.) Swartz	—
11	O. monorchis ('Monochris')	Herminium monorchis (L.) R.Br.	—
12	O. alpina	Chamorchis alpina (L.) L.C.Rich.	—
13	O. camtschatea	Neottia camtschatea (L.) Rchb.f.	—
14	O. anthropophora	Aceras anthropophorum (L.) R.Br.	—
15	O. insectifera	— (O. muscifera Hudson)	—
1	Serapias hellecorine	Epipactis helleborine (L.) Crantz	—
	latifolia	" (E. latifolia (L.) All.	—
	longifolia	Cephalanthera longifolia (L.) Fritsch	—
	palustris	Epipactis palustris (L.) Crantz	—
2	S. lingua	—	—
1	Limodorum tuberosum	Bletia tuberosa (L.) Ames	—
1	Arethusa bulbosa	—	—
2	A. ophioglossoides	Pogonia ophioglossoides (L.) Ker-Gawl.	—
3	A. divaricata	Cleistes divaricata (L.) Ames	—
1	Cypripedium calceolus	—	—
2	C. bulbosum	Calypso bulbosa (L.) Oakes	—
1	Epidendrum vanilla	Vanilla planifolia Andrews	Vanilla fragrans Ames
2	E. domesticum	Vanilla domestica (L.) Druce	—

Linnaeus, Species Plantarum (cont.)

	Linnaean name	*Currently accepted name* (if different from Linnaean name)	*Probable name used by Ames* (if different from currently accepted name)
3	E. flos-aëris	Arachnis flos-aëris (L.) Rchb.f.	—
4	E. tenuifolium	Cleisostoma tenuifolium (L.) Garay	—
5	E. spathulatum	Vanda spathulata (L.) Sprengel	—
6	E. ovatum	Dendrobium ovatum (L.) Kraenzlin	—
7	E. nodosum	Brassavola nodosa (L.) Lindl.	—
8	E. carinatum	Dendrobium carinatum (L.) Willd.	—
9	E. aloifolium	Cymbidium aloifolium (L.) Swartz	—
10	E. guttatum	Oncidium guttatum (L.) Rchb.f.	—
11	E. retusum	Rhynchostylis retusa (L.) Blume	—
12	E. amabile	Phalaenopsis amabilis (L.) Blume	—
13	E. ensifolium	Cymbidium ensifolium (L.) Swartz	—
14	E. moniliforme	Dendrobium moniliforme (L.) Swartz	—

From the above concordance, it will be evident that Linnaeus's 19 species of *Orchis* can be referred to 15 genera or at least 5 genera; his 6 species of *Satyrium* to 6 genera or at least 5 genera; his 15 species of *Ophrys* to 10 genera; his two species of *Serapias* to 3 genera; his 3 species of *Arethusa* to 3 genera; his two species of *Cypripedium* to 2 genera; his 14 species of *Epidendrum* to 10 genera. Thus, in a group of species where Linnaeus saw only 7 genera, modern orchidologists see 50. This change of viewpoint has come largely from the introduction into gardens of allied species during the 19th century, a consequence both of European botanical exploration outside Europe and of improved methods of cultivation, the two together providing living specimens for study and greatly stimulating this study. Of the species accepted by Linnaeus in 1753, Europe provided 30, eastern North America 11, Indonesia and the Philippines 4, Siberia 4, India 6, tropical America 3, Ceylon 2, China 1; only 4 were previously undescribed species. He had a first-hand knowledge of many European species in a living state, but his acquaintance with tropical orchids was meagre. He knew his *Orchis cubitalis* (*Peri-*

stylus cubitalis) and *O. stateumatica* (*Zeuxine stateumatica*) from Ceylonese specimens in Hermann's herbarium, now in the British Museum (Natural History), his *Epidendrum amabile* (*Phalaenopsis amabilis*) and *E. ensifolium* (*Cymbidium ensifolium*) from Chinese specimens collected by Osbeck and his *E. Vanilla* (*Vanilla planifolia*) from cultivated material and *E. nodosum* (*Brassavola nodosa*) from cultivated material and illustrations, but the other 9 he knew only from illustrations published by Rheede and Kaempfer. Wisely he kept these little-known species in a single genus, *Epidendrum;* he could record their existence, give them names but add nothing to an understanding of them. This had to wait for Olof Swartz (1760–1858), who studied many species while in the West Indies, Robert Brown (1773–1858), who studied many in Australia, Carl Ludwig Blume (1796–1862), who studied many others in Java, and John Lindley (1799–1865), who never visited the tropics but studied their products more conveniently in the glasshouses of England and published some 120 currently accepted genera.

Assessment of Linnaeus's main publications relating to orchids depends upon one's viewpoint and this is conditioned by both the knowledge and the scientific fashions of the time. If, for example, we imagine Carl Linnaeus as a Harvard student submitting his account of *Orchidaceae* to Professor Ames as a thesis, which admittedly requires some imagination, we can be sure poor student Linnaeus would have been taken to task for the superficiality of his work, for ignoring so many minute floral details in his definition of genera, for failing to separate groups which, in the Professor's eyes, were obviously distinct; Linnaeus would have been told to examine their floral structure with greater care. On the other hand, if we imagine Oakes Ames as an Uppsala

student making his work on orchidaceous genera known to Professor Linnaeus, we can also imagine the latter severely questioning the propriety of his taxonomic procedure. Linnaeus could well have criticized him for ignoring the overall resemblance of his plants which justified keeping them together, for giving excessive importance to insignificant details and for revealing by his absurd breaking up of natural genera (although Ames in fact was more conservative in his approach than some of his contemporaries) a lack of understanding of the essentials in classification as then understood.

Both professors would have been right within the context of their times. When the known species of a family are few, it is probably more convenient to keep them together within a few genera. When the same species have had added to them a host of others, it may be more convenient to divide them all among a much greater number of genera. Provided the facts about them are understood, it is often a matter of convenience or prevailing fashion or consistency of treatment in comparable situations, or even plain egotism, as to the taxonomic rank these groups should be assigned.

The value of Linnaeus's contributions to orchidology lies primarily not in his treating orchids as a special group but, on the contrary, in giving them the same nomenclatural treatment as other plants in accordance with his methodology. The essentials of this were that:

1) the genera should be named euphoniously and clearly, avoiding names which could be confused;
2) the genera should be defined according to a consistent formal plan, using a fixed terminology;
3) the species should be defined by key characters enabling them to be distinguished and recognized;
4) the species should be given convenient binomial names.

Such procedure has been fundamental to the development and expansion of systematic botany in general and to orchidology in particular, to the work of Oakes Ames no less than to his predecessors, from Linnaeus onwards; but it now seems so commonplace and self-evident that only by comparison with the work of Linnaeus's predecessors does its originality become manifest. Linnaeus distinguished in the *Species Plantarum* (1753) only 7 genera and 62 species out of the 700 or so genera and 20,000 or so species of *Orchidaceae* now known and, by the end of his life, had become acquainted with only 107 or so genera. Nevertheless, his treatment of these few exemplified the methods which, with due modification, have made possible the recording of the many. Thus, in the works of Linnaeus lay the potentialities of the studies in orchidology so honourably associated with Ames and the Botanical Museum of Harvard University.

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ETHNOBOTANY OF THE WESTERN TARAHUMARA OF CHIHUAHUA, MEXICO

I. NOTES ON THE GENUS *Agave*

BY

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INTRODUCTION

The genus *Agave*, native to Mexico and southwestern United States, has played an important role in the material culture of the peoples who lived in its range. In the Greater Southwest, various species played a part in almost every aspect of aboriginal life (Castetter, Bell and Grove, 1938; Gentry, 1972: 9–11). Even in industrialized Mexico, the maguey plants are important sources of commercial fibre (sisal and henequén) and fermented beverages (pulque).

In southwestern Chihuahua, several species of *Agave* are still important to the Tarahumara Indians, although the intensity of some uses has decreased. From the first European observations to the present, numerous writers

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[3] A Western Tarahumara from Municipio of Guazapares who is writing a series of booklets in Tarahumara and Spanish under the direction of Mr. Burgess (cf. Mares, 1972 and 1974).

have commented on the many uses and functions of maguey or the mescal plant. In a future paper, Bye will review these reports with respect to the Tarahumara as a whole. We now propose to review the utilization and significance of the magueys to one group, the Western Tarahumara[4]. This paper is the first part in a series on Western Tarahumara ethnobotany in which we plan to present information on and discussions of plants used by the natives living on the eastern slopes of the Rio Chínipas drainage area in the Municipios of Guazapares, Chínipas and Uruachi in southwestern Chihuahua. The Rio Chínipas, a tributary of the Rio Fuerte, originates west of the Continental Divide near Creel.

Eight species of *Agave* which occur in western Tarahumara region will be discussed[5]. Most of the species are restricted to the northern Sierra Madre Occidental and range from the arid sub-tropical vegetation of the barrancas to the cool pine forests of the sierras. Table I summarizes the range, elevation and ecological association of the Western Tarahumara agaves.

Utilization

Agave is first and foremost a source of food. The common method in preparing the heart (i.e., the secondary thickened stem with compacted nodes) and leaf bases consists of pit-baking, usually by the men. Plants are selected by size and degree of development of the inflorescence bud. The leaves near the centre around the swollen flower stalk bud are usually disposed in a series of smaller leaves contrasting with the previous larger ones. Harvesting the plant just prior to the elongation of the large inflorescence when the concentration of energy-

[4] Tarahumara Baja, according to Mexico's Instituto Nacional Indigenista.

[5] Consideration of other species found to the east and not recognized by the Western Tarahumara will be deferred to a later paper.

rich sugars is highest is done by all people who eat maguey hearts. Pit-baked magueys are an important food source at the time of year when food stores of the previous growing season are dwindling and before the arrival of summer rains which are needed for the growth of wild greens and cultivated plants. Occasionally, magueys are pit-baked at other times of the year.

The plants are dug up with a pointed stick, an iron bar or an old ax. Then the outer leaves are trimmed with a machete, leaving the hearts and leaf-bases. A wooden hook is inserted into the bottom of each heart, two of which are tied together and placed over a burro to carry to the pit. If people are carrying the hearts and the distance to the pit is great, the leaf-bases are cut off and carried separately in a basket.

A fire, usually of green oak wood (*Quercus* spp.) is built in the pit with rocks placed on top of the wood. Hard, heavy rocks are chosen, since they hold heat longer. The round pit is usually about three feet deep and five feet wide. The same pit is used year after year. About noon, when the fire has burned down to coals and the smoke, which would give the hearts a bad taste, no longer comes out, the pit is ready for use. If the coals are too hot, a layer of earth is placed over them. Then the mescal hearts with the leaf-bases still intact are placed in the pit. Sometimes a stick of "rolobusi"[6] (*Bouvardia* sp.) is inserted into each heart to assure sweetness in cooking. If "rolobusi" is not available, leaves of "usabi" (*Prunus Gentryi*) are placed on the hot rocks at the bottom for the same purpose. After the hearts are in the pit, the pit is covered with leaves of a palm (*Sabal uresana*). Then a layer of soil is placed over the top and left for

[6] Western Tarahumara belongs to the Uto-Aztecan family of languages. It is written here using the Spanish orthography with the addition of the glottal ('). The r's and l's differ from Spanish in that they are retroflexed.

two nights. On the morning after the second night, if the tops of the mescals are not done, the hearts are removed and the fire rebuilt under the rocks. Then the hearts are turned over, replaced in the pit, covered again and left for another day. If still not sufficiently cooked, they may remain in the pit-oven an extra day.

Upon removal, the hearts and leaf-bases are loaded into gunny sacks and baskets and taken to the house. They are either eaten by themselves or oftentimes with a corn drink, "gue'huali" (Spanish: esquiate), or a corn gruel, "atónali" (Spanish: atole). The sweet flesh of the heart is eaten and the fibres spit out. The heart is sometimes ground and mixed with tortilla dough. The preparation and consumption of agaves have been described for other areas of the Tarahumara region (Pennington, 1963: 129–131; Bennett and Zingg, 1935: 148–149). The hearts of *Agave pacifica*, *A. Shrevei*, *A. multifilifera* and *A. polianthiflora* and the leaf-bases of *A. americana* var. *expansa*, *A. multifilifera* and *A. polianthiflora* are all pit-baked and eaten.

"Suguí" (Spanish: tesgüino), a fermented beverage, can also be made from the well cooked mescal. In areas where agaves are plentiful, only the leaf-bases are used. In other areas, the hearts are also used. The mescal is thoroughly mashed in a trough or hollow rock with a large mallet cut from the limb of an oak (*Quercus* spp.). The juice is collected and strained, first through a coarse basket, then a cloth. After straining, the sweet juice is cooked in a large pot by women, until all of the impurities have come to the top and are skimmed off. Following the cooking, the juice is placed in a large-mouthed pot to cool and then put into a fermenting pot, "sicolí ronela" (Spanish: botija), where it is left for two or three days. The process can be speeded up by adding the juice of sprouted corn (*Zea Mays*) that has been ground, cooked

and strained. Water is added if the "imé" juice is too strong. When the bubbling of the fermenting process begins to slow down, a handful of ground wheat (*Triticum aestivum*) is added. Then, within five to six hours, the "suguí" is ready to drink. If the drink is not to be used for several days, the pot is sealed with a board and mud. This will keep the drink from going bad for six to eight days. *Agave bovicornuta* is said to make a stronger "suguí" than the other species. *A. americana* and *A. vilmoriana* are the only species not used for making the fermented drink.

Tarahumaras also dry the roasted mescal so that it will last five to six months (during the dry season). The outer fibres are removed from the cooked leaf-bases and the meat is mashed, as when making "suguí", and then ground on the "majtá" (Spanish: metate). It is then shaped into a cylindrical cheese form and placed in the sun to dry for a week. This "mesagoli" or "imé cha'poli", mescal bread, is especially good food for long trips. It is carried in a bag of "cobisi" (Spanish: pinole), toasted corn grain that is ground dry into a powder and later mixed with water to drink, and used as a trail food. *A. pacifica* is not used to make "mesagoli", since it is not so sweet, has less meat and the fibres are harder to chew.

The emergent flower stalks, "balilá" (Spanish: quiote), are eaten as well. A young, tender stalk can be cut from the plant and roasted on coals. Then it is peeled and eaten. The taste is similar to that of the squash. It can also be chopped up, boiled, and mixed with the whey left over from making ranch-style cheese. When a stalk has elongated about a yard, the top foot is cut off and the remainder is peeled and roasted in the pit-oven along with mescal hearts and leaf-bases. The decapitated plant is allowed to grow and is cut the following year for pit-baking when it is sweeter. In other parts of the Tara-

humara region, the prepared stalks are eaten with "gue'-hualí" (Spanish: esquiate), toasted corn ground with water, and "cobisi", but this practice is not common in the western region. The stalks of species of the subgenus *Agave* are eaten, while those of the members of subgenus *Littaea* are not because of their bitterness or small size.

If the stalks be allowed to develop, the unopened flowers with the inferior ovaries removed are cooked and washed to remove the bitter constituent. The cooked flowers can be eaten boiled, fried or made into tortillas. The sweet nectar is likewise gathered with a small tube for consumption. The flowers of *Agave bovicornuta*, *A. pacifica*, *A. Shrevei* and *A. Wocomahi* are eaten. The flowers of *A. bovicornuta* are preferred as food because of their better taste and as they are available when there is little other food. On the other hand, flowers of *A. Wocomahi*, which appear during the rainy season, are not often collected, since there are many other preferred greens (Spanish: quelites) available at that time.

Tortillas made from the perianth of the maguey flowers are especially valued by Western Tarahumara. The unopened flowers are cut from the large inflorescence. Usually a hooked pole is used to gather the flowers, so that the stalk is not broken, and the underdeveloped flower buds are allowed to develop for future gathering. The flowers are put on the house roof and collected early the next morning, when they are much sweeter. They are cooked well and washed overnight in the arroyo to remove the bitterness. The next day they are ground with lime-cooked maize, or "najpili" (Spanish: nixtamal), and made into tortillas. Some cooked flowers are retained for later frying to be eaten with tortillas.

Fibre is extracted from the leaves of *Agave multifilifera* and *A. pacifica*. The larger leaves are cut, beaten

and placed in water. The tissue surrounding the fibre bundles rots away. The resulting fibres are washed in the arroyo and commonly used in making lassos and domestic rope.

Stupefying fish with agaves is well known among the Tarahumara (cf. Gentry, 1972: 11, 89). The Western Tarahumara use *Agave Vilmoriniana*, which is rich in sapogenins, and *A. bovicornuta* and *A. Wocomahi*, the toxic constituents of which are unknown, to stupefy fish trapped in rock enclosures in the rivers. The plants are mashed on a rock, the juices are allowed to drain into the river and, finally, the mashed plants are thrown into the water. Several plants are needed rapidly to stupefy the trapped fish which, upon reaching the surface, are collected and prepared.

The crushed leaves of *Agave Vilmoriniana*, which is rich in the sapogenin smilagenin, are prized as soap for bathing and washing clothes, wool, blankets and dishes. Not all "ahué" leaves are good for washing. The whiter leaves are chosen over the greener ones which produce too strong a soap, especially for washing hair. Another method of selection is to twist the end of the leaf. If it breaks, that leaf is not used.

Ritual curing with agaves is important to the Tarahumara ceremonies (Lumholtz, 1902: 321–322, 363). Small plants of *Agave Shrevei* are placed in pots of water in front of the cross during fertility rites for sheep and goats and in ceremonies for the dead.

Discussion

About 300 years ago, the Tarahumara retreated westward and assimilated various tribes of close cultural and linguistic affiliations (Pennington, 1936: 8, 9, 229, 230, Map I). Today they number about 50,000 (Pennington, 1963: preface). The Western Tarahumara are geographi-

cally isolated from the mainstream Tarahumara and live east of the Guarijio (Warihio). They number fewer than 10,000 (Burgess, 1970: 64).

The Western Tarahumara recognize two groups of *Agave*[7]. They recognize the group "imé" (subgenus *Agave*) through its leaf with terminal and marginal spines and through the paniculate inflorescence. The "imé" group includes: "galime" (*A. americana* var. *expansa*), "sa'pulí" (*A. bovicornuta*), "gusime" (*A. pacifica*), "o'tosá" (*A. Shrevei*), and "ojcome" (*P. Wocomahi*). The introduced succulent, *Aloe vera* (Liliaceae), superficially resembling the maguey plant, is not widely considered an "imé" although it is called "imé me'tagochi". The second group (subgenus *Littaea*) is recognized through its leaf with a terminal spine and smooth margin and its racemose inflorescence. This group includes "chahuí" (*A. multifilifera*), "ri'yéchili" (*A. polianthiflora*) and "ahué" (*A. vilmoriana*). The group carries no generic term. Some Western Tarahumara include "chahuí" and "ra'yéchili" in the "imé" group because they are pit-baked and eaten.

There is a striking similarity and contrast in the recognition of the species of *Agave* among the Western Tarahumara, the Guarijio to the west and the Tarahumara to the east. It may be explained by the geographical distribution of the magueys and, in part, by the historical past. Table II summarizes the names of the eight species of *Agave* occurring in the Western Tarahumara region.

In subgenus *Littaea*, *Agave multifilifera* and *A. Vilmoriniana* are similarly recognized and domestically used by all three groups. One possible explanation is that the

[7] The Spanish word, "mescal", is locally used for the plants of *Agave*, but in other parts of Mexico this term is applied to a distilled beverage made from the *Agave* plant.

leaves and fibres of "chahuí" and the sapogenin-rich leaves of "ahué" can be easily transported and traded throughout the area. On the other hand, food and fermented beverage made from the members of subgenus *Agave* are prepared and consumed near dwellings and can not easily be transported (except mescal bread). *A. polianthiflora* is presently known only from Western Tarahumara region and adjacent Sonora. *A. americana* var. *expansa* is not reported from the Guarijio or Tarahumara regions.

Another significant point is that the species of *Agave* here discussed are commoner on the western slopes and barrancas of the Sierra Madre Occidental. The diversity of species of subgenus *Agave* is greater toward the west (cf. Gentry, 1972). The increased diversity of "imé" encountered by the westward moving ancestors of Western Tarahumara could be handled by an expanded nomenclature borrowed from an assimilated tribe, such as the Guazapar. The language of the Guazapar was said to be the same as Guarijio, although it resembled Tarahumara (Pennington, 1963: 9).

Botanical List of *Agave*

Subgenus *Agave*

Agave americana L. var. *expansa* (Jacobi) Gentry, U.S.D.A., Agric. Handbook no. 399, p. 80. 1972.
Western Tarahumara: GALIME (house maguey)
Mexican: mescal maguey

This large maguey, cultivated near houses, produces easily transplanted sucker shoots or "ranala" (Spanish: hijos). Its antiquity among the Western Tarahumara is unknown, and it is not reported from any other nearby regions of southwestern Chihuahua and adjacent Sonora. Gentry (1972: 84) suggests that it was introduced north-

ward into Sonora and southwestern United States, probably as an ornamental, after 1850.

The bases of large leaves, pit-baked and eaten or prepared as mescal bread, are sweet, bland and lack fibres. One large plant usually provides sufficient material to fill a large baking-pit. Since other parts of the plant—the stalk, flowers and heart—are bitter, they are not consumed.

SPECIMEN: CHIHUAHUA: Municipio de Guazapares, Rocoroibo, ca. 6000 ft. Cultivated plants about 6–8 feet high near governor's house, associated with spineless *Opuntia*, apple and peach trees. Nov. 10, 1973. Bye and Burgess 5827.

OBSERVATION (by R. Bye):

CHIHUAHUA: Municipios de Guazapares y Chinipas, Wasachi, ca. 6000 ft. A recently transplanted linear plantation near walls of a ranchito in the open flat above arroyo. July 23, 1974.

Agave bovicornuta Gentry, Carnegie Inst. Wash. Pub. 527, p. 92. 1942.

Western Tarahumara: SA'PULÍ (meat barranca: meaning uncertain)

Mexican: mescal lechuguilla

This attractive maguey is found in the middle zone of the barrancas associated with oaks (*Quercus* spp.). The flowers, well washed to remove the bitterness, are eaten cooked or in the form of tortillas and are preferred to those of other species in making tortillas. The hearts are baked and used in preparing a strong "suguí" which is said to be similar to "pisto", the local Mexican distilled alcohol from *Agave* and *Yucca*. The caustic juice of the leaves causes a burning irritation, followed by white blisters, on sensitive skin. The plant is employed to stupefy fish.

SPECIMEN: CHIHUAHUA: Municipios de Guazapares y Chinipas, between Cusárare and Nopalero, ca. 3500 ft. Scattered plants on rocky slopes of the barranca associated with oaks (*Quercus* spp.) and below the mixed oak and pine forests. Nov. 8, 1973. Bye, Burgess and Mares 5806.

Observation (by R. Bye):

Chihuahua: Municipios de Guazapares y Chínipas, between Wasachi and La Paz, ca. 5000. Scattered plants in the lower section of the mixed oak and pine forest. The leaves are a light yellow-green. July 23, 1974.

Agave pacifica Trel., U.S. Natl. Herb. Contrib. 23: 118. 1920.

Western Tarahumara: GUSIME (maguey of the woods or stick maguey)
Mexican: mescal del monte (wild plant)
mescal casero (cultivated plant)

Found in the lower parts of the arid sub-tropical barrancas in short thorn forest, *Agave pacifica* produces sucker shoots which are transplanted near dwellings in the lower oak (*Quercus albocincta*) zone of the middle barranca zone. Considered the most delicious and difficult to collect in the field, this species is often grown near the houses. It also became popular with the Spaniards and Mexicans who settled in the deep canyons and later transplanted and cultivated it.

The hearts of the cultivated plants are larger than those of the wild plants. The baked hearts are sweet and consumed baked or in the form of fermented drink. The flowers are eaten cooked or in the form of tortillas. The fibres from the leaves provide cordage and thread.

Specimen: Chihuahua: Municipios de Guazapares y Chinipas, Cusárare, ca. 3000 ft. Cultivated plants, whose suckers originated from the wild in the lower parts of the barranca, in a hollow at the base of a field "trinchera" or stone retaining wall near a ranchito. Plants about 5 feet high with the "quiotes" cut off. Associated with such woody plants as *Ipomoea arborescens* and *Randia* sp. Nov. 8, 1973. Bye, Burgess and Mares 5796.

Observation (by R. Bye):

Chihuahua: Municipios de Guazapares y Chinipas, below La Paz, ca. 3500 ft. Cultivated plants along a stone fence and margin of field near house surrounded by a peach orchard. In the lower oak (*Quercus albocincta*) zone. July 25, 1974.

Agave Shrevei Gentry, Carnegie Inst. Wash. Pub. 527, p. 95. 1942.
Western Tarahumara: o'tosá (white, plural form)
Mexican: mescal blanco

This whitish appearing plant is scattered in open areas in the middle and upper zones of the barrancas in the oak and mixed oak and pine vegetation. The hearts are pit-baked for eating or are employed in making mescal bread or a fermented drink. The stalks are also cooked for food. Small plants are used in curing and in death ceremonies.

SPECIMEN: CHIHUAHUA: Municipios de Guazapares y Chinipas, Nopalero, ca. 4000 ft. Small scattered plants on open, rocky slope with mixture of oaks (*Quercus* spp.), pines (*Pinus* spp.) and *Nolina matapensis*. Some plants with "quiotes" removed. Nov. 9, 1973. Bye and Burgess 5813.

Agave Wocomahi Gentry, Carnegie Inst. Wash. Pub. 527, p. 96. 1942.
Western Tarahumara: OJCOME (pine maguey)
Mexican: mescal verde

A small maguey, *Agave Wocomahi* is found scattered in rock crevices in the sierras among pines. Baked hearts can be used to make "suguí" and "mesagoli", although some hearts are said to have a bad taste and are not ingested. The flowers are an acceptable food but are not eaten, as they appear at a time when there is an abundance of other greens.

SPECIMENS: CHIHUAHUA: Municipios de Guazapares y Chinipas, Nopalero, ca. 4000 ft. Few scattered plants on open, rocky slope with a mixture of oaks (*Quercus* spp.) and pines (*Pinus* spp.). The plants are commoner above. Nov. 9, 1973. Bye and Burgess 5812.—Municipio de Guazapares, Rocoroibo, ca. 6000 ft. On rocky, open slope above arroyo with mixed oaks (*Quercus* spp.), pines (*Pinus Engelmannii* and *P. ponderosa*) and madroños (*Arbutus* spp.). This plant was more robust than usual because of the moist site. Nov. 10, 1973. Bye and Burgess 5835.

Subgenus *Littaea*

Agave multifilifera Gentry, U.S.D.A., Agric. Handbook no. 399, p. 46. 1972.

Western Tarahumara: CHAHUÍ

A medium sized plant, "chahuí" grows in rock outcrops in the upper zone of the barrancas in the mixed oak and pine vegetation. The hearts and leaf bases are pit-baked, eaten or made into "mesagoli" and "suguí". The leaves are an important source of fibre.

SPECIMENS: CHIHUAHUA: Municipios de Guazapares y Chinipas, near Nopalero, ca. 4000 ft. In crevices of rocks in the mixed oaks (*Quercus* spp.) and pines (*Pinus* spp.). Nov. 8, 1973. Bye, Burgess and Mares 5783. —Municipio de Guazapares, along ridge above Nopalero, ca. 5000 ft. Few scattered plants in rock crevices on outcrops in mixed oaks (*Quercus* spp.), pines (*Pinus* spp.) and *Arctostaphylos pungens*. Nov. 9, 1973. Bye and Burgess 5819.

Agave polianthiflora Gentry, U.S.D.A., Agric. Handbook no. 399, p. 51. 1972.

Western Tarahumara: RI'YÉCHILI

This small, attractive and infrequent maguey grows on partially open rocky slopes and outcrops in the mixed oak and pine forest in the upper zone of the barrancas. The hearts and leaf bases were formerly eaten as food and employed to make a fermented drink.

SPECIMENS: CHIHUAHUA: Municipios de Guazapares y Chinipas, above Nopalero, ca. 4500 ft. Few scattered plants in whiterock crevice in open spots with oaks (*Quercus* spp.), pines (*Pinus* spp.) and *Arctostaphylos pungens*. "Quiotes" about one foot high. Nov. 7, 1973. Bye, Burgess and Mares 5779. — Below Wasachi, ca. 5500 ft. Few scattered plants on open, moist rocky surface with mixed oaks (*Quercus* spp.) and pines (*Pinus* spp.). "Quiote" about one foot high with flowers rose. July 23, 1974. Bye, Burgess and Mundy 6414.

Agave Vilmoriniana Berger, in Fedde Repert. Spec. Nov. Reg. Veg. 12: 503. 1913.

Western Tarahumara: AHUÉ

Mexican: amole

These spider-like plants cling to the vertical rock walls of the barrancas from the lower arid sub-tropical region to the higher cooler region. The plant is not eaten. The leaves provide a soap for bathing and washing clothes, wool blankets and utensils, while the macerated plants are used as a fish poison.

Specimen: Chihuahua: Municipios de Guazapares y Chinipas, between Nopalero and Cusárare, ca. 3500 ft. Scattered plants found on protected vertical walls. Nov. 8, 1973. Bye, Burgess and Mares 5805.

Conclusions

Eight species of *Agave* are recognized and used by the Western Tarahumara. The members of subgenus *Agave*, generically called "imé", are distinguished from the members of subgenus *Littaea*. The two groups are differentiated on gross morphology of leaves and inflorescences. Some Western Tarahumara include all of the magueys that are pit-baked under "imé".

Each species of "imé" has a name which reflects the habitat preference or a characteristic of the species. Although the Tarahumara to the east also recognize subgenus *Agave*, "mé", as different from that of subgenus *Littaea*, the Western Tarahumara recognize a greater diversity of species, and their names are similar to Guarijio names. In subgenus *Littaea*, two of the three species on the eastern slopes of the Rio Chínipas area have names in common with Guarijio names to the west and Tarahumara names to the east. The third species, *A. polianthiflora*, has not been reported east of the Western Tarahumara region.

There is a greater specific diversity of *Agave* on the western slopes of the Sierra Madre Occidental than on the eastern slopes. The similarity of the Western Tarahumara names to those of the Guarijio for the members of subgenus *Agave* may be explained, in part, by the western movement of ancestors of the Tarahumara from

the eastern foothills and uplands to the western uplands and barrancas. Subsequent assimilation of former tribes of that region may have included additions to Tarahumara *Agave* nomenclature. The similar names for *A. multifilifera* and *A. Vilmoriniana* may reflect the wide familiarity of the leaf, fibre and soap products of the plants. These plants and products would probably be encountered in travel, transport and trading. The other species provide food and beverage prepared and generally eaten near dwellings and usually not traded or offered to strangers.

Two species of *Agave* produce sucker shoots, and the Western Tarahumara have used this characteristic to advantage in their propagation. The antiquity of propagation of *A. americana* var. *expansa* is unknown, but its presence in northwestern Mexico is thought to be only a century old. The much valued *A. pacifica* has been propagated closer to the locality of its preparation and consumption and at higher elevations than its normal range.

Specimens and Photographs

Voucher specimens were collected, prepared and identified by R. Bye. Dr. H. S. Gentry was very helpful in instructing him in the preparation and identification of sterile and fertile plants and specimens. The specimens are deposited in the Economic Botany Herbarium of Oakes Ames in the Botanical Museum, Harvard University (ECON). Duplicates will be distributed to the Universidad Nacional Autónoma de México (MEXU), Gray Herbarium of Harvard University (GH), and the Herbarium of H. S. Gentry in Phoenix, Arizona.

All photographs were taken by Don Burgess.

TABLE I

Western Tarahumara *Agave*

	Range	*Elevation*	*Ecological Association*[1]
subgenus *Agave*			
americana var. *expansa*	w Mexico to sw U.S. Jalisco to Ariz. & Calif.	(100)–6000 ft.	cult. (PO)
bovicornuta	nw Sierra Madre Occidental Son., Chih. & Sin.	3000–6000 ft.	O–PO
pacifica	nw Mexico Son., Chih. & Sin.	(0)–3500 ft.	sT (cult.sT–O)
Shrevei	nw Mexico Son. & Chih.	3000–6000 ft.	O–PO
Wocomahi	nw Sierra Madre Occidental Son., Chih., Sin. & Dgo.	5000–7500 ft.	PO–P
subgenus *Littaea*			
multifilifera	nw Sierra Madre Occidental Chih.	5000–6000 ft.	O–PO
polianthiflora	nw Sierra Madre Occidental Son. & Chih.	4000–6000 ft.	O–PO
Vilmoriniana	w Mexico Son. & Chih. to Jalisco & Aguascalientes	2000–4000 ft.	sT

[1]—cult.=cultivated; O=oak forest (*Quercus* spp., e.g. *Q. albocincta*); P=pine forest (*Pinus* spp., e.g. *P. Engelmannii, P. arizonica, P. ponderosa*); PO=pine-oak forest; sT=arid sub-tropical forest with *Ipomoea arborescens, Bursera* spp. and various woody Leguminosae.

TABLE II

Nomenclature of Western Tarahumara *Agave*

Species	Guarijio[1]	W. Tar.	Tarahumara[2]
subgenus *Agave*	—	imé	mé
americana var. *expansa*	0	galime	0[3]
borvicornuta	sapuri	sa'pulí	—[3]
pacifica	—	gusime	ku'urí
Shrevei	totosá	o'tosá	mé[4]
Wocomahi	wocomahi	ojcome	mésagori
			mé
subgenus *Littaea*			
multifilifera	chahuí	chahuí	chawí (or chahuí)
polianthiflora	taiehcholi	ri'yéchili	0[3]
Vilmoriniana	hauwé	ahué	awé (or ahué)

[1]—Guarijio (or Warihio) names, from Gentry (1942 and 1963).

[2]—Tarahumara names collected by R. Bye in the region of Creel-Barranca del Cobre–Barranca de Batopilas.

[3]—Western Tarahumara names, plant photographs and specimens not recognized by native informants.

[4]—One informant, who grew up west of Cerocahui near Western Tarahumara region but now lives in Barranca de Batopilas, recalled "retosá" as the name used for this maguey in his youth.

"0" = species not recorded from the area.

"—" = data uncertain.

Acknowledgments

We would like gratefully to acknowledge the help and encouragement of our families and friends in the United States and Mexico who generously supported our studies. A special thanks is extended to those Tarahumara who through friendship shared their knowledge. Without the continual encouragement and critical evaluation of Professor C. W. Pennington, Department of Geography, Texas A & M University, the research upon which these notes are based might have faltered. Professor Richard Evans Schultes, Botanical Museum, and Dr. Bernice Schubert, Arnold Arboretum, kindly read the manuscript and offered suggestions. Robert Bye would like personally to thank Dr. Margaret A. Towle, Curator of the Ethnobotanical Laboratory of the Botanical Museum, for her support and valuable suggestions. Financial support between 1971 and 1974 was generously extended to Robert Bye by the Botanical Museum and the Department of Biology, Harvard University, the National Geographic Society and the National Science Foundation Grant GB-35047 for Improvement of Doctoral Dissertation Research.

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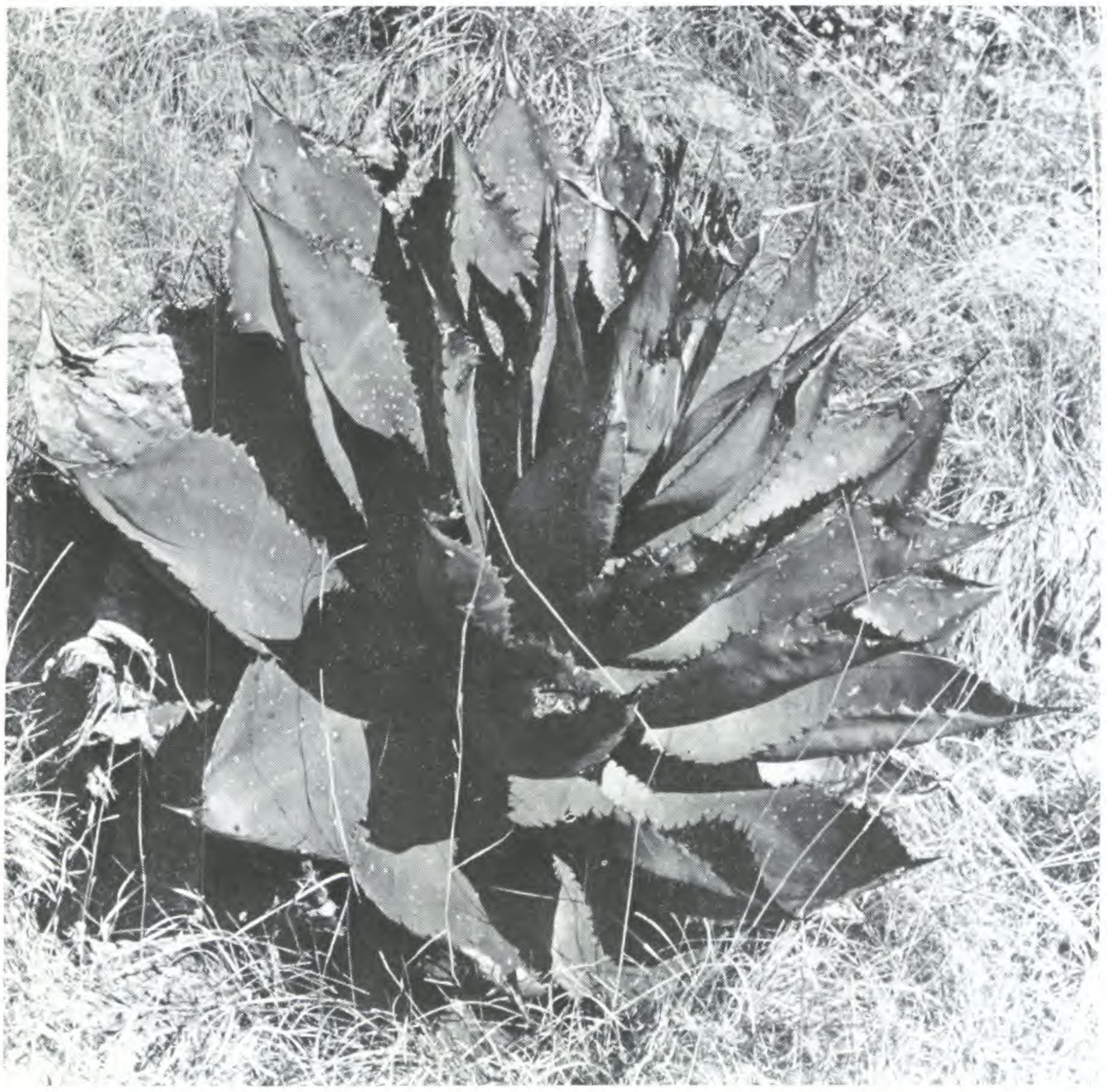
ILLUSTRATIONS

Plate XVII



Agave americana var. *expansa* ("galime")
Mature leaves about 1½ feet long.

Plate XVIII



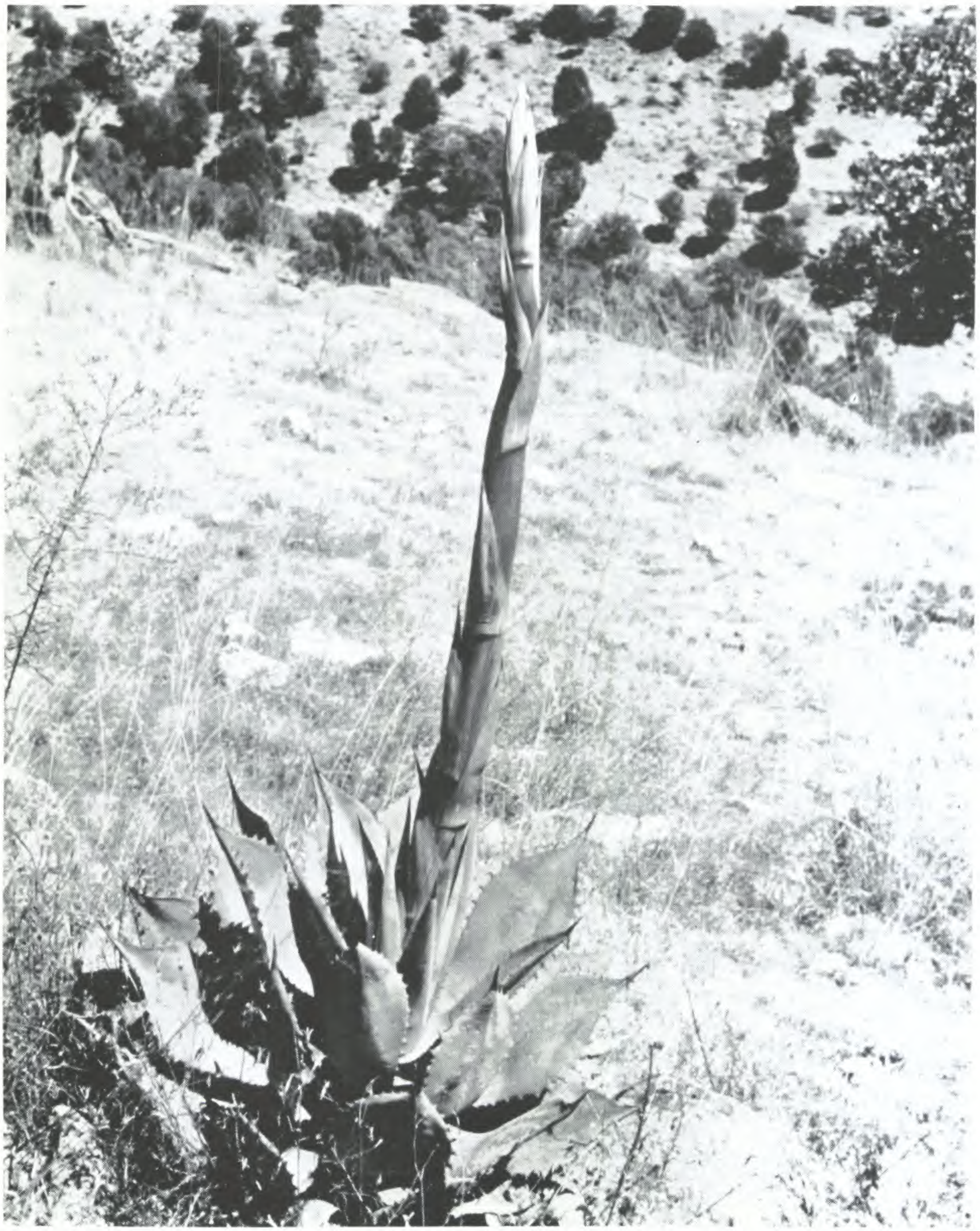
Agave bovicornuta ("sa'puli")
Mature leaves about 2 feet long.

Plate XIX



Agave pacifica ("gusime")
Mature leaves about 3 feet long.

Plate XX

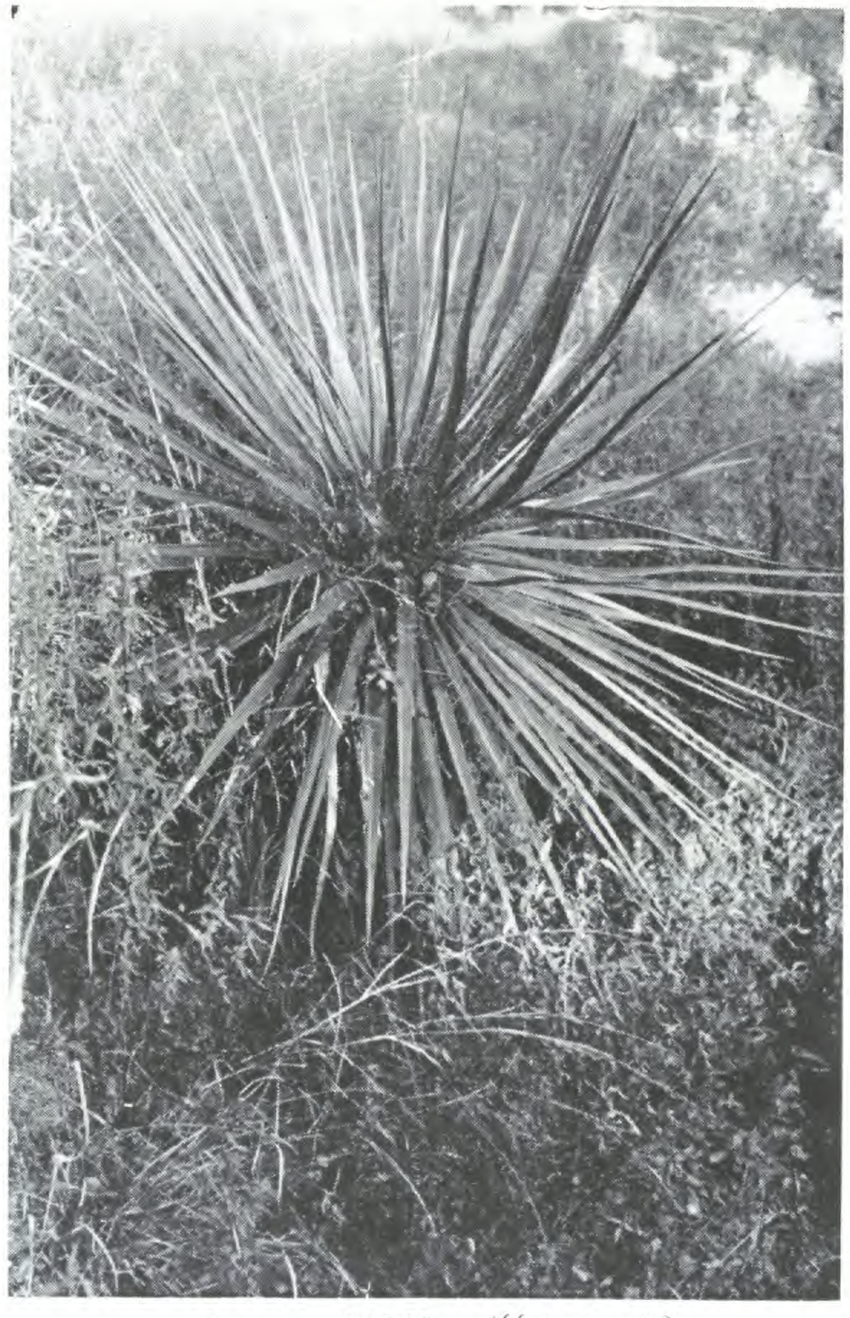


Agave Shrevei (“o’tosá”)
Mature leaves about $1\frac{1}{2}$ feet long.

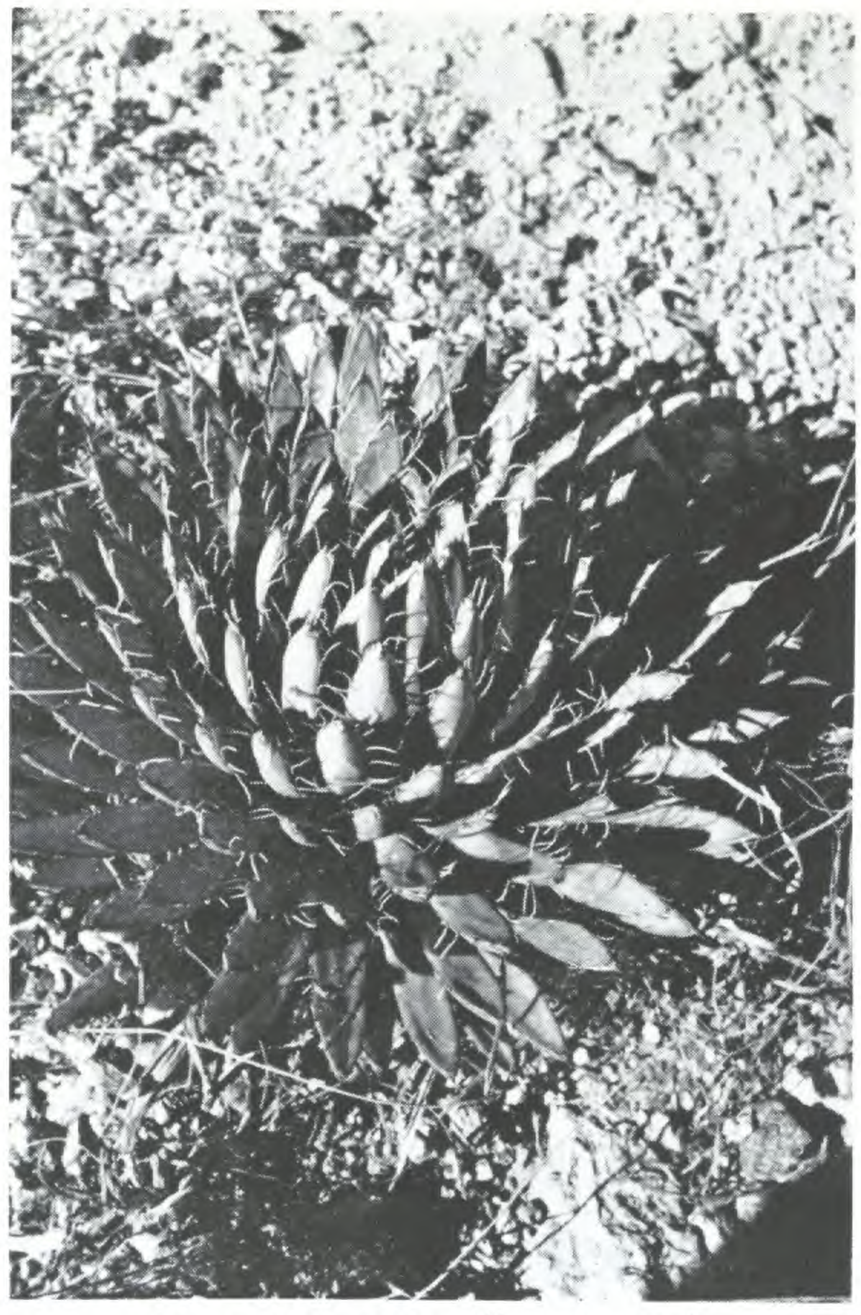
Plate XXI



Agave Wocomahi ("ojcome")
Mature leaves about 1 foot long.



Agave multifilifera (''chahuí'')
Mature leaves about $2\frac{1}{2}$ feet long.



Agave polianthiflora (''ri'yéchili'')
Mature leaves about 4 inches long.

Plate XXIII



Agave Vilmoriniana ("ahuć")
Mature leaves about 5 feet long.

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NUTRITIONAL VALUE OF COCA

BY
JAMES A. DUKE[1], DAVID AULIK[2] AND
TIMOTHY PLOWMAN[3]

Leaves of wond'rous nourishment
Whose Juice Succ'd in, and to the Stomach tak'n
Long Hunger and long Labour can sustain;
From which our faint and weary Bodies find
More Succor, more they cheer the drooping Mind,
Than can your Bacchus and your Ceres join'd.

—ABRAHAM COWLEY in Mortimer's
History of Coca

Abstract. Coca leaves (*Erythroxylum Coca* Lam.) from Chapare, Bolivia, compared to an average of 50 other Latin American vegetable products, are higher in calories (305 per 100 g compared to 279), protein (18.9 g: 11.4 g), carbohydrate (46.2 g: 37.1 g), fiber (14.4 g: 3.2 g), ash (9.0 g: 2.0 g), calcium (1540 mg: 99 mg), phosphorus (911 mg: 270 mg), iron (45.8 mg: 3.6 mg), vitamin A (11,000 IU: 135 IU), and riboflavin (1.91 mg: 0.18 mg). Coca was lower than the average for the 50 plant foods in oil content (5.0 g per 100 g compared to 9.9 g), moisture (6.5 g: 40.0 g), thiamin (0.35 mg: 0.38 mg), niacin (1.3 mg: 2.2 mg), and ascorbic acid

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(1.4 mg: 13.0 mg). Ingestion of 100 g of the Bolivian coca leaves tested would more than satisfy the Recommended Dietary Allowance for reference man and woman of calcium, iron, phosphorus, vitamin A, vitamin B_2 and vitamin E. However, the leaves also contain alkaloids and may harbor pesticide residues.

Unable to establish the nutritional value of coca leaves (*Erythroxylum Coca* Lam.) after consulting many sources, we obtained a one kilogram sun-dried sample from San Francisco, Province of Chapare, Bolivia, in June, 1974. Using methods listed in References and Notes, we obtained the following nutritional analysis (1): calories, 305 per 100 g; moisture, 6.5 g; protein, 18.9 g; carbohydrate, 46.2 g; fat, 5.0 g; vitamin A, 11,000 IU (as beta-carotene); vitamin C, 1.4 mg; vitamin B_1 (thiamine), 0.35 mg; vitamin B_2 (riboflavin), 1.9 mg; niacin, 1.29 mg; calcium, 1,540 mg; iron, 45.8 mg; vitamin E, 43.5 IU (as d-alpha tocopherol); vitamin B_6, 0.508 mg; folic acid, 0.130 mg; vitamin B_{12}, 1.05 mcg; iodine, 5.0 mcg; phosphorus, 911 mg; magnesium, 213 mg; zinc, 2.70 mg; copper, 1.21 mg; biotin, 0.0863 mg; pantothenic acid, 0.684 mg; and sodium, 40.6 mg. The analysis of other elements by emission spectroscopy yielded the following amounts: potassium, 2.02 g per 100 g; aluminum, 39.5 mg; barium, 4.67 mg; strontium, 9.71 mg; boron, 5.35 mg; zinc, 2.70 mg; manganese, 6.65 mg; and chromium, 0.359 mg.

Surprised by the high values, especially in calcium and iron, we tabulated nutritional averages for other plant products ingested by Latin Americans (Table 1). Compared with an average from ten nuts and oilseeds (2) (*Sesamum indicum*, *Terminalia Catappa*, *Prunus Amygdalus*, *Corylus* spp., *Arachis hypogaea*, *Castanea* spp., *Bertholletia excelsa*, *Helianthus annuus*, *Anacardium occidentale* and *Inga* spp.), the San Francisco coca leaves

were higher in protein, carbohydrate, ash, calcium, phosphorus, iron, vitamin A and riboflavin. Coca was lower in calories, moisture, fat, thiamin, niacin, and vitamin C. Compared with an average of ten pulses (*Vigna unguiculata*, *Cicer arietinum*, *Cajanus Cajan*, *Pisum sativum*, *Vicia Faba*, *Phaseolus vulgaris*, *Dolichos Lablab*, *Lens* spp., *Glycine Max* and *Lupinus mutabilis*), coca was equal in fat; higher in fiber, ash, calcium, phosphorus, iron, vitamin A, and riboflavin; and lower in calories, moisture, protein, carbohydrate, thiamin, niacin, and vitamin C. Compared with an average of ten cereals (*Amaranthus caudatus*, *Oryza sativa*, *Avena sativa*, *Chenopodium pallidicaule*, *Chenopodium Quinoa*, *Hordeum vulgare*, *Secale cereale*, *Coix Lachryma-jobi*, *Zea Mays* and *Triticum aestivum*), coca was higher in protein, fat, fiber, ash, calcium, phosphorus, iron, vitamin A, riboflavin, and vitamin C; lower in calories, moisture, carbohydrate, thiamin, and niacin. Compared with an average of ten vegetables (*Canna edulis*, *Capsicum* spp., *Allium sativum*, *Arracacha xanthorrhiza*, *Ipomoea Batatas*, *Cyclanthera pedata*, *Cucurbita maxima*, *Allium Cepa*, *Brassica oleracea*, and *Tropaeolum tuberosum*) and an average of ten fruits (*Persea americana*, *Ananas comosus*, *Musa sapientum*, *Cocos nucifera*, *Passiflora mollissima*, *Annona Cherimolia*, *Prunus persica*, *Fragaria* spp., *Annona muricata*, and *Ficus Carica*), coca was high on all counts except moisture and vitamin C.

The present coca analyses are comparable to an average of three earlier coca analyses from Bolivia (3) and three recently reported from Peru (4). Frequent reports that coca has no nutritional value should be re-evaluated in view of these findings. The comparatively high nutritional values for coca are due partly to the fact that the leaves are dry (less than 10% moisture) when purchased, whereas most other foods are higher in moisture.

In most areas where it is used, coca should be considered a masticatory since it is not wholly consumed by the chewer. Typically, the leaves are first moistened in the mouth with saliva, then formed into a quid with the tongue and pushed into the upper cheek cavity. They are then sucked to extract the rich, green juice which is subsequently swallowed. Usually some form of alkali is added to facilitate this extraction. When the chew is exhausted, it is usually spat out. Thus, the full complement of nutrients present in the coca leaf is not consumed entirely, and the nutritional amounts reported here may be somewhat higher than the amounts actually ingested by the coca chewer. To our knowledge, no studies have been made on the nutritional value of the swallowed extract.

In the Colombian Amazon, a variation of coca use is practiced by several tribes. Coca leaves are pulverized to a fine powder along with the ashes of *Pourouma* or *Cecropia* leaves. The mixture is placed in the mouth on the gums and inner cheeks and is eventually swallowed (8). In this case, and in instances where a coca chewer swallows his quid, the full complement of the leaf nutrients would be ingested. There is essentially no difference here between the use of coca and the direct consumption of food, in terms of nutrition.

The amounts of coca consumed may contribute significantly to the diets of Andean coca chewers (5). If the average chewer ingests 60 g of Peruvian coca per day (5,6), he more than satisfies his requirements for calcium, even without the supplemental ash or lime usually added to the coca quid (6). No other food in the INCAP Food Composition Tables (2) approaches coca for calcium content (1,789 mg). Other food items are high in calcium: sesame seeds, 1212 mg per 100 g; spinach flour, 488 mg; leaves of *Laurus nobilis*, 803 mg; leaves of *Justicia pecto-*

ralis, 663 mg; West Indian Almond (*Terminalia Catappa*), 497 mg; powdered skim milk, 1,301 mg; whole milk, 921 mg; and alligator meat, 1,231 mg; but none equals coca. Few food plants can satisfy the calcium and iron in the Recommended Dietary Allowance (RDA) of reference man ingesting 100 g. The Bolivian coca leaves reported here do satisfy the RDA.

Coca leaves may, however, contain 0.25 to 2.25% toxic alkaloids, including benzoylecgonine, benzoyltropine, cinnamylcocaine, cocaine, cuscohygrine, dihydroxytropane, hygrine, hygroline, methylcocaine, methylecgonidine, nicotine, tropacocaine, and α - and β -truxilline (4,7). These alone could make the nutritious coca leaf undesirable as a source of nutrients. The average coca chewer could also ingest 442 mg of copper in a year if the San Francisco leaves are typical; but this amount is not excessive.

Many coca growers in both high (Chapare, Bolivia) and low (Yungas, Bolivia) rainfall areas may use insecticides. The leaves are not intentionally washed, and harvest and curing are timed to avoid rainfall. In considering coca for human consumption, the leaves should be analyzed for insecticide residues.

Although coca leaves contain relatively high levels of certain nutrients, the presence of alkaloids and the possible presence of insecticide residues suggest caution in coca chewing.

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TABLE 1

Nutritional Comparison per 100 g of Coca Leaves with other Latin American Plant Foods.

FOOD ITEM	# in sample	Cal	H_2O g	Prot. g	Fat g	Carb. g	Fiber g	Ash g	Ca mg	P mg	Fe mg	Vit A[1] IU	Thia mg	Rib mg	Nia mg	Vit C mg
San Francisco coca	(1)	305	6.5	18.9	5.0	46.2	14.4	9.0	1540	911	45.8	11,000	0.35	1.91	1.29	1.4
Bolivia coca	(3)	—[2]	8.8	—	1.6	42.4	8.0	5.3	—	—	—	—	—	—	—	—
Peru coca	(3)	—	10.3	18.7	—	—	17.5	4.6	2038	363	7.9	9,000	0.81	1.55	6.17	—
COCA AVERAGE	(7)	—	8.5	18.8	3.3	44.3	13.3	6.3	1789	637	26.8	10,000	0.58	1.73	3.7	1.4
PLANT FOOD AVERAGE	(50)	279	40.0	11.4	9.9	37.1	3.2	2.0	99	270	3.6	135	0.38	0.18	2.2	13.0
Nuts & Seeds	(10)	521	9.9	16.8	36.0	28.2	3.6	3.1	273	522	4.3	17	0.78	0.28	5.2	2.1
Pulses	(10)	354	11.3	25.4	5.0	55.1	5.5	3.3	102	398	7.1	20	0.58	0.24	2.25	1.9
Cereals	(10)	352	11.5	11.7	3.7	71.0	4.0	2.1	74	346	4.8	13	0.41	0.25	2.7	0.8
Vegetables	(10)	74	87.3	1.8	0.4	16.9	1.5	0.9	26	52	1.2	595	0.09	0.05	1.0	31.0
Fruits	(10)	93	79.6	1.2	4.5	14.1	1.4	0.7	20	33	0.8	35	0.05	0.06	0.08	29.0

[1] as beta-carotene

[2] no data

DE PLANTIS TOXICARIIS E MUNDO NOVO TROPICALE COMMENTATIONES XIII

Notes on poisonous or medicinal malpighiaceous species of the Amazon

BY

Richard Evans Schultes

This paper is offered in continuation of a series presenting ethnopharmacological observations made in the northwest Amazon. The malpighiaceous species enumerated in the following pages—all apparently unstudied from the phytochemical and pharmacological points of view—have been found to have interesting applications amongst the Indians of the region.

The identifications of the voucher specimens were made by Dr. José Cuatrecasas of the Smithsonian Institution and are cited and described in his monograph of Colombian Malpighiaceae which appeared in Webbia 13 (1958) 343–664. The drawings herein produced were prepared by Mr. Joshua B. Clark.

The ethnopharmacological observations were made by the writer in the Amazonian basin of Colombia between 1941 and 1954. They are offered in the hope of stimulating research to discover new biodynamic principles or to find new potentially valuable medicinal plants. Research along these lines is especially needed for this family of 60 genera and more than 880 species which has recently been described as "scarcely touched, chemotaxo-

nomically speaking". (Gibbs, R.D. "Chemotaxonomy of Flowering Plants" 3 (1974) 1676–1677.)

The best known members, from the point of view of their phytochemistry, are undoubtedly the several closely allied species of Banisteriopsis—*B. Caapi*, *B. inebrians*, *B. Rusbyana*—employed in northern South America in elaborating the narcotic drink known variously as *ayahuasca*, *caapi*, *natema*, *pinde* and *yajé*. These species contain psychoactive alkaloids—the first two, β-carboline alkaloids; thethird, N,N-dimethyltryptamine(Deulofeu, V. "Chemical Compounds Isolated from Banisteriopsis and Relative Species" in [Ed. D. Efron] "Ethnopharmacologic Search for Psychoactive Drugs" Public Health Service Publ. No. 1645, Washington, D.C. (1967) 393–402).

One hundred and twenty-five years ago, when Spruce collected the type material of *Banisteriopsis Caapi* and described its narcotic use in the northwest Amazon of Brazil, he despatched material for chemical analysis—material which was not analyzed until 1968 (Schultes, R.E., B. Holmstedt and J.-E. Lindgren "De Plantis Toxicariis e Mundo Novo Tropicale III. Phytochemical Examination of Spruce's Original Collection of *Banisteriopsis Caapi*" in Bot. Mus. Leafl. Harvard Univ. 22 (1969) 121–132). Spruce was struck by the presence in this family of such a potent narcotic. In 1852, he wrote: ". . . . I saw, not without surprise, that it belonged to the order Malpighiaceae and the genus Banisteria, of which I made it out to be an undescribed species. . . . My surprise arose from the fact that there was no narcotic Malpighiad on record, nor indeed any species of that order with strong medicinal properties of any kind. . . . The seed [of Bunchosia] is described in books as poisonous, and if it be really so, then it is the only instance, so far as I know, of the existence of any hurtful principle

in the entire family of Malpighiads, always excepting that of the Caapi. Yet strong poisons may lurk undiscovered in many others of the order, which is very large . . . ." (Spruce, R. [Ed. A.R. Wallace] "Notes of a Botanist on the Amazon and Andes" 2 (1908) 421–422).

Banisteriopsis Martiniana (*Juss.*) *Cuatrecasas* var. **laevis** *Cuatrecasas* in Webbia 13 (1958) 502.

Colombia: Comisaría del Amazonas, Vaupés, Río Apaporis, Raudal de Jirijirimo. *H. García-Barriga 13706.*—Same locality. November 25, 1951. *R.E. Schultes et I. Cabrera 14569.*—Comisaria del Amazonas, Río Apaporis, Soratama. August 20, 1951. *Schultes et Cabrera 13615.*

García-Barriga (*Flora Medicinal de Colombia* 2 (1975) 69) has recently reported that *Banisteriopsis Martiniana* var. *laevis* may be used by the Makuna Indians of the middle Apaporis as one source of the narcotic preparation yajé.

Heteropteris riparia *Cuatrecasas* in Webbia 13 (1958) 483.

Colombia: Comisaría del Putumayo, Río Putumayo, Puerto Ospina. Alt. 300 m. "Extensive liana along river's edge." July 1942. *R.E. Schultes 4029.*—Comisaraía del Vaupés, Río Apaporis, Raudal de Jirijirimo. Alt. 250 m. June 12, 1951. *R.E. Schultes et I. Cabrera 12428.*—Comisaría del Amazonas, Río Apaporis, Soratama. June 18, 1951. *Schultes et Cabrera 12654.*—Comisaría del Vaupés, Río Apaporis, Jinogojé (near mouth of Río Piraparaná). Alt. 260 m. "Vine. Flowers yellow." June 5, 1952. *Schultes et Cabrera 16591.*—Same locality. June 8, 1952. *Schultes et Cabrera 16665.*

The bark of this extensive liana is reported in these widely separated localities to be extremely poisonous, but the Indians in the middle Apaporis rasp the bark and prepare a tea which is employed internally in the treatment of gonorrhoea. The Makuna name on the Río Apaporis is *mee-see-gaw.*

Saponins, tannins and phenolic acids have been reported from the genus Heteropteris (Gibbs, loc. cit.).

Heteropteris macrostachya *A. Jussieu* Malpigh. Synop. (1840) 275.

Colombia: Comisaria del Amazonas, Río Apaporis, Soratama. Alt. 250 m. "Bejuco; hojas doradas envés; flores amarillas. Nombre en lengua 'geral' *capitariiva*." August 16, 1951. *R. E. Schultes et I. Cabrera 13533.*

The seeds of *Heteropteris macrostachya* are reputedly taken in a tea by the Taiwano Indians of the Río Kanarí to treat diarrhoea.

It may be significant that the seeds of *Heteropteris suberosa* Griseb., commonly called *sarabatucú*, are similarly employed on the Río Mauhés in the central Amazon of Brazil (Le Cointe, P.: "A Amazonia Brasileira" 3 (1934) 406).

A collection of *Heteropteris macrostachya* from Panamá (*I.M. Johnston 1377*) bears an annotation that the plant is "toxic".

Hiraea apaporiensis *Cuatrecasas* Webbia 13 (1958) 404.

Colombia: Comisaria del Vaupés, Río Apaporis, Raudal Yayacopi (La Playa). August 18, 1952. *R.E. Schultes et I. Cabrera 16969.*—Jinogojé (near mouth of Rio Piraparaná). August 25, 1952. *Schultes et Cabrera 17022.*—Comisaria del Vaupés, Río Piraparaná. August 1952. *H. García Barriga 14215.*

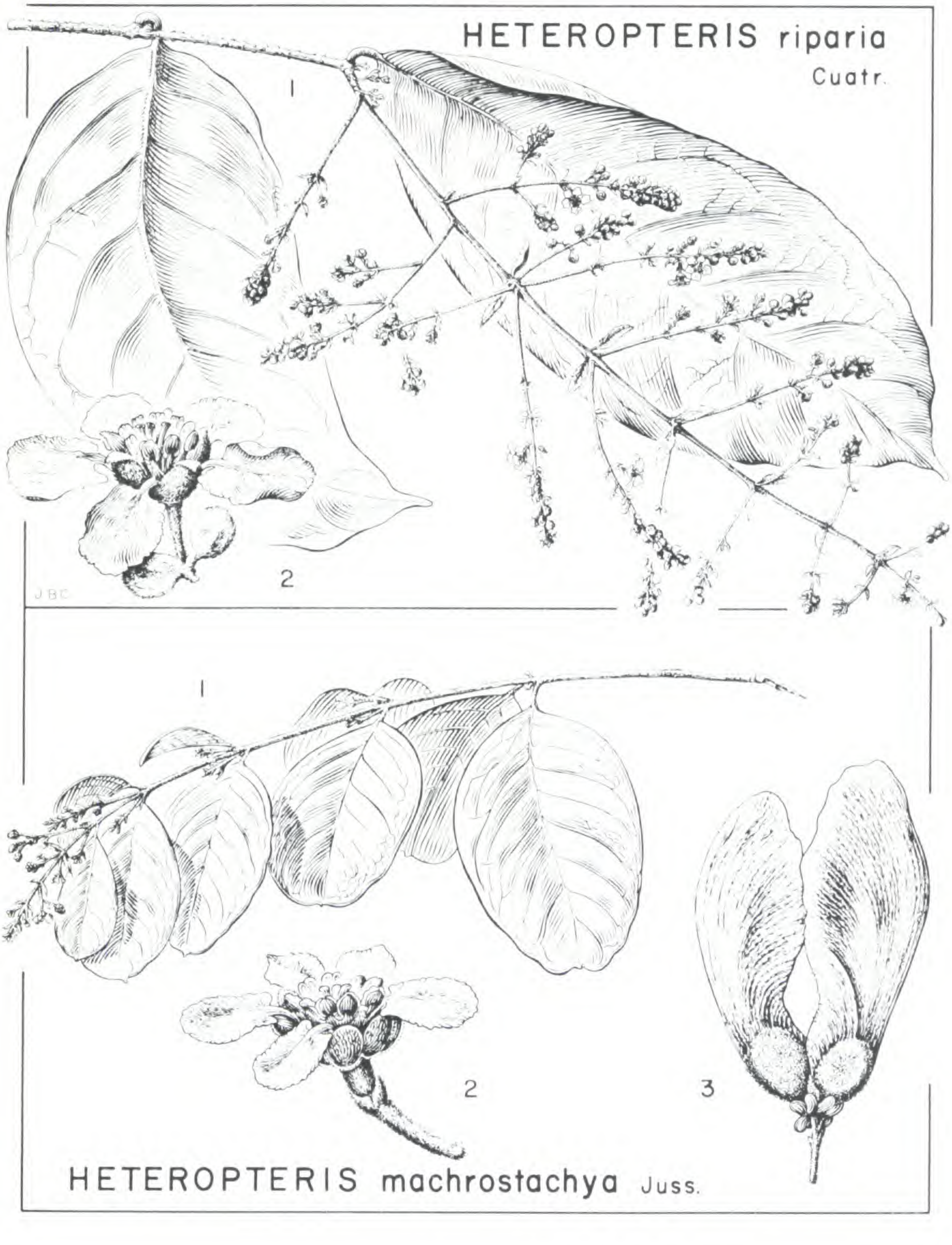
The Maku Indians, who know *Hiraea apaporiensis* as *yé-aing*, employ a tea prepared from the leaves which is valued in the treatment of conjunctivitis.

Hiraea Schultesii *Cuatrecasas* Webbia 13 (1958) 403.

Colombia: Comisaria del Vaupés, Río Apaporis, Raudal Yayacopi (La Playa). March 16, 1952. *R.E. Schultes et I. Cabrera 15996.*

A wash of the leaves of *Hiraea Schultesii* is valued by the Makuna Indians of the middle Apaporis in treating severe conjunctivitis.

Plate XXIV


HETEROPTERIS riparia
Cuatr.
1
2
3
JBC
1
2
3
HETEROPTERIS machrostachya Juss.

Mascagnia glandulifera *Cuatrecasas* Webbia 13 (1958) 365.

COLOMBIA: Comisaria del Amazonas, Río Apaporis, Soratama. July 31, 1951. *R.E. Schultes et I. Cabrera 13208*.—Same locality. August 16, 1951. *Schultes et Cabrera 13594*.

A poultice of crushed and boiled leaves of *Mascagnia glandulifera* is commonly applied to boils and similar infections by Indians of the middle Apaporis.

Saponins have been reported from a species of this genus (Gibbs loc. cit.).

Mezia includens (*Benth.*) *Cuatrecasas* in Webbia 13 (1958) 450.

COLOMBIA: Comisaria del Vaupés, Rio Apaporis, Jinogojé (at mouth of Rio Piraparaná) and vicinity. "Vine. Flowers bright yellow." *R.E. Schultes et I. Cabrera 15691*.

This vine represents one of the medicinal plants with most uses amongst the Makuna Indians of the middle Apaporis. It is unusual that this should be so, in view of the relative scarcity of the plant.

The bark, which contains apparently high concentrations of tannin, is prepared in an infusion which is taken warm in large quantities to treat urinary troubles and to provoke urination. Perhaps because of its diuretic properties, it is employed in the form of a tea in cases of swollen legs—obviously edemas due to age and circulatory ailments.

The root is considered a strong laxative: it is crushed and soaked together with water in which *fariña* (the flour prepared from *Manihot esculenta* has been setting for several hours.

The leaves, boiled for long periods into a tea, provide a strong emetic drink. They are also considered, when applied over the abdomen in the form of a cataplasm, a help in the treatment of what appears to be jaundice.

The Makuna Indians call this vine *ee'-taw-gaw*.

Plate XXV



Tetrapteris mucronata *Cavanilles* Diss. 9 (1790) 434, t. 262.

COLOMBIA: Comisaría del Amazonas, Río Apaporis, Soratama. June 15, 1951. *R.E. Schultes et I. Cabrera 12554.*—Comisaría del Vaupés, Río Apaporis, mouth of Río Pacoa. June 15, 1951. *Schultes et Cabrera 13559.*—Río Apaporis, Jinogojé (near mouth of Río Piraparaná). June 20, 1952. *Schultes et Cabrera 16771.*

The natives of the lower Río Piraparaná prepare a weak type of curare by boiling together for four or five hours the bark of *Tetrapteris mucronata* and of *Strychnos Erichsonii* R. Schomb. (*Schultes et Cabrera 16770*).

Tetrapteris mucronata is said to be "employed by the Karaparana tribe in preparing yajé" (*Schultes et Cabrera 12107*). In this connection, it is of interest to note the report of the narcotic use of a species of *Tetrapteris*, *T. methystica* (*Schultes et Lopez 10184*), in the Rio Negro basin of Brazil (Schultes, R. E. in Bot. Mus. Leafl., Harvard Univ. 16 (1954) 202–205.

Tetrapteris silvatica *Cuatrecasas* Webbia 13 (1958) 425.

COLOMBIA: Comisaría del Vaupés, Río Apaporis, Raudal Yayacopi (La Playa). August 18, 1952. *R.E. Schultes et I. Cabrera 16960.*

The leaves of *Tetrapteris silvatica* are burned by the Makuna Indians, and the ashes, mixed with any oil or grease, are applied to what appear to be fungal patches on the skin. The Makunas refer to this vine as *tee-mee-a-mee-see-ma* and recognize its very close relationship with the following species, *Tetrapteris styloptera.*

Tetrapteris styloptera *Jussieu* in Ann. Sci. Nat., ser. 2 Bot. 13 (1840) 262.

COLOMBIA: Comisaría del Amazonas, Río Igaraparaná, La Chorrera and vicinity. June 1942. *R.E. Schultes 3914.*—Same locality and date. *Schultes 3927.*—Río Apaporis, Soratama and vicinity. August 3, 1951. *R.E. Schultes et I. Cabrera 12880.*—Same locality. August


JBC
MASCAGNIA glandulifera Cuatr.
1
2
3

16, 1951. *Schultes et Cabrera 13573.*—Comisaria del Vaupés, Rio Apaporis, mouth of Río Pacoa. June 17, 1951. *Schultes et Cabrera 12597.*—Jinogojé (near mouth of Rio Piraparaná). June 5, 1952. *Schultes et Cabrera 16591.*—Same locality. June 8, 1952. *Schultes et Cabrera 16667.*—Same locality. June 20, 1952. *Schultes et Cabrera 16778.*—Same locality. September 20, 1952. *Schultes et Cabrera 17600.*—Raudal Yayacopi (La Playa). August 18, 1952. *Schultes et Cabrera 16953.*—Same locality and date. *Schultes et Cabrera 16961.*—Cachivera Jirijirima. November 1951. *H. García-Barriga 13700.*

The Tanimuka Indians on the Río Miritiparaná know this yellow-flowered vine as *wee-po-awk*. The bark is rasped and boiled to prepare an extremely bitter drink taken as a febrifuge.

Amongst the Makunas, the leaves, reduced to ashes, are applied to itching infections of the skin that may be due to fungal growth. The ashes are mixed with oil or fat for application. This vine is one of the most important medicines amongst the Makunas, who have three distinct names for it: *bee-ra-ree-a-ma*, *ho-ree-a-mee-see* and *nö-ña'-mee-koo-ma*.


TETRAPTERIS
styloptera Juss.
1
2
3
TETRAPTERIS
mucronata Cav.
1
2
3

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STUDIES IN THE GENUS ONCIDIUM. I.

BY

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The genus *Oncidium*, one of the largest orchid genera in the New World, has been of continuous intrigue to both botanists and horticulturists. Although during the past 175 years several attempts have been made to clarify the various species that comprise this genus, no satisfactory compendium is presently at hand. It was Lindley who first produced a kind of monograph, or rather a revision of the genus in 1841, in his Sertum Orchidaceum under t. 48 with 101 species, and an expanded version of it in 1855 in his Folia Orchidacea with 198 species. These treatments were in use almost uninterruptedly until 1922 when a new attempt was made by Kraenzlin. It is unfortunate that the Kraenzlinian version was anything but an improvement on the former treatments. Since that time two synopses have appeared, one in 1970 by Garay (Taxon 19: 443–467, 1970), and the other jointly by Garay and me in 1974 (Bradea 1(40): 393–424, 1974). I believe that in this latter synopsis we have clearly outlined the infrageneric divisions which I intend to follow section by section in this series. These papers will not follow the sequence outlined in the key to the sections, but rather will treat them randomly depending on the demand and need of immediate attention. Conse-

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quently this first study deals with the *Section Cucullata.*

The actual identity of the plants with colorful and attractive flowers of the *Section Cucullata* have been plagued with confusion and misunderstanding since the early days of their introduction to European horticulture. During the nineteenth century hundreds of these plants were flowered in England and Europe and many of their floral variations were noted. For the most part, the early botanists considered the morphological differences as being minor and not worthy of specific rank. Lindley, for example, chose to combine several different plants as varieties of *O. cucullatum* including his earlier described *O. nubigenum.* This action, since no universally accepted Code of Nomenclature existed at that time, prompted Reichenbach to remark (Gard. Chron. 367, 1867) " . . . he (Lindley) called this plant a good species (*nubigenum*) but when he was older it had come into fashion to combine very heterogeneous types into one species because there were too many species". Despite Reichenbach's attempt to separate these plants into distinct entities, the practice started by Lindley continued and *O. Phalaenopsis*, *O. olivaceum* as well as *O. andigenum* were declared to be varieties of *O. cucullatum* by Nichols in 1886, Veitch in 1892, and Gower in 1899, respectively.

Reichenbach maintained a vigorous separation of the species in this affinity, attested by his drawings and descriptions. In 1922, Kraenzlin, in his monograph of Oncidium, attempted to expand the work of Reichenbach by establishing the *Section Cucullata* as a distinct unit. This effort, although noteworthy, included several species which belong to other affinities. He also omitted *O. andigenum* which he placed in a section together with *O. cornigerum* for reasons known only to him. In general Kraenzlin well understood his *Section Cucullata*, but he

was rather careless and inconsistent in the allocation of the species.

The circumscription of a section composed of seemingly similar flowering plants in itself is not a difficult or tedious task, but the delimitation of the species assigned to a given section is altogether a different matter. This latter approach demands a careful examination of all type specimens along with the associated descriptive data. Living material must be studied in the field and in cultivation, and compared with the types. Camera lucida drawings of the floral parts of type specimens as well as of additional material must be prepared for comparative purposes. Data presented in this paper, and those to be published in the future, are assembled through these methods.

The plants of the *Section Cucullata* are endemic to the Andes of South America and grow in the cold and humid climate found at about 3,000 meters. Their range is from Venezuela southward to northern Peru, with an obvious concentration in Ecuador. In the mid-nineteenth century, several collectors shipped plants by the thousands to England and Europe, which formed the basis for many of the herbarium specimens. These plants are relatively common in living collections today, although as, expected, in rather small numbers, for repeated field trips to previously lucrative areas vividly tell of the encroachment by man. There is no doubt that these plants will continue to be found, but certainly not in the presently accessible areas known to current collectors.

Because of the rather peculiar relationship between the callus of the lip and base of the column, I entertained the thought that the *Section Cucullata* should be excluded from the genus *Oncidium*. In all of the species, the base of the column has a tumid member on either side projecting forward and enclosing the base of the

callus. Most of the species of the other sections of *Oncidium* have a short, variously tumid column-base, but only the Cucullata types enjoy the horseshoe-like shape which shelters part of the callus. Yet, analogous situations exist in the *Section Stellata*, which is a different type of modification of the basic pattern. Until we have a satisfactory key to the various genera of the Oncidium alliance, I decided to maintain this section under *Oncidium*.

In the past, several *Odontoglossum* species of the *O. rigidum* relationship have been referred to the *Section Cucullata* because of the connate lateral sepals and the sessile sepals and petals. A study of all the characters has necessitated the exclusion of these species from the genus *Oncidium* for the above listed characters document an obvious case of parallel evolution rather than similarity based on close relationships. Likewise *Oncidium Storkii* and *O. Warscewiczii* must also be excluded from the *Section Cucullata* due to the different columnar structures of the flowers.

Several noteworthy characters within the section serve to distinguish the species. Of the 19 species recorded in this paper, ten have a tuft of hairs at the base of the elongate callus, while the remainder have a short tumid callus without hairs. With respect to the calli, three species—*O. andigenum*, *O. mimeticum* and *O. sanguinolentum*—have five subglobose tubercles in three rows. All others are with three-membered, variously merged, tumid or keel-like structures. The familiar long nose-like tubercle is found in *O. cucullatum*, *O. olivaceum*, *O. Kennedyi* and *O. rhodostictum;* long, sulcate callus which is tridenticulate at the apex, on the other hand, is limited to *O. spathulatum*, *O. tripterygium* and *O. Dayanum*.

Five species—*O. cucullatum*, *O. mimeticum*, *O. olivaceum*, *O. rhodostictum* and *O. sanguinolentum*—have a

prominently cucullate clinandrium, while the remainder have only a low collar which partially encircles the anther.

The lip is the most conspicuous part of the flower in each species and contributes greatly to the overall size. Most species have a variously constricted lip with a well-defined isthmus or with a cuneate base to the midlobe suggesting a trend toward an isthmus. Otherwise, the midlobe is sessile and cordate, precluding an isthmus as in *O. nubigenum*.

The most important non-floral character within the section is found in the inflorescence. Only *O. cucullatum*, *O. Kennedyi* and *O. olivaceum* have a long, erect, rigid peduncle with a fractiflex rachis, while all others have a flaccid, arcuate peduncle with a sinuously flexuous rachis. This character alone is sufficient to separate the three species mentioned from the rest in the section.

Section Cucullata *Krzl.* in Pflanzenr. Heft 80: 128: 1922.

Type: *Oncidium cucullatum* Lindl.

The flowers range between 2 to 4 cm. vertically and have attractive color patterns. The sepals and petals are subsimilar, ovate-oblong, sessile, acute, and often concave. The color is variable, frequently mottled, often solidly colored with a well-defined margin. The lateral sepals are variously connate, always shorter than, and hidden by, the lip. The lip is conspicuous, usually constricted in the middle, with or without a well-defined isthmus; the side lobes subquadrate to rounded and often deflexed. The midlobe is spreading, emarginate, variously maculated, occasionally on both sides. The crest consists of an odd number of keels or tumors with or without a hirsute base. The column is short, glabrous, occasionally with a cucullate clinandrium, and a thickened base; the rostellum is short.

The plants are rather small with aggregate or approximate ovoid to pyriform and slightly compressed pseudobulbs which are enveloped by several imbricating sheaths of which the uppermost may be leaf-bearing. The one or more terminal leaves are linear to elliptical or narrowly lanceolate and subcoriaceous. The inflorescence, frequently precocious, emerges laterally from the basal bracts and is usually slender, arching, few-flowered, and racemose; occasionally it is rigid and erect, or many-flowered and paniculate, often conspicuously fractiflex.

Key to Species

1. Part of callus enclosed by the auriculate base of column adorned with a tuft of hairs 2

1a. Part of callus enclosed by the auriculate base of column without a tuft of hairs 15

2. Inflorescence rigid, erect, with more or less flexuous rachis 3

2a. Inflorescence flaccid, arcuate with sinuous rachis 8

3. Column with erect clinandrium, callus of lip keel-like, one-fourth to one-sixth of entire length of lip, triangular in lateral view, with a small, divaricately spreading lobe resembling nostrils on each side 4

3a. Column with dorsally reclining clinandrium; callus of lip keel-like, one-third of entire length of lip, triangular in lateral view consisting of three, parallel, distinct ridges of which the median is longer and nose-like without small spreading lobes on each side 5

4. Inflorescence racemose, rarely with a few short branches; sepals at least 16 mm. long; lip 30 mm. long . . . . . *O. olivaceum* var. *olivaceum*

4a. Inflorescence paniculate with numerous, long, diffused branches; sepals up to 10 mm. long; lip up to 20 mm. long . . . . . *O. olivaceum* var. *giganteum*

5. Column with distinct, linear processes on each side of the stigma; disc of lip with scattered wart-like papillae in center . . . . . *O. Kennedyi*

5a. Column without any processes on each side of stigma; disc of lip without any wart-like papillae in center 6

6. Flowers medium size; sepals not more than 15 mm. long; lateral lobes of lip oblong-rectangular with obliquely truncate apex . . . *O. cucullatum* var. *cucullatum*

6a. Flowers large; sepals at least 20 mm. long; lateral lobes of lip never oblong-rectangular 7

7. Lateral lobes of lip rectangularly spreading obliquely triangular or dolabriform . . . . . *O. cucullatum* var. *dolabratum*

7a. Lateral lobes of lip recurved toward midlobe, obliquely ovate . . . . . *O. cucullatum* var. *macrochilum*

8. Callus of lip elongate, consisting of three variously confluent, parallel ridges 9

8a. Callus of lip short, consisting of five confluent tubercles in three rows, two on each side and the fifth in the middle 13

9. Petals unicolored except margins; clinandrium cucullate; callus of lip compressed, keel-like, the median ridge much longer than the very obscure lateral ridges, nose-like laterally . . . *O. rhodostictum*

9a. Petals marmorate to barred; clinandrium collar-like, marginate; callus of lip not compressed, the median ridge often considerably shorter than the lamella-like lateral ridges, never nose-like 10

10 Lateral sepals connate into a bifid synsepal; petals from a cuneate base elliptic-lanceolate, abruptly acute to acuminate 11

10a. Lateral sepals free at least to middle, spreading; petals broadly elliptic, sessile, obtuse . . *O. spathulatum*

11. Callus of lip obovate in outline, *concave* with entire, raised margins, bidentate at apex and with a shorter keel in the center originating from the middle of the callus . . . . . *O. Phalaenopsis*

11a. Callus of lip quadrate to oblong in outline, *convex*, consisting of three parallel ridges of which the two outer ones are obscurely lobu-

late, and the third in the center originating from the base of the lip between the column-wings 12

12. Median keel much shorter than the lateral ones . *O. Dayanum*

12a. Median keel as long as the lateral ones . . . . *O. triplerygium*

13. Column slender; clinandrium low, marginate . . *O. andigenum*

13a. Column stout; clinandrium high, cucullate 14

14. Flowers rather small; lip when expanded distinctly pandurate, i.e., constricted in middle; midlobe of lip truncate to cuneate at base . . . . . *O. sanguinolentum*

14a. Flowers medium to large, lip when expanded never pandurate, but constricted above the middle; midlobe of lip transversely reniform, deeply cordate at base . . . . . *O. mimeticum*

15. Lip when flattened truncate to subcordate at base 16

15a. Lip when flattened cuneate at base 20

16. Midlobe of lip sessile, transversely elliptic to cordate-reniform 17

16a. Midlobe of lip cuneate to cuneate-flabellate 18

17. Sepals and petals conspicuously muricate-papillose dorsally, especially towards base; petals distinctly mucronate at the more or less emarginate apex . . . . . *O. azuayense*

17a. Sepals and petals glabrous dorsally; petals neither mucronate nor emarginate at apex . . *O. nubigenum*

18. Lateral lobes of lip ovate-oblong, forming an acute to subacuminate, open sinus with median lobe; callus large, basally produced into a retrorse, conical point . . . . . *O. aequinoctiale*

18a. Lateral lobes of lip subrotund to obliquely obovate with rounded lobes, often imbricating the base of median lobe; callus small without a retrorse, conical point 19

19. Flowers medium size; lip 15–17 mm. long; callus quadrate in outline, porrect, composed of three ridges . . . . . *O. alticola*

19a. Flowers large; lip 22–24 mm. long; callus transversely rectangular-oblong, distinctly curved upwards in front without any ridges but slightly depressed . . . . . *O. tarquiense*

20. Petals with transverse bars; lateral lobes of

lip quadrate, truncate; midlobe of lip with a rectangularly transverse, erose apex . . . . . *O. erosilabium*

20a. Petals without transverse bars; lateral lobes of lip rounded; midlobe of lip 2-lobulate without an erose apex 21

21. Pseudobulbs one-leaved; lip wider than long, transversely elliptic in outline . . . . . *O. chimborazoënse*

21a. Pseudobulbs two-leaved; lip as long as wide, rhombic in outline . . . . . *O. tunguraguense*

Systematics of Species

Oncidium olivaceum H.B.K., Nov. Gen. et Sp. Pl. 1: 347, 1816.

Syn.: *Oncidium cucullatum* subvar. *olivaceum* (H.B.K.) Veitch, Man. Orch. Pl. pt. 8: 31, 1892.

Oncidium cucullatum var. *olivaceum* (H.B.K.) Gower in Garden 55: 38, 1899.

Type: Colombia, Depto. de Cauca, Puracé near Popayan. Coll. Humboldt no. 2020! (P).

Observation: Dorsal sepal 16 mm. long, 6 mm. wide; lateral sepals cymbiform, bifid, 16 mm. long, 7 mm. wide; petals 15 mm. long, 8 mm. wide; lip 3-lobed, lateral lobes obliquely ovate, 12 mm. long, 7 mm. wide, midlobe from a narrow isthmus reniform, deeply cordate at base, bilobed in front, whole lip 30 mm. long, 32 mm. wide across midlobe. The callus is triangular laterally, keel-like, with a small, divaricately-spreading lobe, resembling nostrils on each side.

Oncidium olivaceum is readily separable from *O. cucullatum* by its callus which is one-fourth to one-sixth of the length of the entire lip and by the presence of nostril-like lobes on each side of the nose-like keel. It is noteworthy that I have not seen any material of this species outside the Cauca area in Colombia.

Oncidium olivaceum var. **giganteum** (Hort.) Stacy, *comb. nov.*

Basionym: *Oncidium cucullatum* var. *giganteum* Hort. in Garden 22: 166, 1882.

Type: Reported only from cultivation; no specimen is known to exist. The original color plate is regarded here to represent the holotype.

Syn.: *Oncidium olivaceum* var. *Lawrenceanum* Gower in Garden 52: 26, 1897.

Neotype: Ecuador, without exact locality. Coll. Lehmann no. 10031! (K, AMES). Since no type specimen has ever been designated, the above-cited collection by Lehmann is selected here because duplicates of it already exist in various herbaria under this name.

Observation: The long, almost straight branches produced in profusion lend a very distinct appearance to the plants of this variety. I have seen specimens from the Imbabura province of Ecuador and from the Cauca, near Popayan in Colombia. When more information will be available of this remarkable plant, it may prove to be a distinct species.

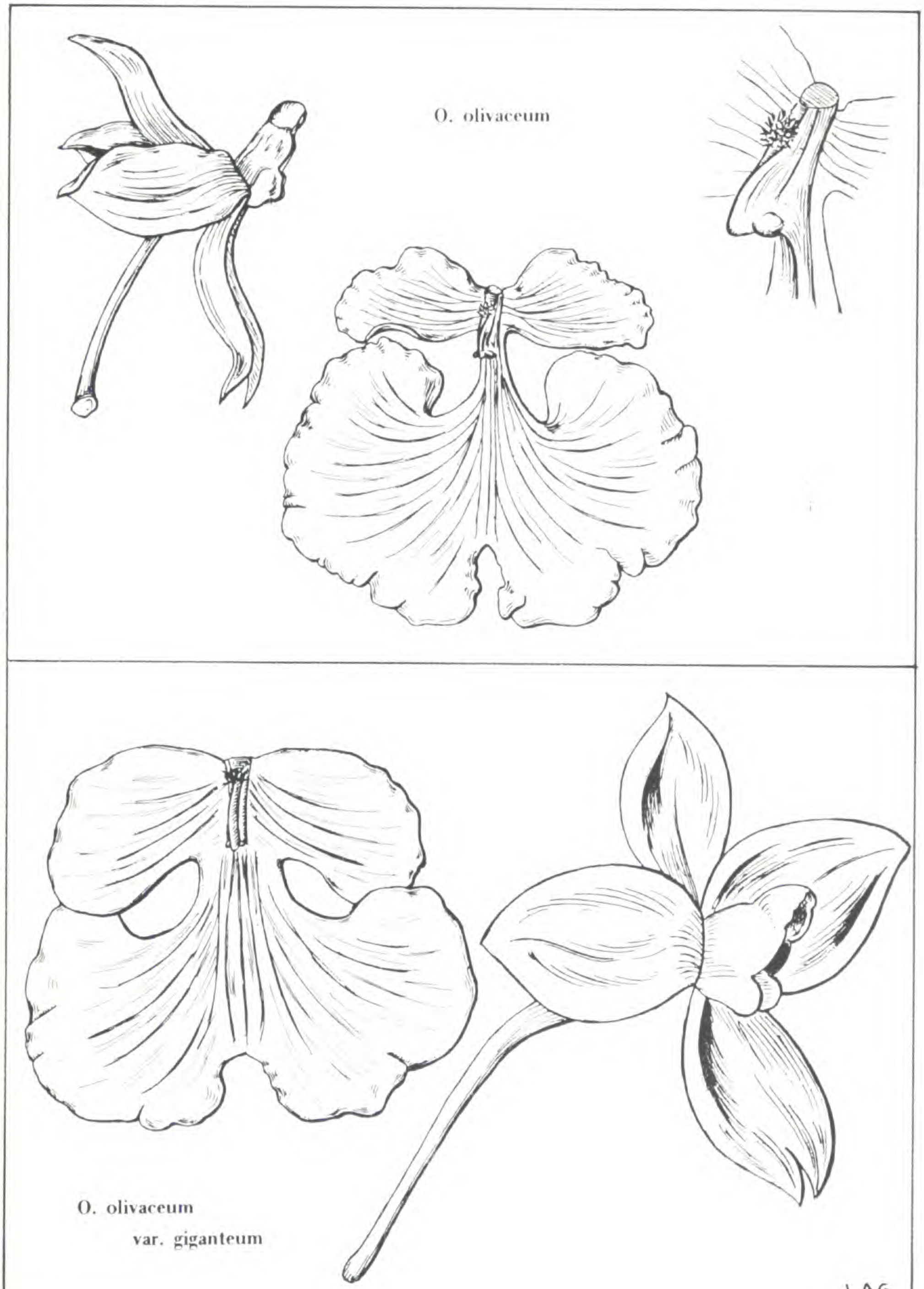
Illustrations: Cogniaux, Dict. Icon. Orch. Oncidium pl. 23, 1899, as *O. cucullatum;* Amer. Orch. Soc. Bull. 37: 13, 1968, as *O. cucullatum.*

Oncidium Kennedyi Stacy, *sp. nov.*

Type: Ecuador, along road from Quevedo to Latacunga, ca. 6000 ft. alt. Coll. G. Kennedy *s.n.!* (AMES).

Epiphytica, caespitosa, usque ad 65 cm. alta; radicibus crassiusculis, glabris; pseudobulbis ovoideis, bifoliatis, usque ad 7 cm. altis; foliis lineari-oblongis, usque ad 22 cm. longis, 2.5 cm. latis; inflorescentiis arcuatis, paniculatis, usque ad 65 cm. longis; pedunculo rigidiusculo, tereti; rhachide fractiflexa; sepalo postico valde concavo, anguste ovato-oblongo, acuto, 15 mm. longo, 5 mm. lato; sepalis lateralibus inter se connatis, bifidis, ovato-cymbiformibus, 16 mm. longis, 7 mm. latis; petalis reflexis, ovato-ellipticis, undulatis, obtusis, 15 mm. longis, 6 mm. latis; labello 3-lobo, lobis lateralibus oblique ovatis, obtusis, lobo intermedio cuneato-flabellato, antice bilobulato, margine undulato, disco sparse papilloso, callo lateraliter compresso, obscure 3-carinato; columna erecta, auriculis oblongo-linearibus juxta stigma ornata; clinandrio suborbiculari, crenulato; ovario pedicellato 3.5 cm. longo.

Plate XXVIII



Observation: In many respects both the plants and flowers belonging to this new species resemble those of *O. cucullatum* Lindl. It is unique in the whole alliance on account of the presence of distinct ears on each side of the stigma as well as the papillose lip. No doubt that many more undescribed species and forms are yet to be reported in this alliance.

Oncidium cucullatum Lindl., Sert. Orch. sub. t. 21, 1838.

Type: Ecuador: On the western declivity of Pichincha. Coll.: Jameson *s.n.!* (K).

Observation: The plants belonging to this species are rather small-flowered. Dorsal sepal 12 mm. long, 6 mm. wide; lateral sepals deeply concave, connate, bifid, 13 mm. long, 8 mm. wide; petals elliptic, obtuse, 12 mm. long, 8 mm. wide; lip 3-lobed, lateral lobes quadrate, midlobe from a narrow isthmus reniform, deeply cordate, bilobed in front, 20 mm. long, 15 mm. across lateral lobes, 25 mm. across midlobe. The callus consists of three, keel-like, parallel ridges, the median ridge is triangular in lateral view, nose-like and longer than the lateral ridges which divaricate at front.

The callus of the lip in the typical form as well as in the recognized varieties is always one-third of the length of the entire lip. Most probably because the type belonged to the Hooker Herbarium and because Lindley did not make a copy of it for himself, he confused it with *O. sanguinolentum* and with others now kept separate under *O. olivaceum* and *O. mimeticum*.

Oncidium cucullatum is essentially Ecuadorian in distribution, but it may extend into Southern Colombia across the political boundary, up to Pasto in Depto. de Nariño.

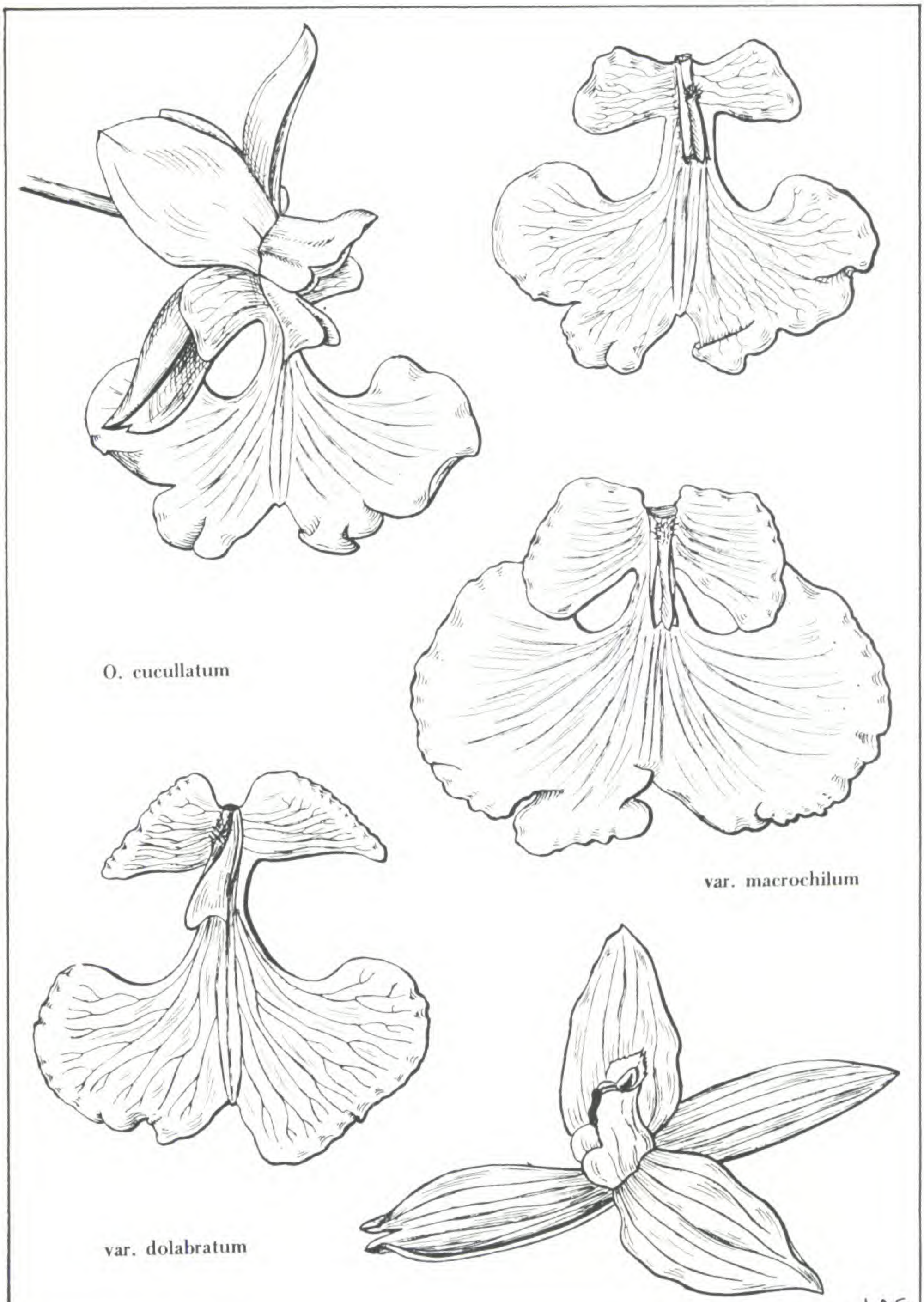
Oncidium cucullatum var. **dolabratum** Stacy, *var. nov.*

Type: Ecuador, without proper locality. Coll. Jameson *s.n.!* (K).

A var. *cucullatum*, floribus multo majoribus et lobis lateralibus labelli oblique triangulari-dolabriformibus differt.

Dorsal sepal oblong-lanceolate, acute, 20 mm. long, 6 mm. wide; lateral sepals connate, bifid, acute, 22 mm. long, 7 mm. wide; petals ovate-lanceolate, acute, 19 mm.

Plate XXIX



O. cucullatum

var. macrochilum

var. dolabratum

LAG

long, 10 mm. wide: lip 3-lobed, lateral lobes obliquely triangular-dolabriform, acute, 10 mm. long, midlobe from a narrow isthmus reniform, cordate at base, bilobed in front; callus an elevated, laterally compressed, nose-like keel, with a tuft of hairs at base, 10 mm. long; whole lip 30 mm. long, 22 mm. across lateral lobes, 30 mm. across terminal lobe.

Oncidium cucullatum var. **macrochilum** Lindl., Folia Orch. Oncidium 22, 1855.

Syn.: *Oncidium olivaceum* var. *macrochilum* (Lindl.) Sander, Orch. Guide 187, 1901.

Type: Ecuador, Quitinian Andes, on trunks of tree, at 4000 m., Coll. Jameson *s.n.!* (K–L, AMES–GH).

Observation: Dorsal sepal narrowly elliptic, abruptly acute, 18 mm. long, 8 mm. wide; lateral sepals connate, bifid, deeply navicular, 20 mm. long, 10 mm. wide; petals broadly ovate-elliptic, obtuse, 17 mm. long, 12 mm. wide; lip 3-lobed; lateral lobes obliquely ovate, rounded, recurved toward midlobe; midlobe from a short isthmus reniform, cordate at base, bilobed in front; whole lip 28 mm. long, 20 mm. across lateral lobes, 38 mm. across terminal lobe.

Oncidium rhodostictum Krzl. in Pflanzenr. Heft. 80: 235, 1922.

Type: Specimen without proper locality, cultivated by Sander *s.n.!* (W).

Syn.: *Oncidium cucullatum* var. *maculosum* Lindl., Folia Orch. Oncidium 22, 1855.

Oncidium olivaceum var. *maculosum* (Lindl.) Sander, Orch. Guide 188, 1901.

Lectotype: Colombia, near Mariquita, in the forest of Quindiu. Coll. Linden 1887! (K–L), *in hoc loco.*

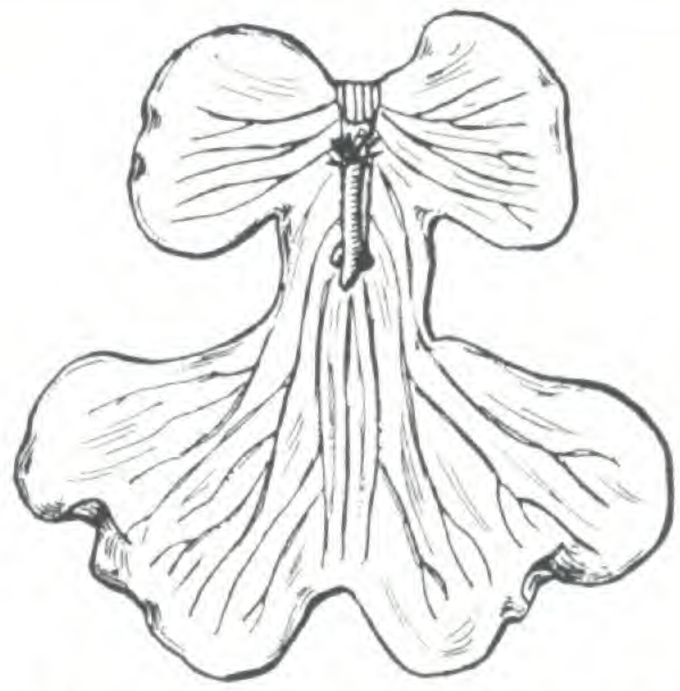
Oncidium cucullatum var. *purpurascens* Hort. in Garden 21: 94, 1882.

Type: Reported only from cultivation; no specimen is known to exist.

Plate XXX

O. rhodostictum

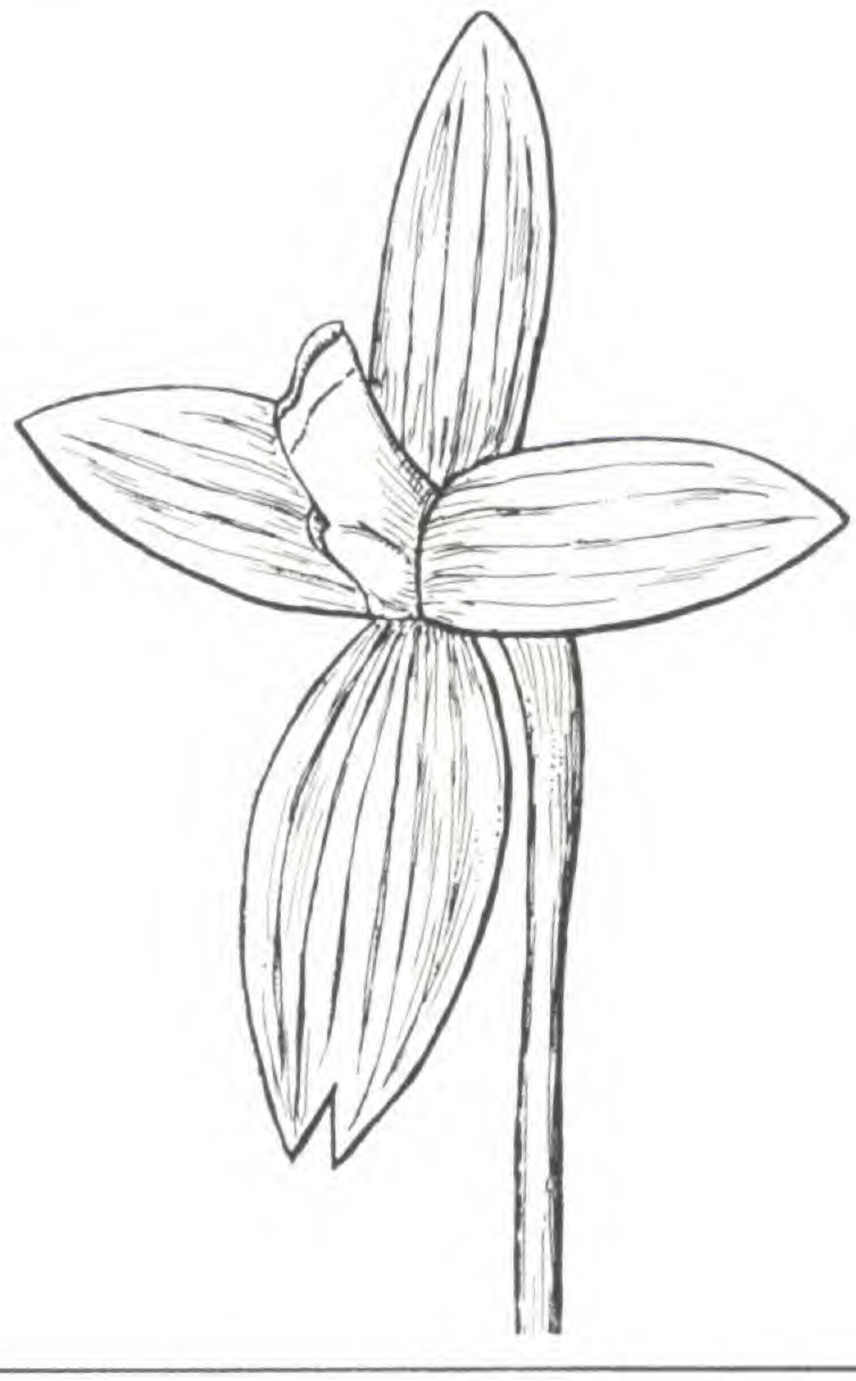






O. andigenum





LAG

Oncidium cucullatum var. *Chestertoni* Hort. in Garden 23: 574, 1883.

Type: Reported only from cultivation; no specimen is known to exist.

Observation: Sepals 18 mm. long, 5 mm. wide; petals 18 mm. long, 7 mm. wide; lip 20 mm. long, 10 mm. across lateral lobes, 20 mm. across terminal lobe.

In appearance, this plant is very similar to *O. mimeticum* in growth habit as well as in the floral structure, especially the proportions of the lip. Yet, the two species can easily be separated because of the configuration of the callus. In *O. rhodostictum*, the callus of the lip is always nose-like, triangular in lateral view. In *O. mimeticum*, the callus is always a five-parted tubercle which is rectangular in lateral view, but never nose-like.

Oncidium spathulatum (Lindl.) Stacy, *comb. nov.*

Basionym: *Oncidium cucullatum* var. *spathulatum* Lindl., Folia Orch. Oncidium 22, 1855.

Syn.: *Oncidium nubigenum* var. *spathulatum* (Lindl.) Rchb.f. in Gard. Chron. 539, 1872.

Oncidium cucullatum subvar. *spathulatum* (Lindl.) Veitch, Man. Orch. Pl. pt. 8: 31, 1892.

Type. Ecuador, without proper locality. Coll. Lobb *s.n.!* Veitch sale 1847 (K–L).

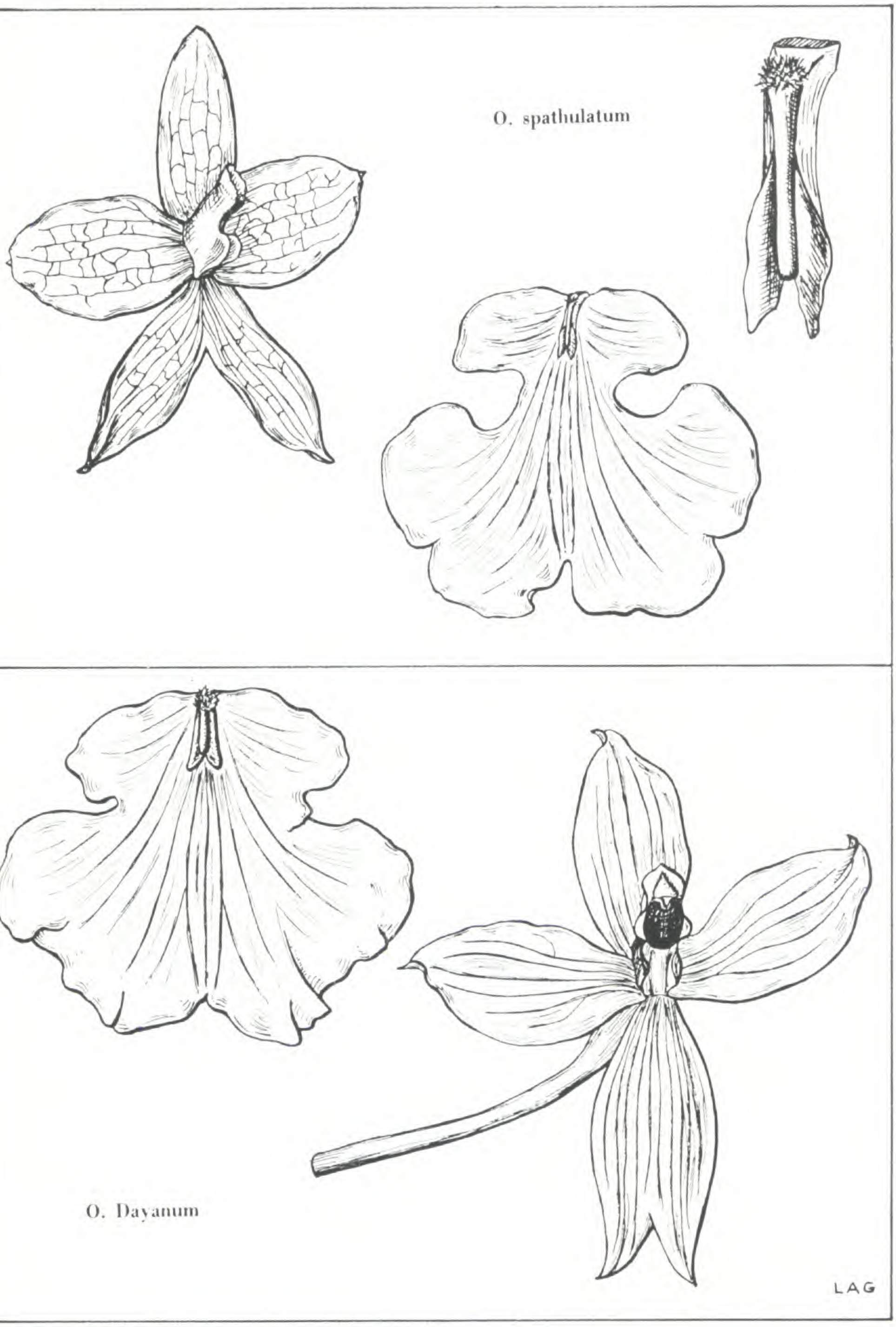
Oncidium Phalaenopsis var. *excellens* Linden in Lindenia 12:53, t. 553, 1897.

Lectotype: Ecuador, without precise locality. Imported and flowered by Linden *s.n.* No specimen is known to exist. The illustration in Lindenia is chosen here for the Lectotype.

Observation: Dorsal sepal 16 mm. long, 7 mm. wide; lateral sepals connate to middle, 17 mm. long, 6.5 mm. wide; petals broadly elliptic, obtuse, more or less mucronate, 14 mm. long, 8.5 mm. wide; lip constricted above middle with open, rounded sinuses, up to 25 mm. long, 18 mm. across lateral lobes, 22–32 mm. across terminal lobe.

Illustrations: Warner & Williams, Orch. Album 2: t. 96, 1883, as *O. Phalaenopsis;* Veitch, Man. Orch. Pl. pt. 8: 30, 1892, as *O. cucullatum* var. *Phalaenopsis;* Amer. Orch. Soc. Bull. 27: 758, 1958, as

Plate XXXI



O. Phalaenopsis, Amer. Orch. Soc. Bull. 42: 1009, 1973, as *O. Phalaenopsis*.

Oncidium Phalaenopsis Linden & Rchb.f. in Gard. Chron. 416, 1869.

Syn.: *Oncidium cucullatum* var. *Phalaenopsis* (Linden & Rchb.f.) Nichols., Ill. Dict. Gard. 2: 485, 1886.

Oncidium olivaceum var. *Phalaenopsis* (Linden & Rchb.f.) Sander, Orch. Guide 188, 1901, in syn.

Type: Ecuador, without precise locality. Coll. Wallis *s.n.!* (W).

Observation: Dorsal sepal 18 mm. long, 9 mm. wide; lateral sepals connate, bifid, 18 mm. long, 7 mm. wide; petals acute, 17 mm. long, 10 mm. wide; lip 33 mm. long, 22 mm. across lateral lobes, 32 mm. across terminal lobe.

The callus of the lip is very characteristic, obovate in outline, *concave* with entire raised margins, bidentate at apex, and with a third, shorter keel in the center originating from the middle of the callus. There is a good colored drawing from the type plant among Day's sketches at Kew, Book 13, page 33, prepared in 1868, a year earlier than Reichenbach's description.

Oncidium Dayanum (Rchb.f.) Stacy, *comb. nov.*

Basionym: *Oncidium cucullatum* var. *Dayanum* Rchb.f. in Gard. Chron. 834, 1871.

Type: Ecuador, without proper locality. Imported and cultivated by Day, *s.n.!* (W).

Syn.: *Oncidium Phalaenopsis* var. *Brandtiae* Hort. in Sem. Hortic. 2: 175, 1898.

Type: Reported from cultivation, no specimens known to exist. The photograph published subsequently under *O. Phalaenopsis* in Orchid Rev. 9: 169, 1901, most probably represents a picture of the type.

Observation: *Oncidium Dayanum* is much smaller than *O. tripterygium*. Dorsal sepal narrowly elliptic, acute, 13 mm. long, 6 mm. wide; lateral sepals connate, bifid, 16 mm. long, 7 mm. wide; petals subspathulate, elliptic, acute, 13 mm. long, 7 mm. wide; lip 3-lobed, wider than long, constricted above the middle, without an isthmus; whole lip 20 mm. long, 16 mm. across lateral lobes, 24 mm. across terminal lobe.

Oncidium Dayanum has been imported together with *O. Phalaenopsis* by Linden. Excellent color drawings exist at Kew among Day's drawings, Book 15, page 56, drawn on Febr. 16 and 28, 1871.

Illustrations: Amer. Orch. Soc. Bull. 27: 729, 1958; ibid. 42: 1009, 1973; ibid. 44: 580, 1975, as *O. Phalaenopsis;* Dodson & Gillespie, The Biology of the Orchids, Frontispiece, 1967 as *O. Phalaenopsis.*

Oncidium tripterygium Rchb.f. in Bot. Zeit. 10: 694, 1852.

Type: Ecuador, Loja. Coll. Warscewicz *s.n.!* (W).

Observation: Dorsal sepal 18 mm. long; lateral sepals connate, bifid, 18 mm. long, 6 mm. wide; petals from a cuneate base elliptic-lanceolate, acute, 17 mm. long, 8 mm. wide; lip longer than wide, 33 mm. long, 22 mm. across lateral lobes, 30 mm. across terminal lobe.

The type material consists of a single flower in a rather poor state of preservation. In size it is very close to *O. Phalaenopsis*, but the callus of the lip is very different. It is quadrate to oblong in outline, *convex*, consisting of three parallel ridges of which the two outer ones are obscurely lobulate, the third in the center originates from the base of the lip between the column-wings and as long as the lateral ones.

Illustration: Ill. Hortic. 17: t. 3, 1870, as *O. Phalaenopsis.*

Oncidium andigenum Linden & Rchb.f. in Gard. Chron. 416, 1869; ibid. 539, 1872.

Syn.: *Oncidium cucullatum* var. *andigenum* (Linden & Rchb.f.) Hort. in Garden 22: 166, 1882.

Oncidium cucullatum subvar. *andigenum* (Linden & Rchb.f.) Veitch, Man. Orch. Pl. pt. 8:31, 1892.

Oncidium olivaceum var. *andigenum* (Linden & Rchb.f.) Sander, Orch. Guide 184, 1901.

Type: Ecuador, without proper locality. Coll. Wallis *s.n.!* (W).

Observation: Dorsal sepal 6 mm. long, 2.5 mm. wide; lateral sepals connate, bifid, cymbiform, 7 mm. long, 3 mm. wide; petals elliptic-oblong, obtuse, 6 mm. long, 2.5 mm. wide; lip pandurate, 7 mm. long, 4.5 mm. across lateral lobes, 5 mm. across terminal lobe.

Although references have been made to this species in literature, I have seen only one collection in addition to the type to which I can satisfactorily refer here. There is a color drawing with details of flowers of this species in the Kew Herbarium among Day's drawings, Book 18: page 54, drawn on October 19, 1874. The corresponding

specimen was sent to Reichenbach by Day, and it is mounted on the type sheet. *Oncidium andigenum* is the smallest flowered in the group and has a five-parted callus.

Oncidium sanguinolentum (Lindl.) Schltr. in Fedde Rep. Beih. 6: 98, 1919.

Basionym: *Leochilus sanguinolentus* Lindl. in Bot. Reg. 30: Misc. p. 91, 1844.

Syn.: *Oncidium cucullatum* var. *sanguinolentum* (Lindl.) Lindl., Folia Orch. Oncidium 22, 1855.

Oncidium olivaceum var. *sanguinolentum* (Lindl.) Sander, Orch. Guide 188, 1901.

Type: Colombia, La Guayra. Coll. Barker *s. n.!* (K-L).

Observation: The type specimen consists of two separately mounted flowers and a colored drawing apparently prepared from a living flower by Lindley. The flowers are rather small: dorsal sepal 11 mm. long, 5 mm. wide; lateral sepals 13 mm. long, 5.5 mm. wide; petals 11 mm. long, 6 mm. wide; lip 15 mm. long, 10 mm. across base, 14 mm. across the bilobed terminal part.

The reduction of this species by Lindley to *O. cucullatum* is difficult to understand because of the distinctions in growth habit and the differently constructed callus. *Oncidium sanguinolentum* flowers from an undeveloped new growth and has a 5-parted callus; while *O. cucullatum* flowers from mature pseudobulbs and has a nose-like, keeled callus.

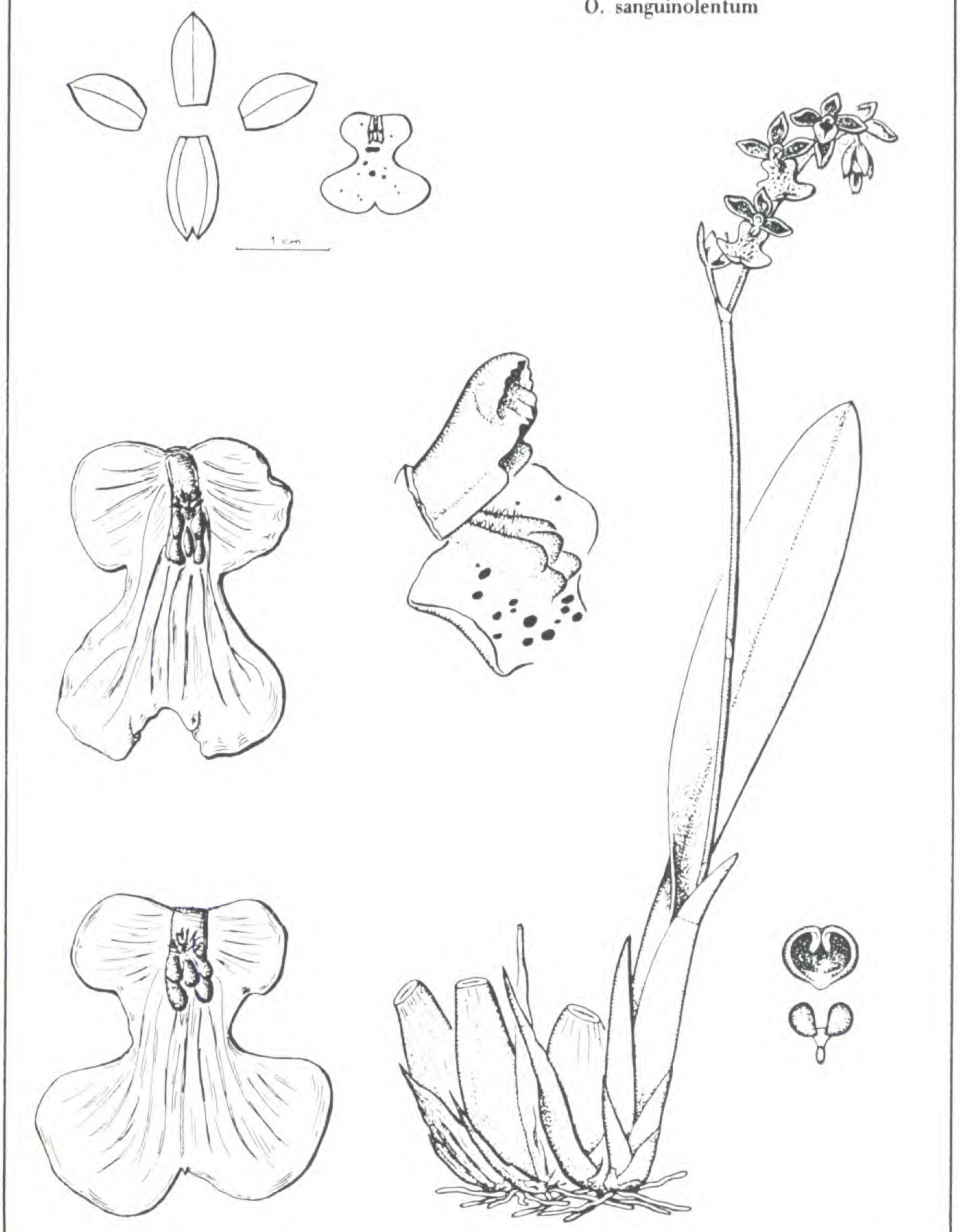
Illustrations: Dunsterville and Garay, Venezuelan Orchids Illustr. 5: 220, 1972, only Fig. B, as *O. andigenum*. Foldats in Lasser, Flora Venez. Orch. 15 (5): 360, 1970, as *O. nubigenum:* Bertha Ospina, Orquideas de la Clarita, 75, 1972, as *O. cucullatum*.

Oncidium mimeticum Stacy, *sp. nov.*

Type: Columbia, Depto. Norte de Santander, Ocaña. Coll. Schlim no. 411! (K-L).

Epiphytica, caespitosa, variabili; radicibus flexuosis, glabris; pseudobulbis approximatis, ovoideis vel pyriformibus, vulgo unifoliatis, cataphyllis obtectis; foliis anguste oblongo-ellipticis vel lanceolato-oblongis, obtusis, basi conduplicatis, quam inflorescentiis vulgo brevioribus; inflorescentiis elongatis, prominenter pedunculatis,

Plate XXXII



supra laxe paucifloris; floribus vulgo secundis; bracteis late triangularibus, acutis, pedicellis multo brevioribus; sepalo postico elliptico, obtusiusculo, valde concavo, usque ad 15 mm. longo, 6 mm. lato; sepalis lateralibus inter se fere usque ad apicem in synsepalo connatis, cochleato-cymbiformibus, apice divaricatim bidentatis, usque ad 16 mm. longis, 7 mm. latis; petalis late ellipticis vel obovatis, obtusiusculis, reflexis, usque ad 13 mm. longis, 8 mm. latis; labello distincte lobulato, lobis lateralibus auriculatis vel subquadratis, lobo intermedio transverse reniformi, bilobo, antice vulgo sinuato vel prominenter exciso, basi valde cordato, margine undulato, disco tuberculis 5-nis, cariniformibus elevatis ornatis: toto labello usque ad 25 mm. longo, 30 mm. lato, basin inter lobos laterales 12 mm. lato; columna humili, 6 mm. alta; clinandrio cucullato: ovario pedicellato ca. 15–20 mm. longo.

Observation: The rather abundant material of this species present in the various herbaria has been confused repeatedly with *O. cucullatum* Lindl. The specimens belonging to this new species can readily be differentiated by the shape of the callus which consists of 5 tubercles or humps arranged in three rows; 2 humps on each side and a fifth one in the middle which is shorter than the lateral ones. Although the structure of the calli is similar to *O. sanguinolentum* (Lindl.) Schltr., the flowers of the latter species differ, in addition to being much smaller, in the construction of the lip which is pandurate and the midlobe of lip is truncate to cuneate at the base.

The original error dates back to Lindley who confused this apparently distinct species with *O. cucullatum* in Paxton's Flower Garden. It should be noted that the plate in Paxton's Flower Garden is based on an abnormal specimen, showing a terminal inflorescence.

Illustrations: Paxton Fl. Gard. 3: t. 87, 1852, as *O. cucullatum;* Fl. des Serres 8: t. 853, 1853, as *O. cucullatum;* ibid. 23: t. 2457, 1880, as *O. cucullatum;* Veitch, Man. Orch. Pl., pt. 8: 30, 1892, as *O. cucullatum;* Amer. Orch. Soc. Bull. 27: 750, 1958; ibid. 44: 581, 1975, as *O. cucullatum;* Dunsterville & Garay, Venez. Orch. Ill. 5: 220, 1972, Fig. A only, as *O. andigenum;* Foldats in Lasser, Flora Venez. Orch. 15(5): 360, 1970, dotted outline of lip only, as *O. nubigenum*.

Plate XXXIII



Oncidium mimeticum var. **flavidum** (B. S. Wms.) Stacy, *comb. nov.*

Basionym: *Oncidium cucullatum* var. *flavidum* B. S. Wms., Orch. Grow. Man. ed. 4, 229, 1871.

Syn.: *Oncidium cucullatum* var. *flavidum* Linden, Catalogue under nos. 33 to 36, 1870.

Oncidium olivaceum var. *flavidum* (B. S. Wms.) Sander. Orch. Guide 187, 1901.

Neotype: Since no material is known to exist of the original introduction by Linden in 1870, Catalogue nos. 33 and 36, the watercolors prepared by Day of the flowers sold under no. 33 and 36, and which are now kept at Kew are regarded here as representing the holotype. Although this unusual color variant was noticed at first by Linden, the plant became officially described only by Williams in 1871. The color variant is maintained here distinct on account of its flowering time which is in December. The flowering period of *O. mimeticum* is April–May.

Illustration: Ill. Hortic. 25: t. 305, 1878, as *Oncidium cucullatum*.

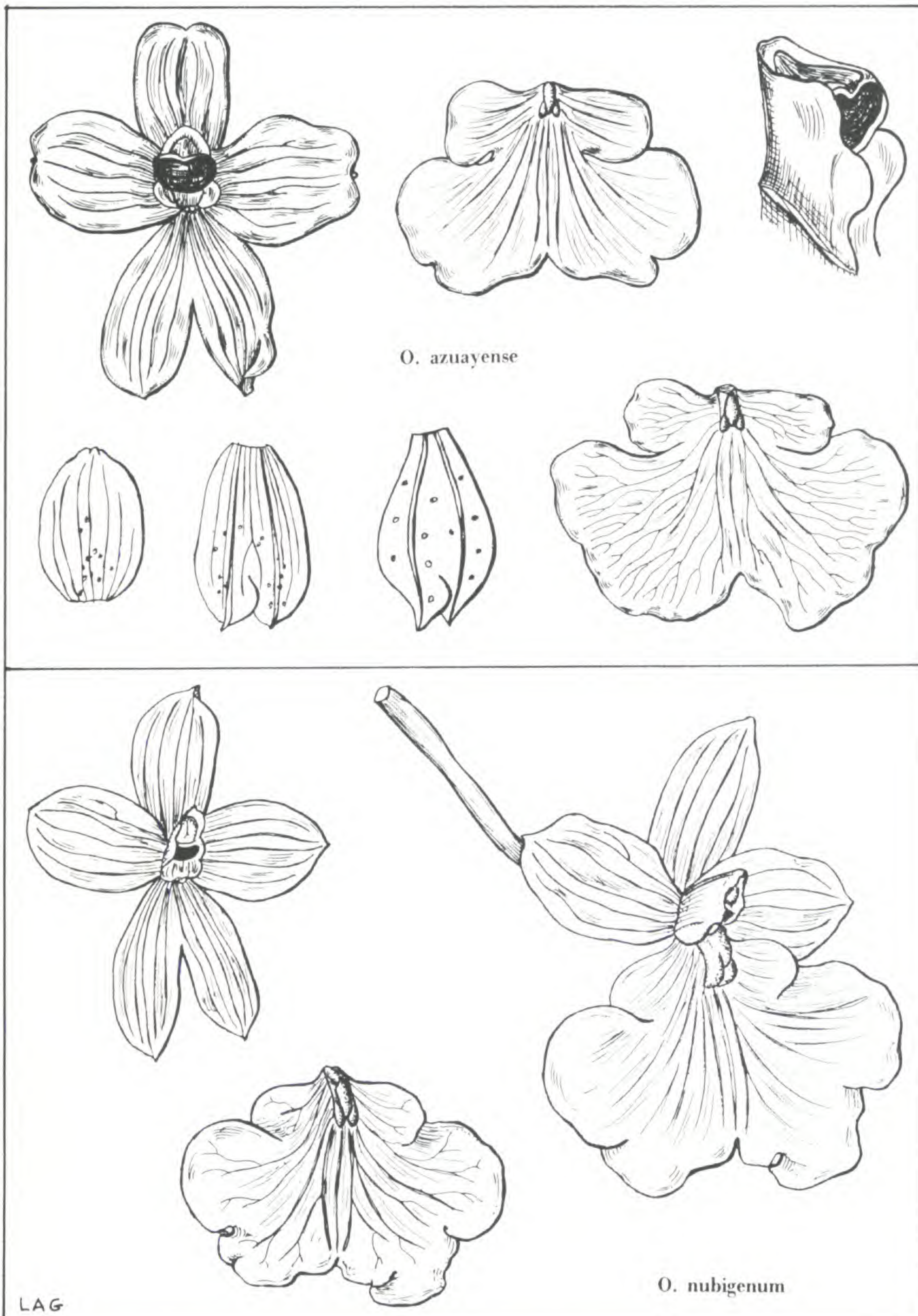
Oncidium azuayense Krzl. in Pflanzenr. Heft 80: 321, 1922.

Type: Ecuador, southern slope of the Azuay mountains. Coll. Lehmann no. 537! (G).

Observation: Dorsal sepal broadly elliptic, obtuse to truncate, occasionally somewhat retuse at mucronate apex, dorsally sparsely but distinctly papillose-muriculate, 9 mm. long, 5 mm. wide; lateral sepals connate, bilobulate in front, the inside margins of lobes often imbricate, dorsally prominently keeled and sparsely papillose-muriculate, especially near base, 10 mm. long, 8 mm. wide; petals broadly elliptic, rounded to deeply emarginate at the mucronate apex, dorsally with a few papillae near the base, 10 mm. long, 7 mm. wide; lip 3-lobed, lateral lobes oblong to subquadrate, midlobe sessile, cordate-reniform, bilobed in front, 16 mm. long, 14 mm. across lateral lobes, 24 mm. across terminal lobe; callus with a retrorse median tooth.

The plants of this rather commonly occurring species in the Azuay region can easily be recognized by the dorsally papillose-muriculate

Plate XXXIV



O. azuayense

O. nubigenum

LAG

sepals and petals and the frequently deeply emarginate petals with a mucronate tip. The sepals and petals are always fleshy-coriaceous.

Illustrations: Amer. Orch. Soc. Bull. 27: 748, 1958, as *O. nubigenum;* ibid. 27: 757, 1958; Florida Orchidist 10: 14, 1967, as *O. nubigenum.*

Oncidium nubigenum Lindl., Gen. and Sp. Orch. Pl. 197, 1833.

Syn.: *Oncidium cucullatum* var. *nubigenum* (Lindl.) Lindl. Folia Orch. Oncidium 22, 1855.

Oncidium olivaceum var. *nubigenum* (Lindl.) Sander, Orch. Guide 188, 1901.

Type: Ecuador, on the ridge of Azuay mountains. Coll. Jameson *.s.n.!* (K, K–L).

Observation: Dorsal sepal elliptic, dorsally carinate, 11 mm. long, 6 mm. wide; lateral sepals, connate basally to $\frac{1}{3}$ of their length, carinate toward apex, 13 mm. long, 5 mm. wide; petals elliptic, obtuse to abruptly subapiculate, never mucronate, 11 mm. long, 7 mm. wide; lip 3-lobed, lateral lobes semiovate, without a sinus and imbricating the reniform midlobe, 17 mm. long, 13 mm. across lateral lobes, 23 mm. across terminal lobe; callus very large in comparison with others of the immediate relationship, with a retrorse conical point.

The flowers of *O. nubigenum* can be compared only with those of *O. azuayense*, but the two differ from one another in many important points. The flowers in *O. nubigenum* are of thin texture, sepals and petals never papillose dorsally, petals never mucronate, lateral sepals free almost to base, and the callus of the lip is robust. The flowers in *O. azuayense* are rather coriaceous in texture, sepals and petals papillose dorsally, petals mucronate and commonly emarginate, lateral sepals connate nearly to apex, and the callus of lip is insignificant.

What prompted Lindley to reduce this species to a variety of *O. cucullatum* in 1855 will never be understood. But, it surely has confused the issue ever since. Already in 1867 Reichenbach complained (Gard. Chron. p. 376) ". . . . when the lamented Dr. Lindley was a young lynx-eyed observer, he called this plant a good species. When he was older, and it had come into fashion to combine very heterogeneous types in 'one species' because 'there were too many species', he believed it was his duty to cancel some of his own, and this Oncidium was degraded to the rank of a variety. We believe this was a mistake, since the many flowers . . . . never show any cucullate anther-bed, never have a nasiform keel on the lip, nor is there ever an isthmus to the lip".

Notwithstanding Reichenbach's clear analysis of the distinctions, Lindley's error has been carried on to the present. Veitch in his Manual of Orchidaceous Plants pt. 8 : 30, 1887, suggests that since *O. nubigenum* was described first, Lindley should have reversed the reduction by calling *O. cucullatum* a variety of *O. nubigenum*. This opinion is echoed by Dodson and Frymire in Amer. Orch. Soc. Bull. 27 : 750–751, 1958, by calling *O. cucullatum* and *O. Phalaenopsis* a subspecies of *O. nubigenum*. Fortunately, no legitimate transfers were made at that time.

Oncidium alticola Stacy, *sp. nov.*

Type: Ecuador, Prov. Azuay, Nudo de Potate, pass between headwaters Rio Tarqui and Girón, ca. 9,000 ft. alt. "Epiphyte. 5 segments pale to ochraceous-yellow with purplish tinge; 6th white with purple splotch at base. Base of column purple, apex white. 'Bulbs' (pseudobulbs) called 'guagra saccha' and when ground said to be diuretic; but natives often eat them when thirsty." Coll. Camp no. E-2163! (AMES).

Epiphytica, caespitosa, usque ad 16 cm. alta; radicibus flexuosis, glabris; rhizomate abbreviato, crasso; pseudobulbis approximatis, lateraliter compressis, anguste cylindraceis vel cylindraceo-ovoideis, 2-foliatis, usque ad 4 cm. altis; foliis lineari-oblongis vel oblongo-oblanceolatis, acutis, usque ad 11 cm. longis, 1.2 cm. latis; inflorescentiis, satis gracilibus, remote paucifloris, usque ad 16 cm. longis; bracteis ovato-cucullatis, acutis, 4 mm. longis; sepalo postico obovato-oblanceolato, acuto, 12 mm. longo, 4 mm. lato; sepalis lateralibus inter se usque ad medium connatis, anguste obovatis, acutis, 12 mm. longis, 4 mm. latis; petalis ellipticis, obtusis, breviter apiculatis, 10 mm. longis, 6 mm. latis; labello 4-lobo, lobis lateralibus subrotundis, inter se 9 mm. latis, lobo intermedio e cuneata basi flabellato, antice valde bilobo, lobis subrotundis, disco ima basi callo 3-partito, tumido ornato, toto labello 19 mm. longo, antice 17 mm. lato; columna humili; clinandrio tenuiter marginato; ovario pedicellato usque ad 2 cm. long.

Observation: The large lateral lobes of the lip and the cuneate-flabellate midlobe readily identify the plants belonging to this new species. It appears to be rather common in the Azuay region.

The following additional specimens belong here; Ecuador: Azuay-Tarqui. Coll. Harling & Andersson no. 13205 bis! (AMES, S); Cuena, Coll. Strobel *s.n.!* (AMES); without exact locality. Coll. Rodrigo Escobar-R. no. 1380! (AMES).

Illustrations: Amer. Orch. Soc. Bull. 32: 905, 1963, as *O. nubigenum*.

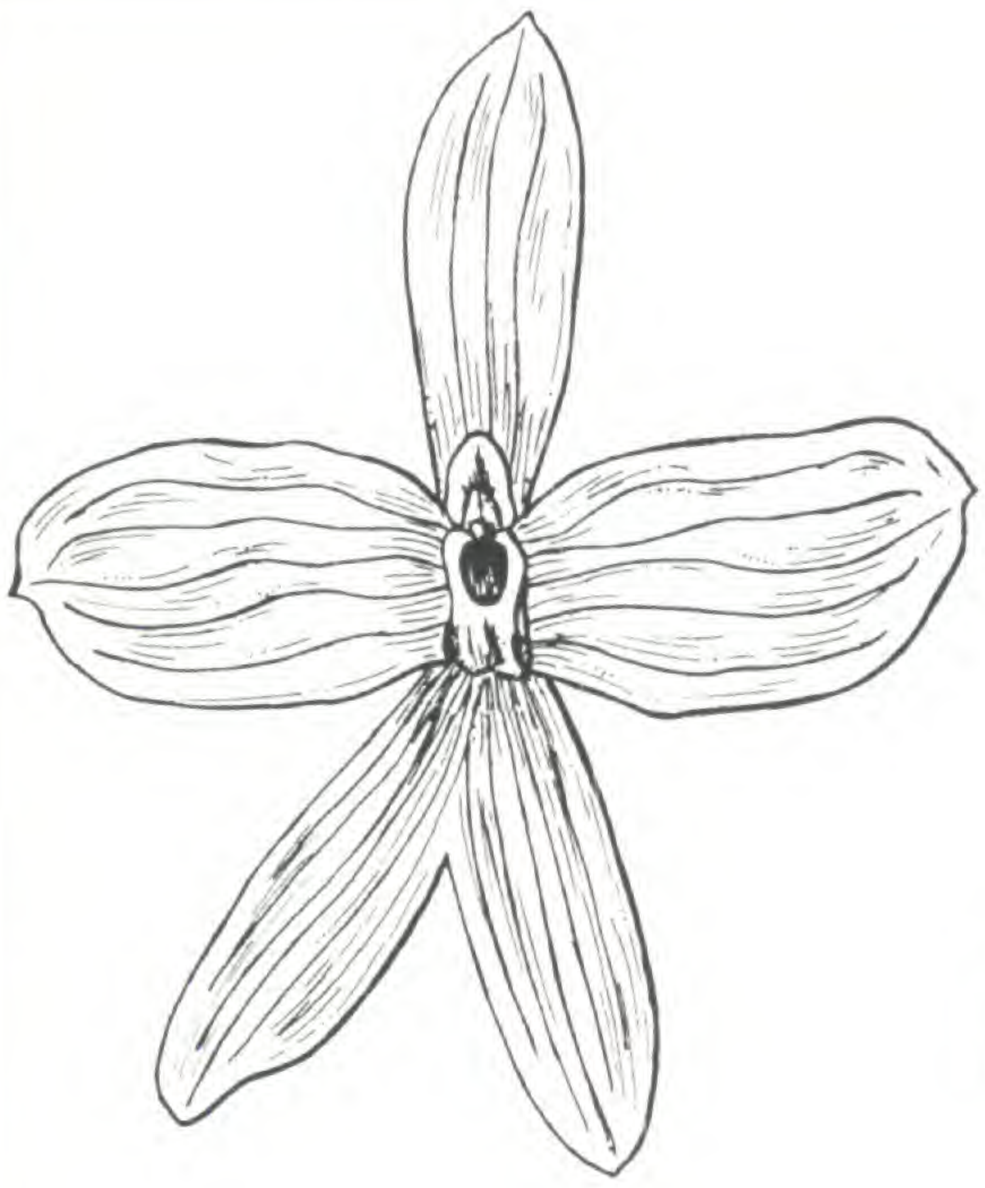
Oncidium tarquiense Stacy, *sp. nov.*

Type: Ecuador, Province Azuay, Portete del Tarqui, Cuenca-Girón, 2700–2950 m. altitude. Coll. Harling & Andersson no. 13205! (S).

Epiphytica erecta, usque ad 30 cm. alta; radicibus flexuosis, glabris, pseudobulbis ascendentibus ovoideis vel pyriformibus, 2-foliatis, basi vaginis chartaceis obtectis, usque ad 5 cm. longis, 1.5 cm. latis; foliis satis tenuibus, lineari-oblanceolatis, obtusis, usque ad 10 cm. longis, 1.5 cm. latis; inflorescentiis gracilibus, paululo arcuatis, laxe secundifloris; racemo laxifloro; bracteis infundibuliformibus, oblique ovato-triangularibus, 5 mm. longis; sepalo postico elliptico, obtuso vel subacuto, 16 mm. longo, 6 mm. lato; sepalis lateralibus quarta parte basali inter se connatis, supra liberis, anguste ellipticis, acutis, 17 mm. longis, 5 mm. latis; petalis late ellipticis, acutiusculis, 14 mm. longis, 8 mm. latis; labello 3-lobo, lobis lateralibus oblique ovatis, lobo intermedio maximo, cuneato-flabellato, antice bilobulato, lobulis rotundatis; disco basin callo minuto, subquadrato, sursum curvato ornato; toto labello 24 mm. longo, 28 mm. lato; columna humili; clinandrio marginato; ovario pedicellato usque ad 35 mm. long.

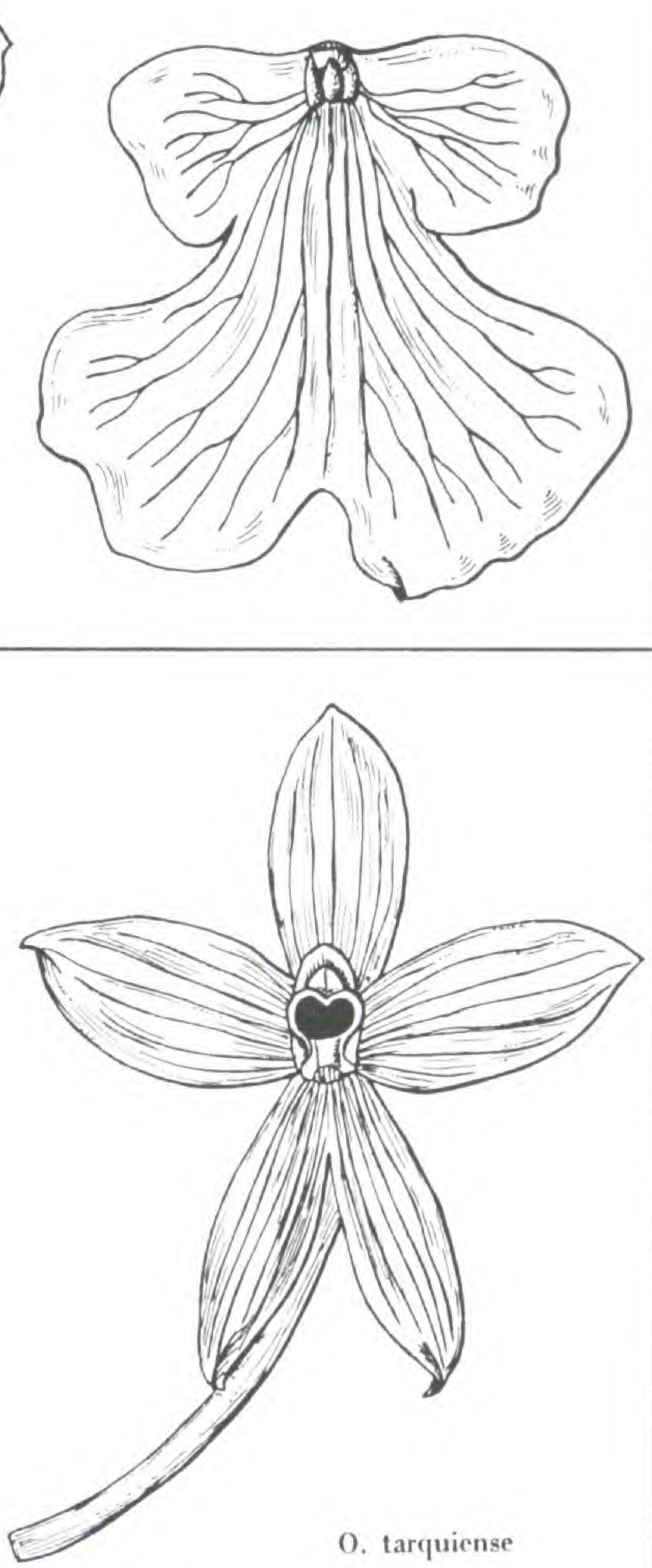
Observation: The flowers in general appearance are larger than those found in *O. alticola*. The transversely rectangular-oblong callus which is distinctly curved upwards is unique in the whole alliance, hence affords an excellent field character for identification.

Plate XXXV



O. alticola





O. tarquiense

LAG

Oncidium aequinoctiale Stacy, *sp. nov.*

Type: Ecuador, without precise locality. Coll. André *s.n.!* (K).

Epiphytica, usque ad 30 cm. alta; radicibus flexuosis, glabris; pseudobulbis approximatis, anguste ovoideis, unifoliatis, usque ad 5 cm. altis; foliis lineari-lanceolatis, acutis vel subacuminatis, usque ad 17 cm. longis, 1.5 cm. latis; inflorescentiis erectis, supra racemosis, laxe pauciflоris, usque ad 30 cm. longis; floribus satis tenuibus, secundis; bracteis cucullatis, acutis, ovariis pedicellatis multoties brevioribus, 4 mm. longis; sepalo postico valde concavo, elliptico, obtuso, 11 mm. longo, 6 mm. lato; sepalis lateralibus ad tertiam partem apicalem inter se connatis, valde concavis, obtusis, usque ad 12 mm. longis, 6 mm. latis; petalis obovatis, obtusis, inconspicue apiculatis, 11 mm. longis, 7 mm. latis; labello 3-lobo, lobis lateralibus divergentibus, ovato-oblongis, lobo intermedio sessili, paululo cuneato, transverse elliptico, antice bilobo, utrinque sinuoso; callo satis prominenti, 3-partito, partitione intermedia retrorse conica; toto labello 18 mm. longo, basin 14 mm. lato, antice 24 mm. lato; columna humili, clinandrio marginato.

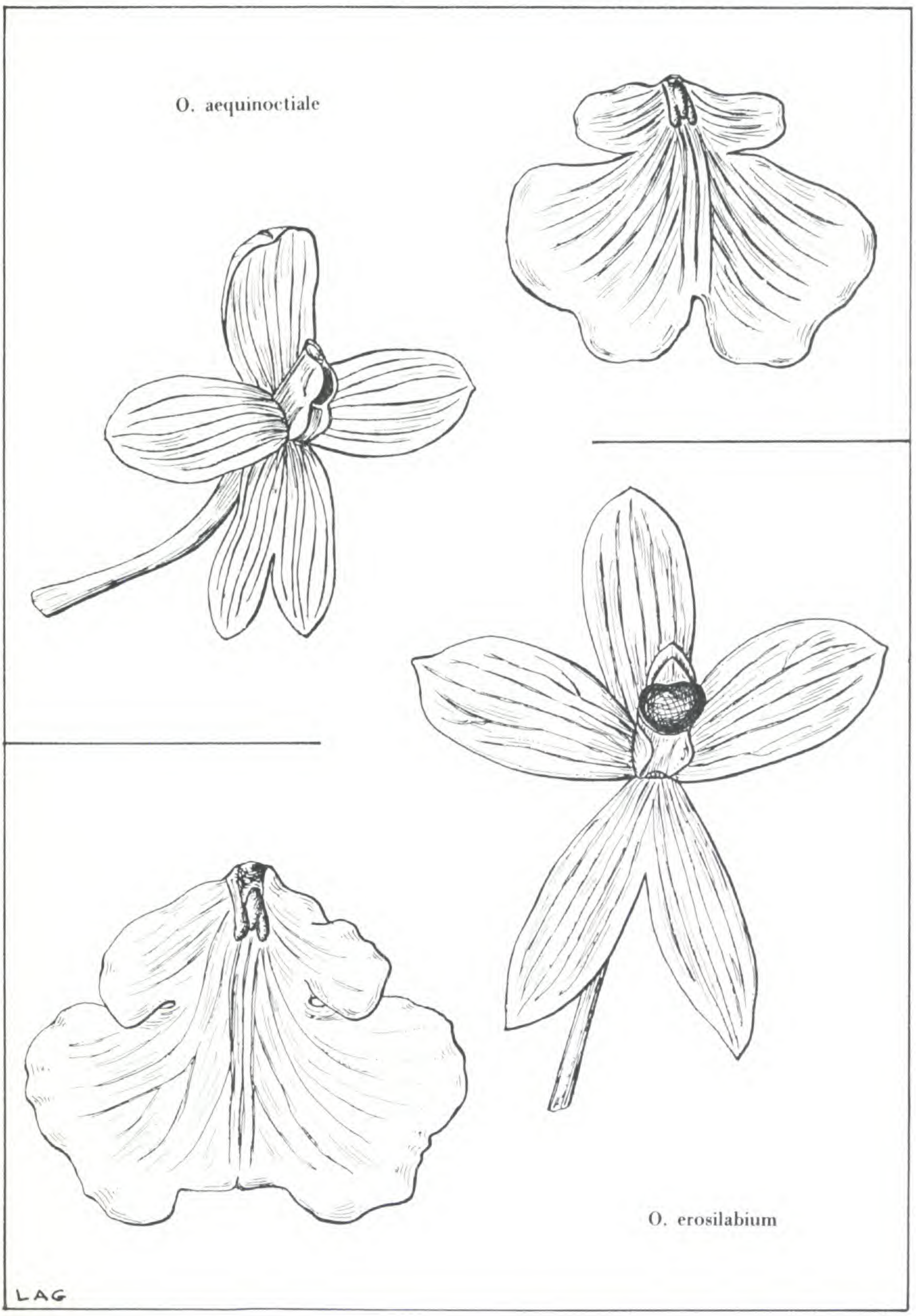
Observation: In floral structures the plants of this new species resemble those of *O. nubigenum*. It differs from *O. nubigenum* especially in having free lateral lobes forming open, acute to acuminate sinuses with the midlobe of the lip; the midlobe is cuneate not cordate at the base.

Onsidium erosilabium Stacy, *sp. nov.*

Type: Ecuador, without precise locality. Cultivated by Rodrigo Escobar-R. no. 1379! (AMES).

Epiphytica erecta, usque ad 30 cm. alta; radicibus flexuosis, glabris; pseudobulbis ovoideis, lateraliter compressis, usque ad 6 cm. altis; foliis linearibus, acutis, 18–25 cm. longis; inflorescentiis gracilibus, paululo arcuatis, pauciflоris, usque ad 10 cm. longis; floribus albidis, sepalis petalisque pallide brunneo maculatis striatisque,

Plate XXXVI



O. aequinoctiale

O. erosilabium

LAG

labello basin purpureo maculato, callo aurantiaco; sepalo postico elliptico, obtuso, 11 mm. longo, 6 mm. lato; sepalis lateralibus tertia parte basilari inter se connatis, oblongo-ellipticis, acutis, 14 mm. longis, 5 mm. latis; petalis late ellipticis, obtusis, 11 mm. longis, 6 mm. latis; labello e cuneata basi 3-lobo, lobis lateralibus subquadratis, truncatis, lobo intermedio sessili, transverse reniformi, antice rectangulariter late eroso; disco venis incrassatis ornato; callo cylindrico, antice 3-partito; toto labello 18 mm. longo, 21 mm. lato; columna erecta; clinandrio marginato; ovario pedicellato usque ad 24 mm. longo.

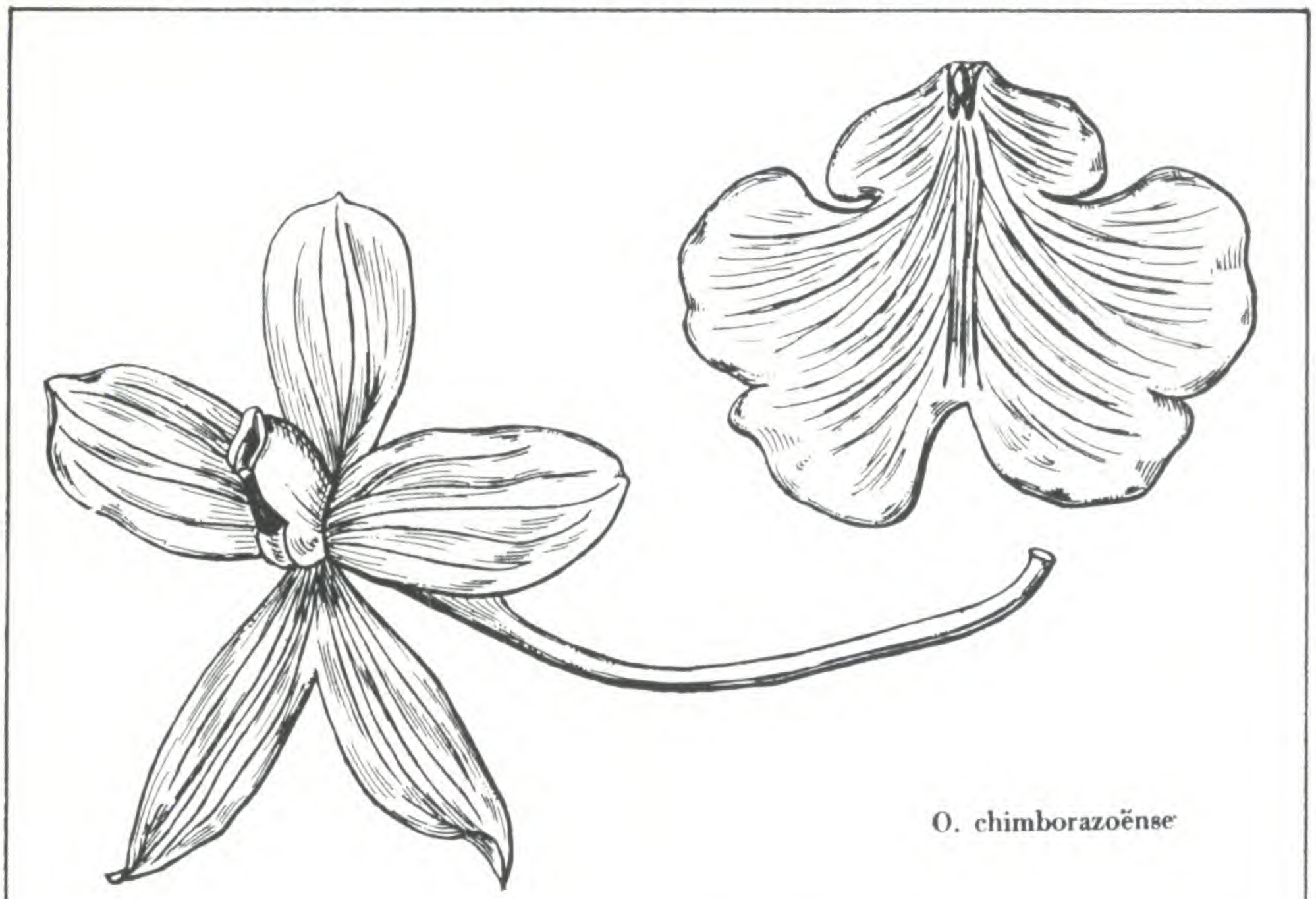
Observation: In floral structure the plants of this species are similar to *O. chimborazoënse*, but the barred petals and the squarely erose lip differentiates it immediately not only from that species but from every member of the whole alliance. I have seen another specimen referable to this species in the Kew Herbarium; it was cultivated during the turn of the century under the name of *O. cucullatum* var.

Oncidium chimborazoënse Stacy, *sp. nov.*

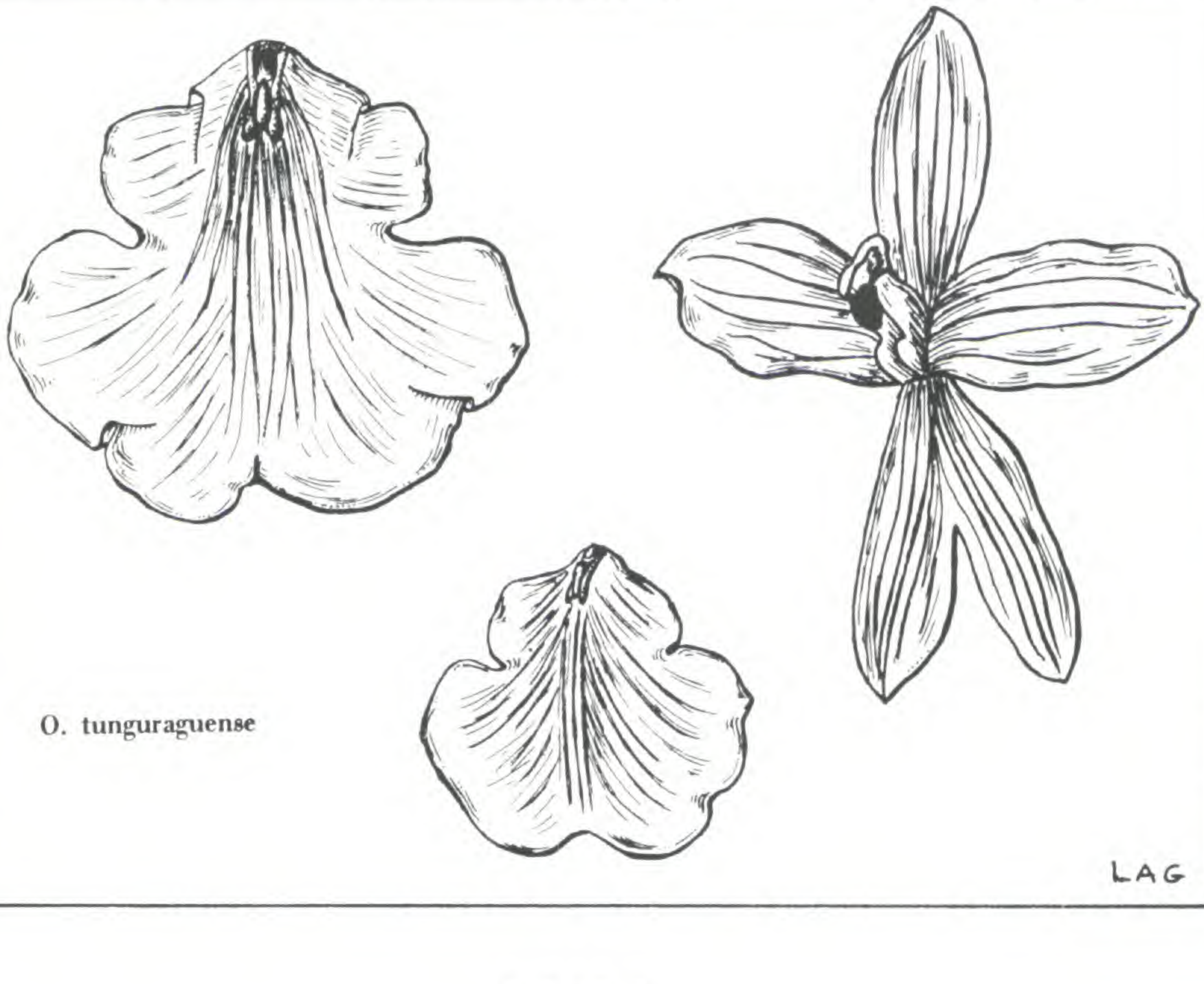
Type: Ecuador, Chimborazo, 3200–3400 m. altitude. Coll. F.C. Lehmann no. 215! (AMES, K).

Epiphytica, ascendenti, usque ad 25 cm. alta; radicibus flexuosis glabris; pseudobulbis approximatis, oblique ovoideis, unifoliatis, usque ad 25 mm. altis; foliis pergameneis, anguste lanceolato-ellipticis, subacutis vel obtusis, usque ad 18 cm. longis, 1 cm. latis; inflorescentiis erectis vel paululo arcuatis, supra laxe paucifloris; floribus ut videtur secundis; bracteis infundibuliformibus, ovato-triangularibus, acuminatis, 5 mm. longis; sepalo postico obovato-elliptico vel elliptico-oblanceolato, acuto, vel abrupte subacuminato, usque ad 12 mm. longo, 6 mm. lato; sepalis lateralibus basin inter se breviter connatis, anguste ellipticis, acutis vel subacuminatis, usque ad 13 mm. longis, 5 mm. latis; petalis late ellipticis, obtusis, usque ad 11 mm. longis, 6 mm. latis; labello e cuneata basi 3-lobo, lobis lateralibus obliquis, apice ro-

Plate XXXVII



O. chimborazoënse



O. tunguraguense

LAG

tundatis; lobo intermedio maximo, transverse reniformi, antice valde bilobulato, basi subcordato, disco basin callo tumido, 3-partito ornato, toto labello usque ad 23 mm. longo, 28 mm. lato; columna humili, crassa, clinandrio marginato; ovario pedicellato usque ad 25 mm. longo.

Observation: *Oncidium chimborazoënse* is larger than *O. tunguraguense*, especially in the size of the flowers. It differs from the latter in the plants having only one-leaved pseudobulbs and the lip is much wider than long.

There is another specimen at Kew collected also in Chimborazo by Cross no. 52! (K), who sent it to the Veitch establishment in 1882.

Illustration: Bot. Mag. 94: t. 5708, 1868, as *O. cucullatum* var. *nubigenum;* Belg. Hortic. 19: t. 19, 1869, as *O. nubigenum;* Dict. Icon. Orch. Oncid. t. 30, 1900, as *O. nubigenum;* Amer. Orch. Soc. Bull. 41: 1001, 1972, as *O. nubigenum.*

Oncidium tunguraguense Stacy, *sp. nov.*

Type: Ecuador, Vulcan Tunguragua, 3000–3400 m. alt. Aug.–Sept. Coll. F.C. Lehmann no. 8572! (K).

Epiphytica, erecta, usque ad 25 cm. alta; radicibus flexuosis, glabris; pseudobulbis approximatis, pyriformibus, lateraliter compressis, bifoliatis, usque ad 4 cm. altis; foliis ellipticis vel lanceolato-ellipticis, acutis, usque ad 13 cm. longis, 2.5 cm. latis; inflorescentiis erectis, sursum arcuatis, laxifloris, usque ad 25 cm. longis; floribus ut videtur secundis; sepalo postico oblanceolato vel obovato-oblanceolato, acuto vel obtusiusculo, usque ad 10 mm. long, 4.5 mm. lato; sepalis lateralibus supra basin inter se breviter connatis, lineari-oblongis, acutis vel obtusiusculis, 11 mm. longis, 3 mm. latis; petalis ellipticis obtusis vel abrupte acutis, usque ad 9 mm. longis, 5 mm. latis; labello in ambitu trapezoideo, 3-lobo, lobis lateralibus e cuneata basi triangulis, lobo intermedio transverse reniformi, antice retuso vel subbilobulo; disco venis incrassatis ornato; callo tumido, 3-partito; toto labello usque ad 15 mm. longo, 16 mm. lato; columna humili; clinandrio marginato; ovario pedicellato usque ad 2 cm. longo.

Observation: From the closely related *O. chimborazoënse* this new species is readily distinguishable by the 2-leaved pseudobulbs and the rhombic lip which is approximately as long as wide. The sepals and petals are maroon inside, much paler and suffused outside; the lip is white with heavy crimson blotches on the basal half especially on the lateral lobes; the callus is orange.

Acknowledgments

The steady cooperation of my colleagues at the Orchid Herbarium of Oakes Ames, and especially the guidance of Dr. Leslie A. Garay, have been a continuous inspiration throughout the preparation of this study. Their help is deeply appreciated. My special thanks to Dr. Peter Taylor, the Orchid Herbarium, Royal Botanic Gardens and to Dr. Luciano Bernardi, Conservatoire et Jardin Botaniques, Genève, for their kind cooperation in providing specimens and drawings of types. For permission to reproduce their color slides so essential to this study I am indebted to Mr. Gilberto Escobar-R, Mr. Rodrigo Escobar-R, Dr. George Kennedy and Mrs. Henry T. Northen. The publication of color plates was made possible through the generosity of Mr. Maurice T. Freeman, Mr. Walter Hunnewell, Mr. and Mrs. Lee B. Kuhn, the Lear Siegler Foundation, Mrs. Henry T. Northen, Mr. Robert M. Scully, Sr., Mr. Richard Seifert and Mr. Robert G. Stone. Their thoughtfulness and help are sincerely acknowledged. To Miss Gertrude Ahern I am grateful for the dedicated attention given by her to this paper.

PLATES

Top left: *Oncidium cucullatum.* Photograph: R. Northen.
Top right: *Oncidium cucullatum.* Photograph: G. Escobar-R.
Bottom left: *Oncidium olivaceum.* Photograph: G. Escobar-R.
Bottom right: *Oncidium rhodostictum.* Photograph: G. Kennedy.

Plate XXXVIII.

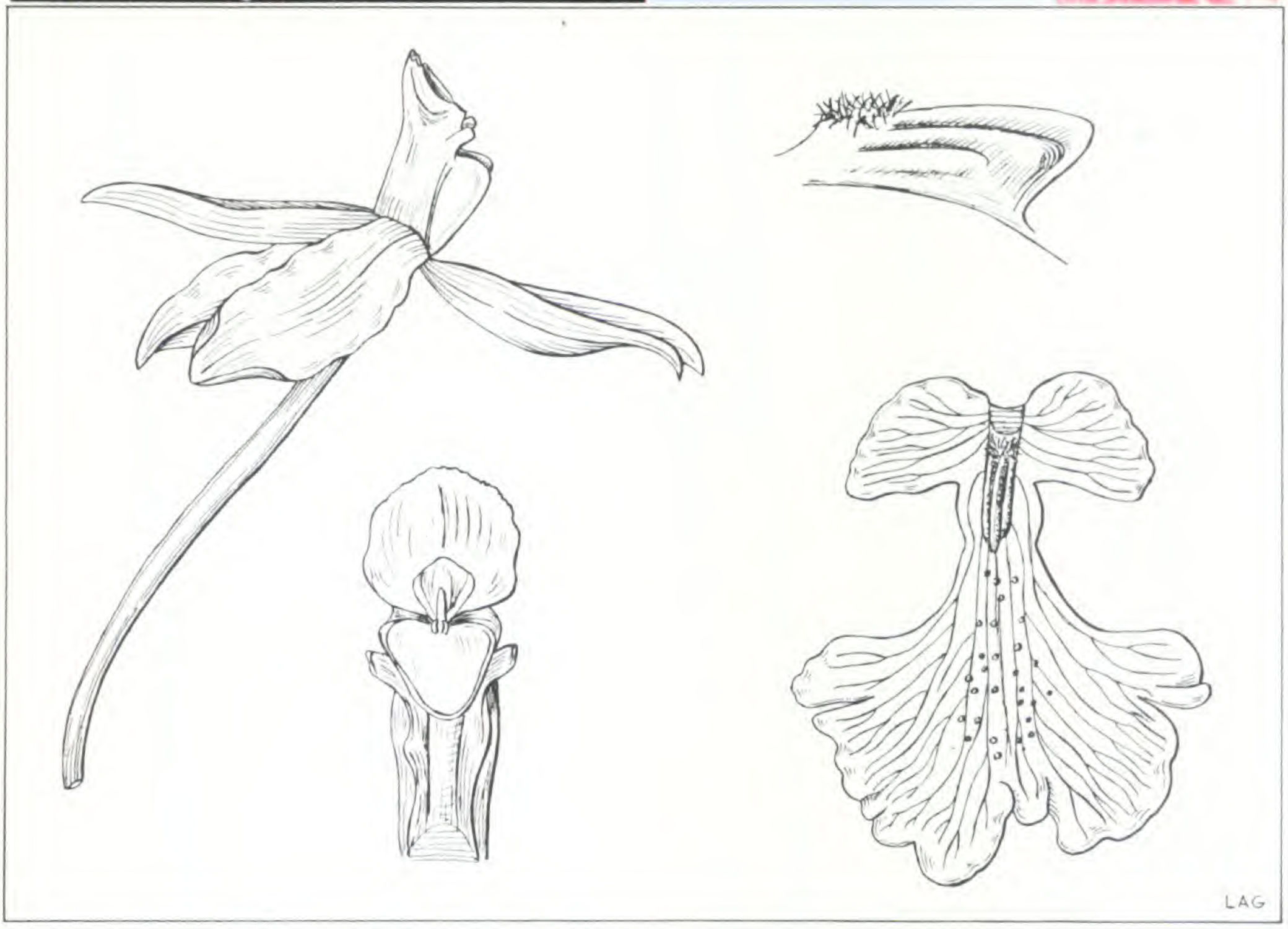


Top left and right: *Oncidium Kennedyi.* Photographs: G. Kennedy.
Bottom: Floral details of *Oncidium Kennedyi.*

PLATE XXXIX.







Top: *Oncidium mimeticum*. Photograph: R. Northen.
Bottom: *Oncidium mimeticum*. Photograph: G. Kennedy.

Plate XL.



Top left: *Oncidium mimeticum.* Photograph: G. Kennedy.
Top right: *Oncidium sanguinolentum.* Photograph: G. Escobar-R.
Bottom left: *Oncidium sanguinolentum.* Photograph: R. Escobar-R.
Bottom right: *Oncidium sanguinolentum.* Photograph: G. Escobar-R.

Plate XLI.









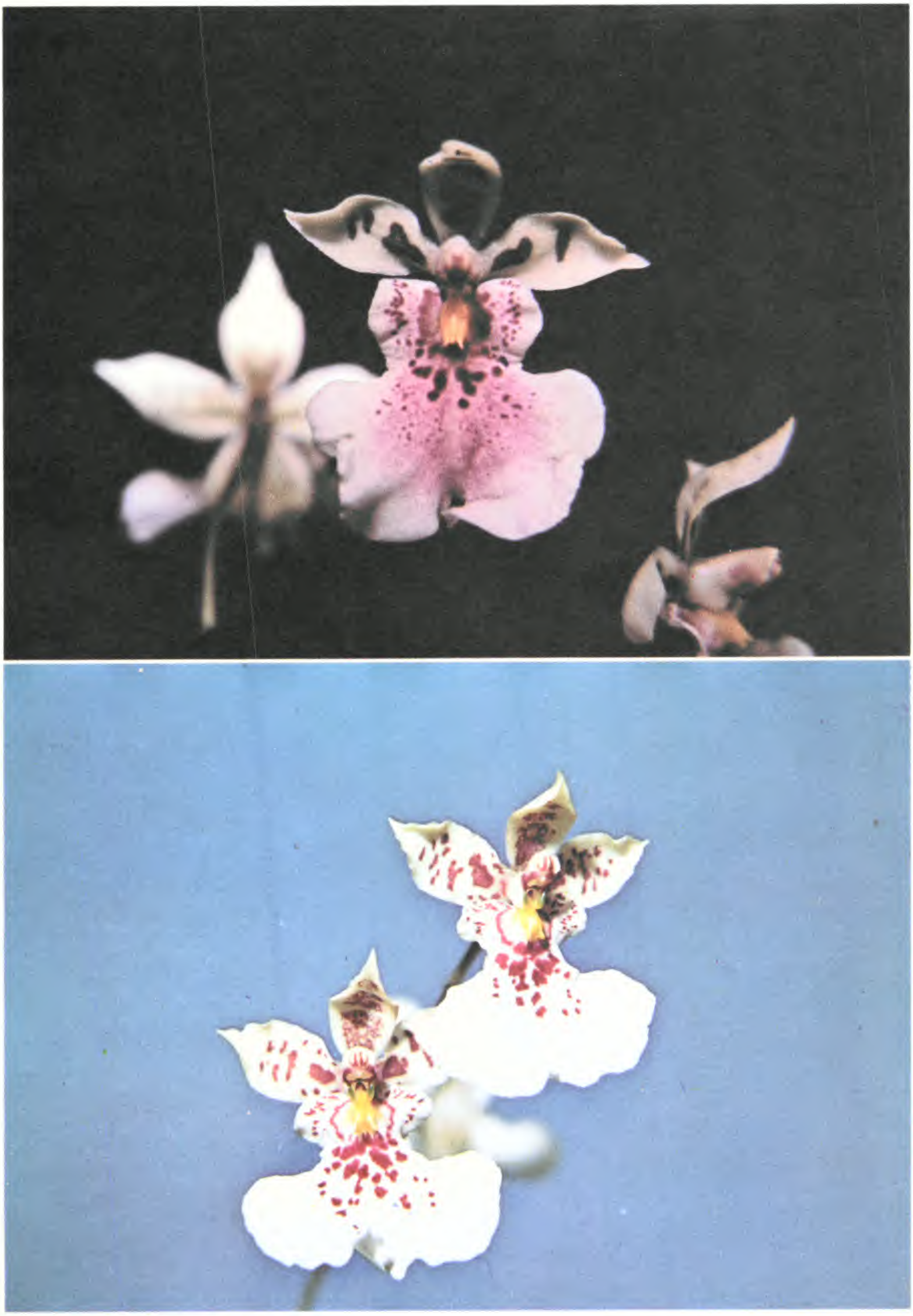
Top left and right: *Oncidium mimeticum*. Photographs: G. Kennedy.
Bottom: *Oncidium tripterygium*. Photograph: R. Northen.

Plate XLII.



Top: *Oncidium Phalaenopsis.* Photograph: R. Northen.
Bottom: *Oncidium Dayanum.* Photograph: R. Northen.

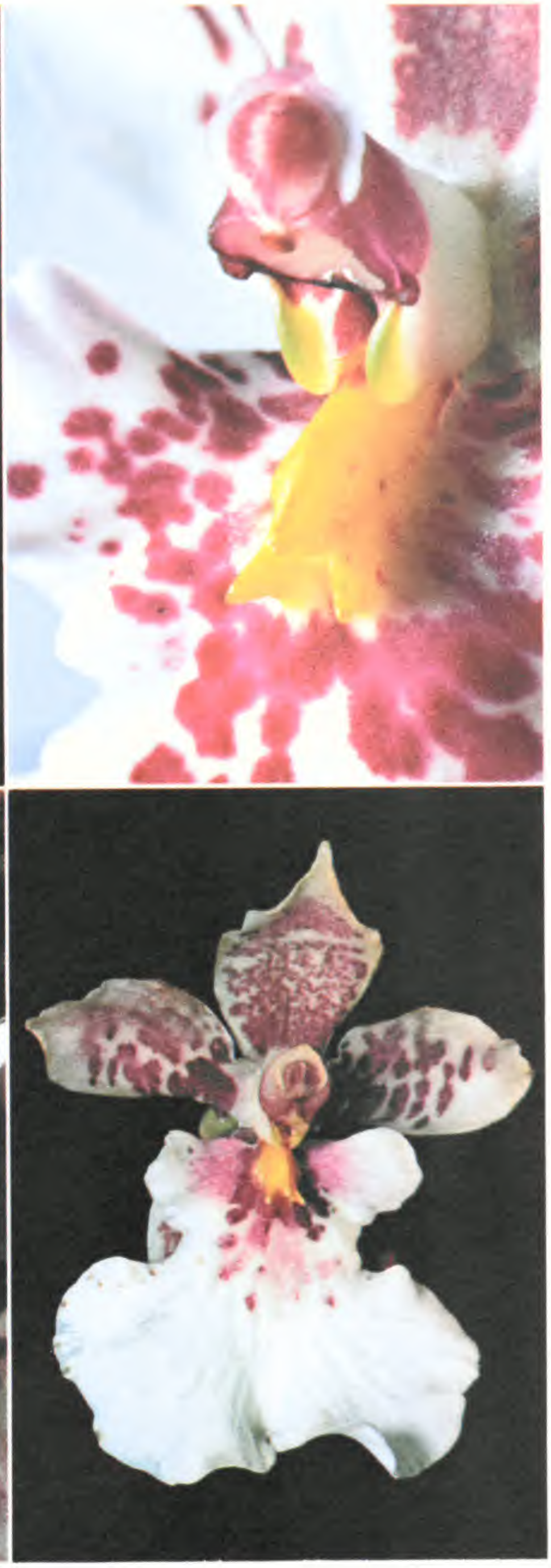
Plate XLIII.



Top left and right: *Oncidium Dayanum*. Photographs: G. Kennedy.
Bottom left and right: *Oncidium spathulatum*. Photographs: G. Kennedy.

Plate XLIV.





Top: *Oncidium tarquiense.* Photograph: J. Stacy.
Bottom: *Oncidium alticola.* Photograph: R. Escobar-R.

Plate XLV.



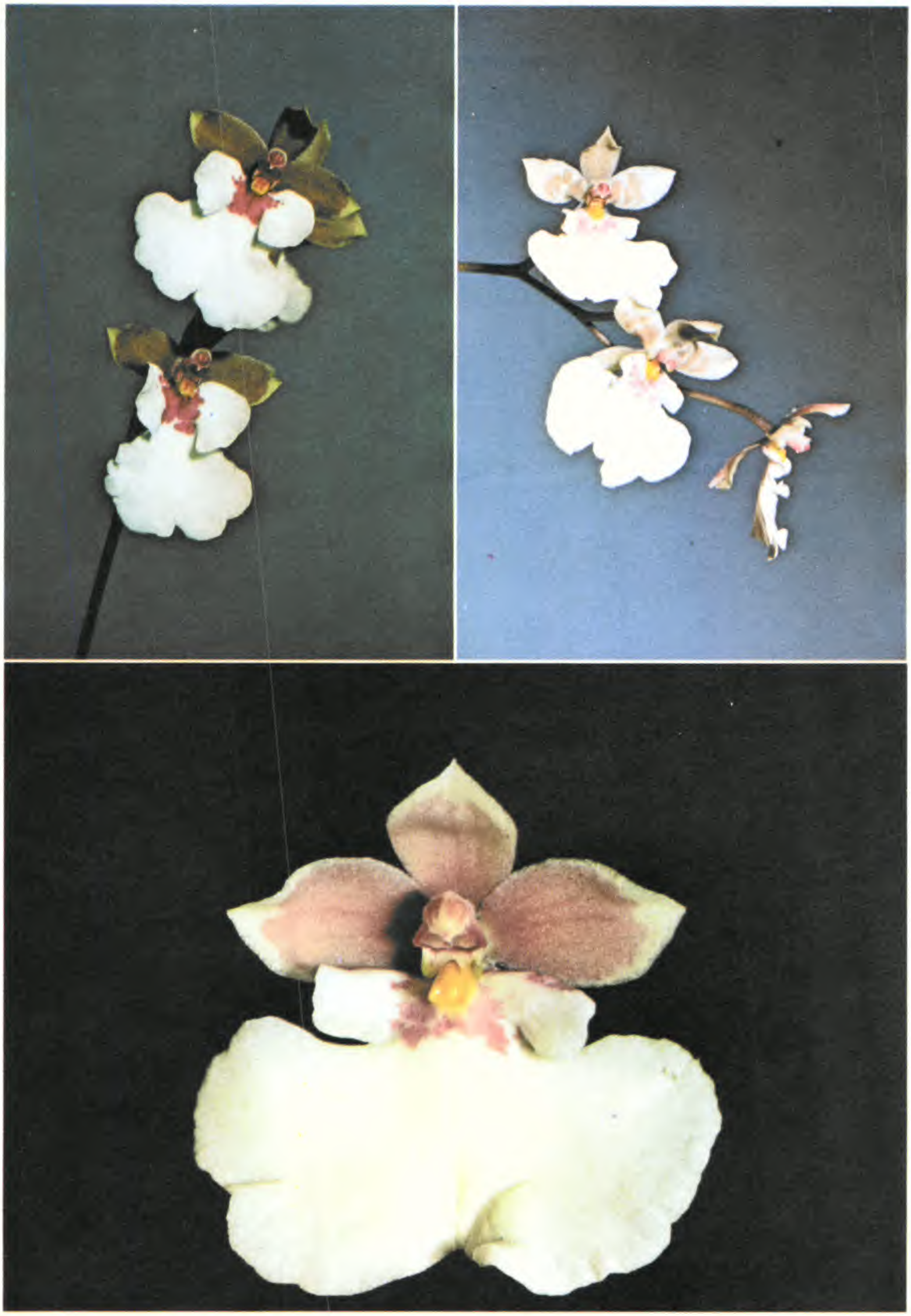
Top and bottom: *Oncidium nubigenum*. All photographs by G. Kennedy.

Plate XLVI.



Top left: *Oncidium alticola*. Photograph: G. Escobar-R.
Top right: *Oncidium erosilabium*. Photograph: R. Escobar-R.
Bottom: *Oncidium chimborazoënse*. Photograph: G. Kennedy.

Plate XLVII.



Top: *Oncidium aequinoctiale*. Photograph: R. Northen.
Bottom: *Oncidium tunguraguense*. Photograph: J. Stacy.

Plate XLVIII.



APR 19 197

BOTANICAL MUSEUM LEAFLETS
HARVARD UNIVERSITY

CAMBRIDGE, MASSACHUSETTS, APRIL 9, 1976 VOL. 24, NO. 8

PLANTAE COLOMBIANAE XIX

E PARTIBUS AMAZONICIS WITOTORUM PLANTAE FRUCTUARIAE SATIVAE NOVAE

BY

RICHARD EVANS SCHULTES

In studiis ethnobotanicis meis de plantis alimentis indiorum witotorum e Amazonia colombianae duas arbores novas inveni: unam e genere leguminosarum, Inga; alteram e genere apocynacearum, Macoubea. In regionibus Río Karaparaná et Río Igaraparaná utraeque arbores ab indigenis coluntur.

Doctori Thomas S. Elias pro descriptione speciei Ingae novae gratias ago. Similiterque erga Patrem Miguel Junyent, Matrem Holga Edith Sajona et Sororem Ligia Maria Ochoa, propagatores doctrinae christianae catholicae in colonia San Rafael apud Río Karaparaná inferiorem, pro beneficentiis suis, praecipue mihi flores ex arbore typica praebuisse, gratus sum.

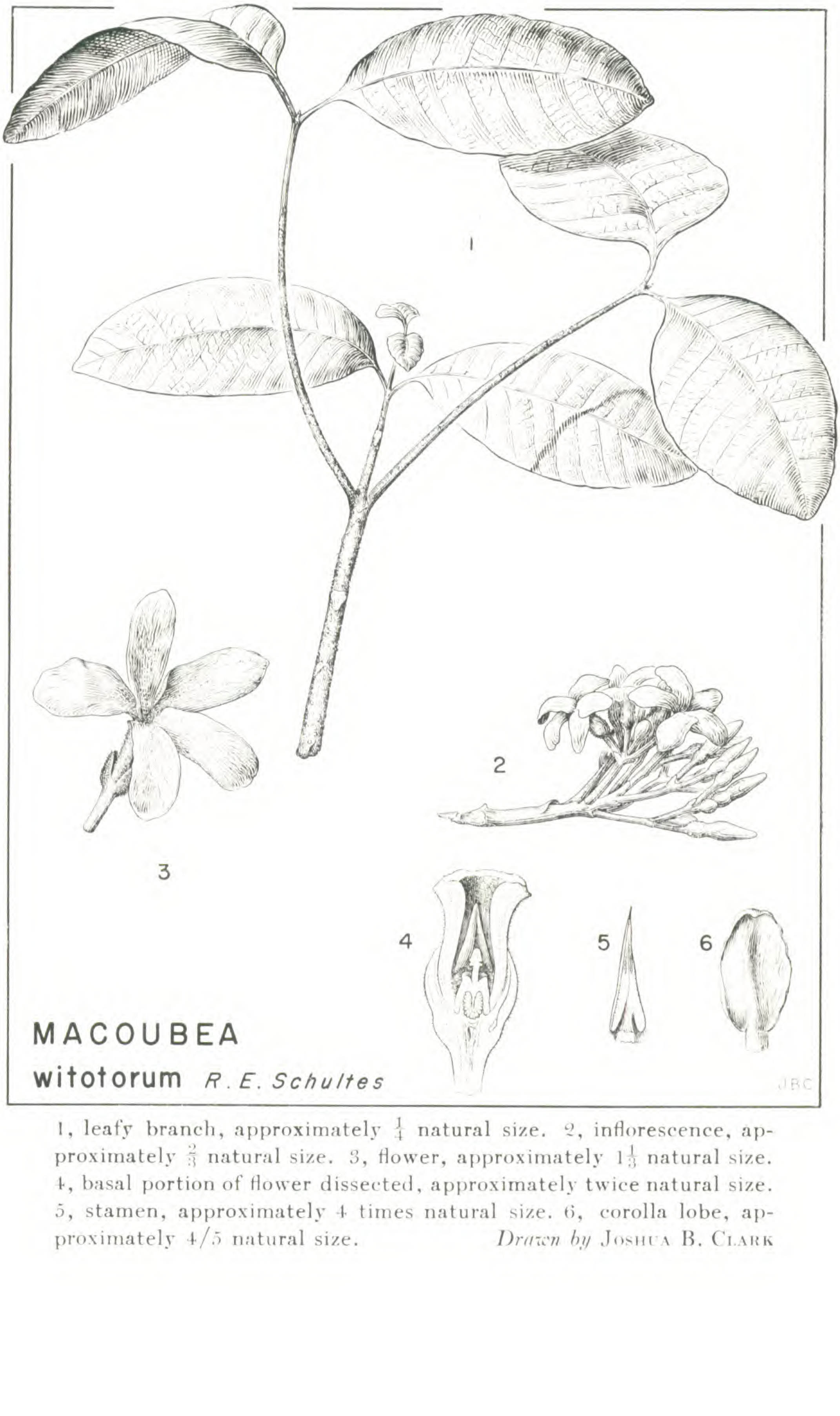
APOCYNACEAE

Macoubea witotorum *R. E. Schultes spec. nov.*

Arbore usque ad quadraginta ped. alta, dense foliosa, ex radice singulare truncis multis, in terra non inundabile culta; cortice laeve, crasso, in maculis albido-griseo, abundanter albo-lactifere. Folia valde chartacea, supra atroviridia, infra pallide viridia, late elliptica, base aequalia, apice obtusa vel rarenter subacuta, lamina 20–24

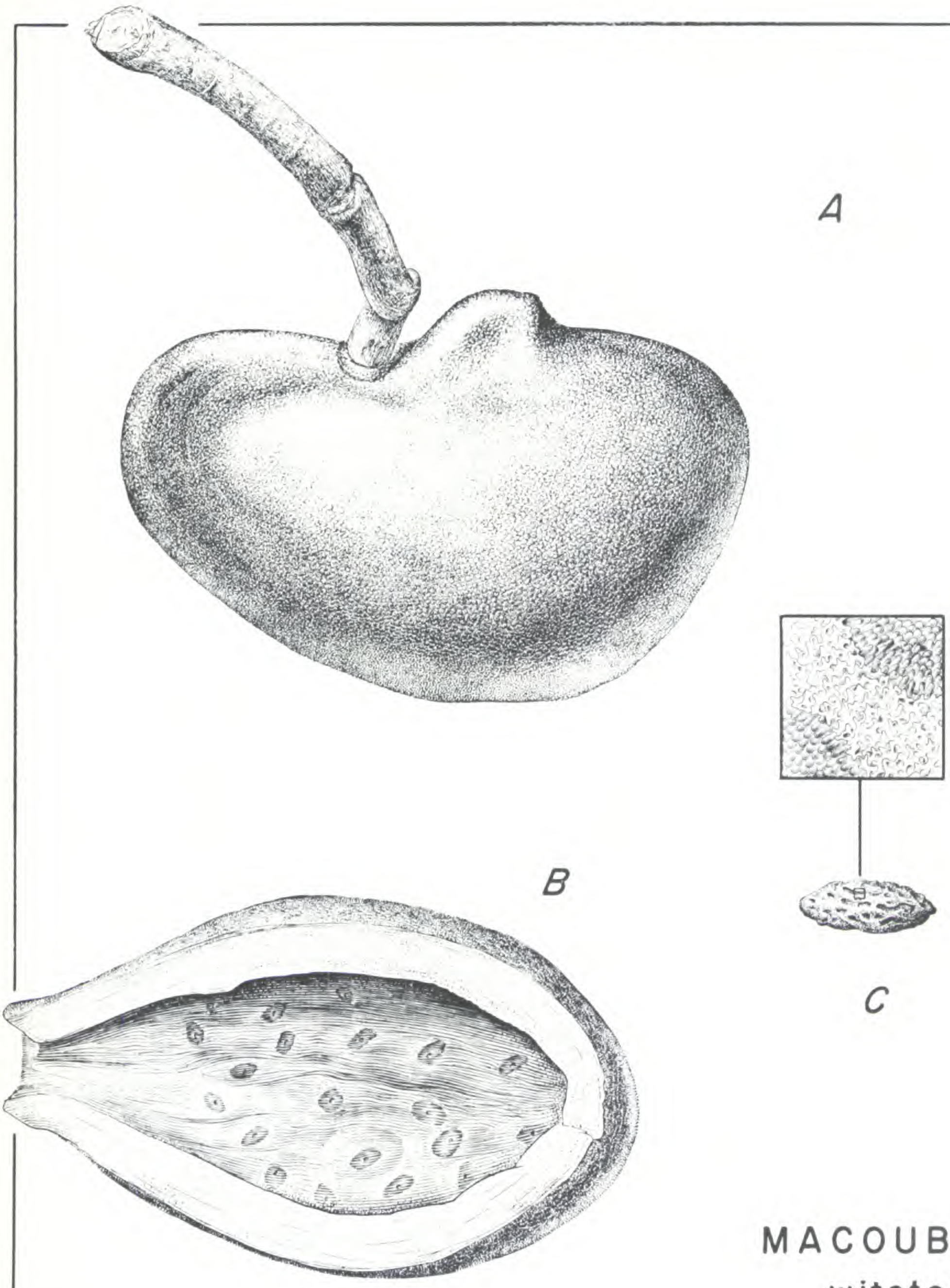
ECONOMIC BOTANY LIBRARY
OF OAKES AMES
HARVARD BOTANICAL MUSEUM

Plate XLIX



1, leafy branch, approximately $\frac{1}{4}$ natural size. 2, inflorescence, approximately $\frac{2}{3}$ natural size. 3, flower, approximately $1\frac{1}{3}$ natural size. 4, basal portion of flower dissected, approximately twice natural size. 5, stamen, approximately 4 times natural size. 6, corolla lobe, approximately 4/5 natural size. *Drawn by* Joshua B. Clark

Plate L



A, fruit, approximately $\frac{1}{2}$ natural size. B, dissected fruit, showing placement of seeds, approximately $\frac{1}{2}$ natural size. C, seed, approximately natural size, with detail of surface greatly enlarged.

Drawn by Joshua B. Clark

cm. longa, 11–15 cm. lata, utrinque glabra, nervis utrinque prominentibus; petioli 1–2.5 cm. longi. Inflorescentiae corymbosae, multiramosae, usque ad trigintiflorae, bracteatae, minutissime griseo-puberulae, axibus principalibus robustis, usque ad 3 cm. longis, pedicellis brevibus, plerumque 1 cm. vel brevioribus, minute bracteolatis. Flores albido flavi vel eburnei, non fragranti, plus minusve 25 mm. longi. Calyx persistens; corollae lobis vix contortis, base glandulosis, ovatis, 15 mm. longis et basin 10 mm. latis; corollae tubo quam lobis multo breviori, in fauce albo-piloso; antheris sessilibus, sagittatis, usque ad 4 mm. longis; ovario dense albo-piloso, stylo 0.8–1.2 mm. longo annulo crasso atrobrunneo coronato et crista quinquelobata capitata in acumine 0.8 mm. producto. Apocarpium magnum, usque ad 16 cm. longum, 11 cm. ×9 cm. in diametro, irregulariter reniforme vel stomachiforme, petioli basin versus submammiforme, extus in maturitate brunneum vel subaureo-brunneum, sordide granuloso-squammulosum, intus viridulum praeter seminarum lectum atrobrunneum, usque ad 15 mm. crassum, pulpa brunneola liquida dulce; seminibus plurimis, rubrobrunneis, curvatim elliptico-oblongis, superficie dense et grosse vermiculato-foveolatis, inter foveas minutissime cristatis, cristis magnopere minute indumento albospongioso indutis, 16 mm. longis, 6 mm. latis; pedunculo lignoso, 10 mm. crasso, usque ad 13 cm. longo, calyce valde persistente.

Colombia: Comisaria del Amazonas, Rio Karaparaná, San Rafael (in vicinity of El Encanto), near confluence with Rio Putumayo. "Tree up to 40 ft. Many trunks from root. Cultivated. Bark smooth, light grey with whitish patches. Latex copious, white, sticky. Leaves thick, coriaceous. Outside of fruit brown; inside light green except where seeds lie (which is brown). Pulp liquid, light brown, sweet, eaten. Seeds dark brown. Seeds and pulp from one fruit 250 cc. Witoto name: *oo-rroo'-soo-jẽ* (in Rio Karaparaná), *oo-koo-jẽ* (in Rio Igaraparaná)". March 30–April 2, 1970. *Richard Evans Schultes 26072* (Typus in Herb. Gray; Typi Duplicati in Econ. Herb. Oakes Ames;

Plate LI



Fruit of tree from which the type material of *Macoubea witotorum* was taken. *Photograph:* R.E. Schultes

Herb. Nac. Colomb.).—Same locality. "Flowers yellow-cream or whitish yellow, without fragrance. Taken from type tree". August 1970. *P. Miguel Junyent sine num.* (Floris Typi in Herb. Gray; Econ. Herb. Oakes Ames; Herb. Nac. Colomb.).

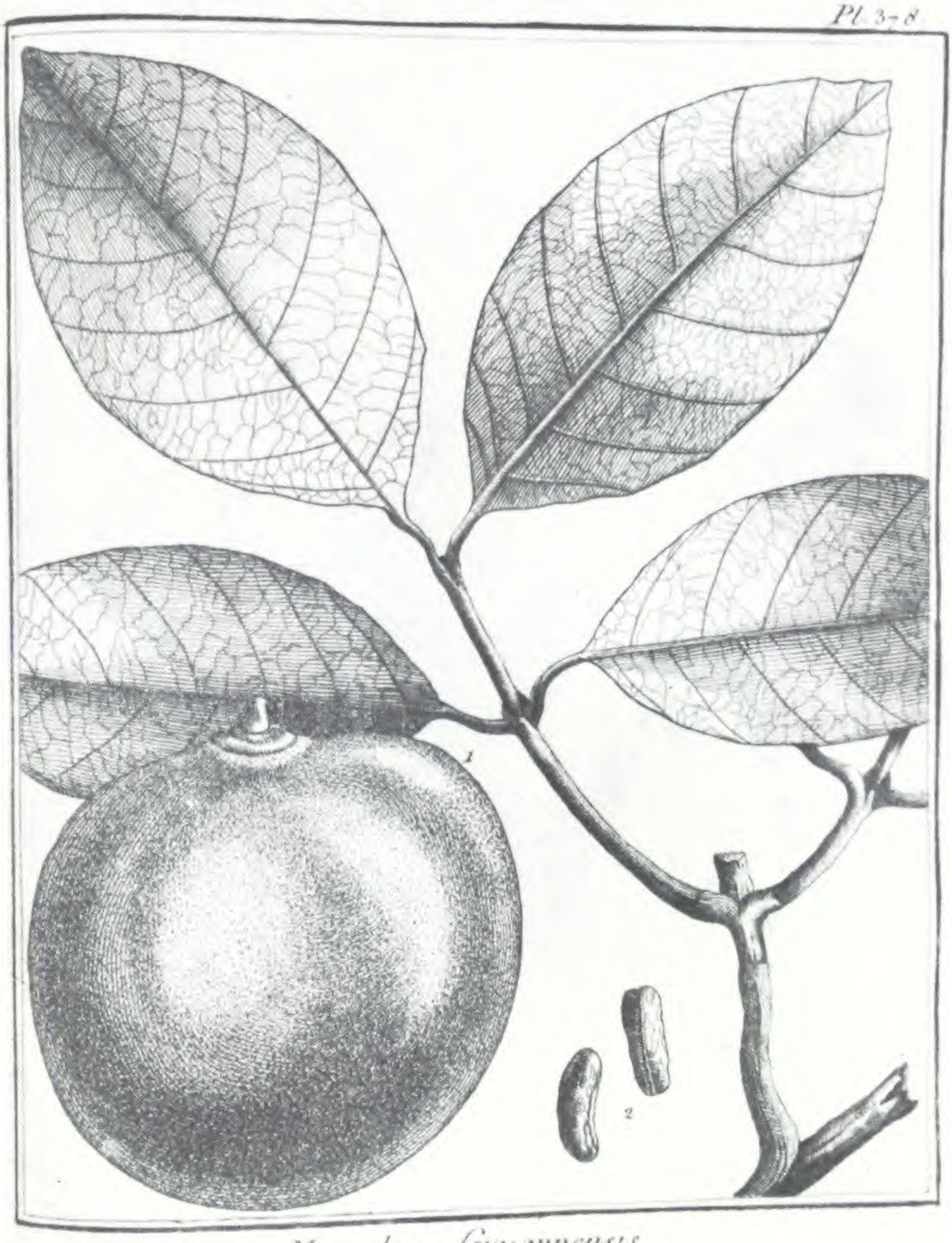
Genus Macoubea, ut hodie comprehenditur, duas species includit: *M. guianensis* Aubl., quae totam terram regionem guianarum atque Brasiliae amazonicae inhabitat, sed varietas eius, *M. guianensis* var. *pubiflora* Monachino, non nisi ex loco typi prope civitatem Iquitos, e regione Amazoniae peruvianae observatur; *Macoubea Sprucei* (Muell.-Arg.) Markgraf, cuius typus a Richard Spruce apud Río Uaupés juxta Brasiliae Colombiaeque terminum collectus est, tantum in regione Río Negro Brasiliae amazonicae afferitur; distributio varietatis eius, *Macoubea Sprucei* var. *pauciflora* (Spr. ex Muell.-Arg.) Monachino, cum specie congruit.

Secundum Monachino (Lloydia 8 (1945) 296), "species Macoubearum inter sese arcte affines. Differentiae primae quae in elementis variis discernendae possint in florium proportionibus magnitudinibusque fundantur, sed nequaquam constantes sunt".

Macoubea witotorum a speciebus adhoc cognotis non solum florium characteres proportionesque differt, sed etiam a *M. guianense* fructus formae proportionesque valde dissimilis est.

Praeterea haec species nova ab utraque specie florium characteribus minoribus distingui potest. *Macoubea witotorum* corollae lobi 15 mm. longi atque 10 mm. lati metiuntur, dum in *M. guianense* 3–4 mm. et in *M. Sprucei* 5–7 mm. lati sunt; corollae tubus quam lobus multo brevior qui in *M. guianense* quam lobus dimidium vel longior, et in *M. Sprucei* prope eadem aequilongus est. *Macoubea witotorum* a *M. guianense* fructus forma proportioneque facile distinguitur: in priore mericarpio immaniter reniforme vel stomachiforme est, 16 cm. longo

Plate LII



Macoubea Guyannensis

Illustration of *Macoubea guianensis*, published in Aublet: *Plantes de la Guiane Française* 2 (1775) t. 378.

et 11 cm. × 9 cm. in diametro metitur; in posteriore, globoso, circiter 6–8 cm. in diametro metitur.

Secundum exiguos libros, Macoubea arbores sunt silvicola et semper sua sponte crescunt et silvas in terra humida sed supra inundationem annuam preoptans. *Macoubea witotorum* est arbor quae ut videtur solum in cultura exsistit et semper in terra alta, bene siccata, nunquam inundata prosperat.

Indigenae tribus witotorum ut arbores solum in regione Ríos Karaparaná et Igaraparaná coleri affirmant, et verum est a me nunquam ipsis in multis meis annis explorationis in regionibus amazonicis invenitis per quos annos cogitationes meas plerumque versus plantas cultas dirigi. Si naturaliter occurrit, ea est rara.

Indigenae fructus parte terminale acutiore praecidunt vel in eo foramen faciunt et copiosam pulpam fulvam ducunt quae in forma liquidi dulcis adest. Infeliciter, studia nutrimenta huius liquidi non facta sunt, sed sine dubio sacchari abundantia saturata est. Semina non devoruntur.

Arbores mensibus martio aprileque fructus abundanter ferunt. Unusquisque exempla quae in cultura vidi multas (usque ad quinque vel sex) truncos corpulentos ex radice unico surgentes habuerunt. Utrum hoc proprium incrementum mutilationibus trunci primarii an ab indigenis eventus est non potuit, sed indigenae ipsae arborem normaliter hoc modo crescere affirmant et se nullo modo arborem ad conditionem faciendam truncare vel secare. Certe, hae incrementi consuetudo mensuram arbore coronae magnopere auget atque, propter hoc, abundantem segetem fructuum.

Doctor C. Sastre (Museum d'Histoire Naturelle, Paris) specimina florescentia quae ut videtur esse eiusdem Macoubeae species in pago La Chorrera prope Río Igaraparaná colligit.

Plate LIII


DIAGONAL SHADING ON INSET INDICATES AREA SHOWN IN DETAIL BELOW
COLOMBIA
QUITO
ECUADOR
RÍO CAQUETÁ
RÍO PUTUMAYO
PERÚ
BRASIL
IQUITOS
AMAZONAS
LETICIA
RÍO AMAZONAS
ARARACUARA
RÍO CAQUETÁ
FLORIDA
ÚLTIMO RETIRO
ENTRE RÍOS
UNIÓN
SABANA
LA CHORRERA
ORIENTES
STA. CATALINA
CONCEPCIÓN
RÍO KARAPARANÁ
RÍO KAHUINARÍ
EL RETIRO
PROVIDENCIA
FILADELFIA
MENAJE
ABISINIA
EL ENCANTO
SOLEDAD
ENEA
INDOSTAN
MEDIO DÍA
ARICA
RÍO PERÚ
RÍO PUTUMAYO
KARAPARANÁ-IGARAPARANÁ REGION of the COLOMBIAN AMAZON

COLOMBIA: Comisaría del Amazonas, Río Igaraparaná, La Chorrera. "Arbre, 10 m., latex blanc abondant, petales jaunes, fruits comestibles, pulpe liquide avec graines noires. Nom witoto: *ukurai*." September 29, 1973. *C. Sastre 2340*.

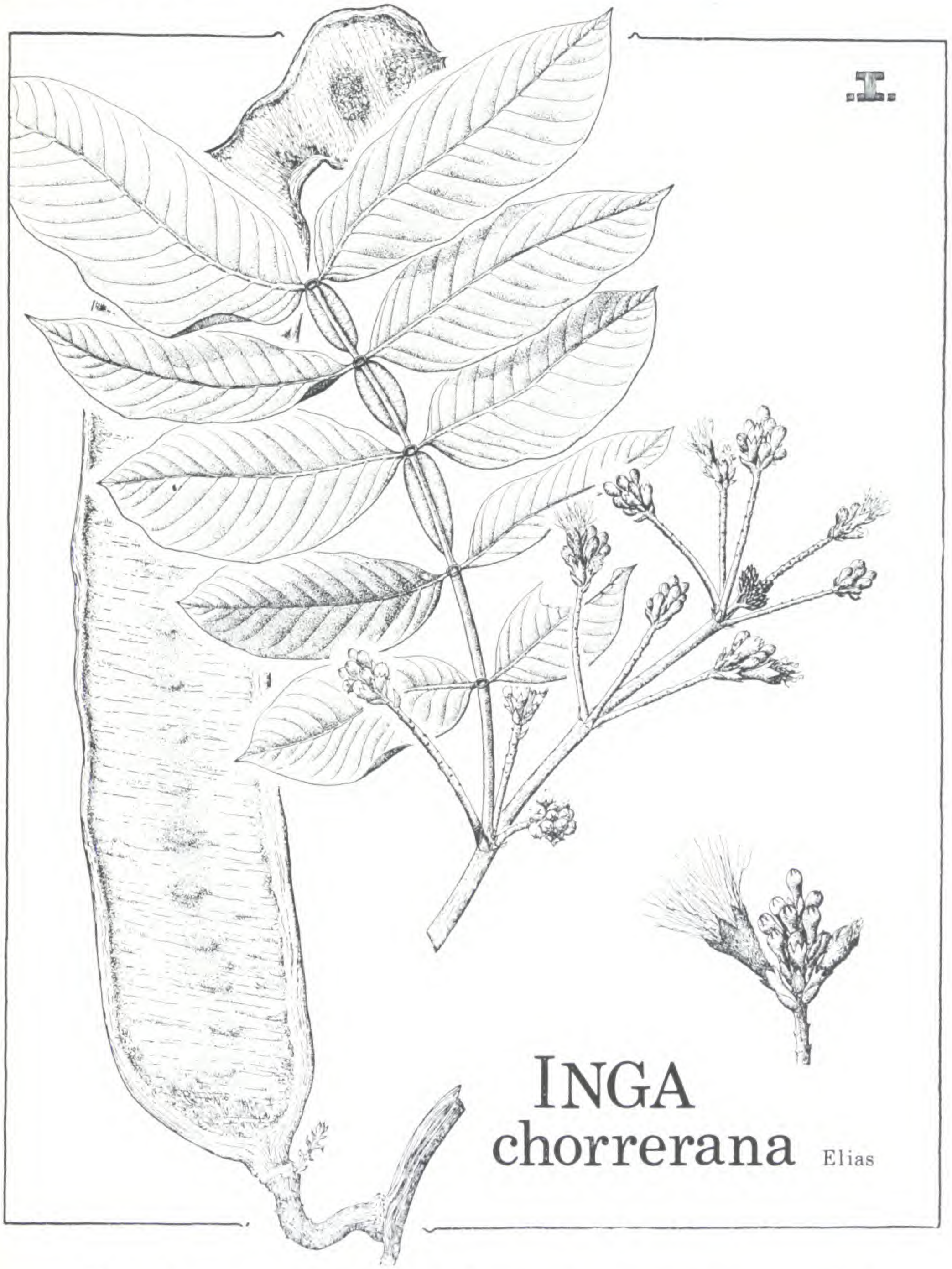
LEGUMINOSAE

Inga chorrerana *Elias spec. nov.*

Arbores parvae: ramis teretibus, sparse ferrugineo-tomentellis, lenticellis conspicuis. Ramuli ferrugineo-tomentosi. Folia petiolis 4–5 cm. longis, dense ferrugineo-tomentosis, partim inter juga superiora foliolorum dilatatis; ala late ellipticis vel obovatis, 6–12 mm. latis. Foliola 6-jugata, petiolulis 2–3 mm. longis, dense ferrugineo-tomentosis; lamina elliptica, apice apiculata, basi rotundata, 5.5–15 cm. longa, 2.8–5.5 cm. lata, subcoriacea, nervis lateralibus 16–20, subtus conspicuis; glandulae rhachidis 3–3.5 mm. diam., orbiculares; stipules non visae. Inflorescentiae multiflorae, spiciformes, 3–5 cm. longae, terminales aut in axillis superioribus dispositae; pedunculis 1–2 cm. longis, dense ferrugineo-tomentosis; bracteis late ovalis, apice acuminatis vel subapiculatis, 5–6 mm. longis, dense ferrugineo-tomentosis; calyx cylindricus, sessilis, 7–9 mm. longus, sparse tomentosus, lobis ovatis 1–1.5 mm. longis; corolla cylindrica, apice vix dilatata, 1.7–1.9 cm. longa, dense villosa, lobis ovatis 2.5–3 mm. longis; stamina tubo vix exserto; filamenta alba, ad 3.5 mm. longa; antherae dorsifixae; pistillum sessile, teres, ca. 2 mm. longum, glabrum. Legumen coriaceum, in maturitate areis ciliorum diffusis ferrugineo-villosum, plano-compressum, ad 45 cm. longum, 5–7 cm. latum, ca. 1 cm. crassum, marginibus vix elevatis. Semina sine testa, cotyledonibus 3–3.2 cm. longis, 1 cm. latis.

COLOMBIA: Comisaría del Amazonas, Río Igaraparaná, La Chorrera. Small tree. Pulp of fruits edible. Cultivated. Fruit 1–1½ ft., long, slender, thickness of index finger. Flowers white, fragrant. June 6, 1942. *Richard Evans Schultes 3896*. (TYPUS in Herb. Gray).

Plate LIV



INGA
chorrerana Elias

Habit drawing, approximately $\frac{1}{3}$ natural size. Pod, approximately $\frac{3}{8}$ natural size. Inflorescence, approximately natural size.

Drawn by Irene Brady

Hanc speciem arborem fructiferem ob siliquaram magnarum pulpa albam dulcem semina cingens coleri ferunt.

Doctor Elias scripsit: "*Inga chorrerana* in Sectione Inga, Series Spectabiles propter proprietates florales fructuosas debet. Ab aliis speciebus affinibus folio sexjugati, folium apice apiculato atque fructu pubescente distingueri potest. Ad *Ingam spectabilem* Willd. propinqua atque fortissime proxima ad *I. Goldmannii* Pittier ut videtur est."

PACHYTENE CHROMOSOME MORPHOLOGY AND ITS BEARING ON INTERSPECIFIC AND INTERGENERIC RELATIONSHIPS OF COIX*

BY

J. VENKATESWARLU[1], R.S.K. CHAGANTI[2], AND PANUGANTI N. RAO[1]

The genus Coix is a member of the tribe Maydeae (family Gramineae) which comprises seven genera. Two of these, Zea and Tripsacum, are native to the New World, while the rest, Coix, Chionachne, Trilobachne, Sclerachne and Polytoca, are native to southeast Asia (Mangelsdorf and Reeves, 1939). The Maydeae is a taxonomic rather than a natural assemblage of genera (Chaganti, 1965), with monoecism as the feature in common to both the New World and Asiatic members. However, from time to time, the existence of possible phylogenetic relationships between the two geographically separated groups has been postulated (Anderson, 1945; W.C. Galinat, personal communication).

Coix is the largest of the five maydeaceous genera native to Asia. Its systematics is confusing (Venkateswarlu

* Investigation supported by a grant from the Indian Council of Agricultural Research, New Delhi.

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and Chaganti, 1973). At least three highly polymorphic species assemblages are recognized, namely *C. aquatica* Roxb., *C. Lachryma-Jobi* L., and *C. gigantea* Koen. *C. aquatica* and *C. Lachryma-Jobi* have chromosome numbers of 2n=10 and 20 respectively, while in the case of *C. gigantea* populations with chromosome numbers of 2n=20 and 40 have been reported (Venkateswarlu and Chaganti, 1973).

Comparative chromosome morphology, especially at the pachytene stage of meiosis, where the chromosomes are more extended than at mitotic metaphase and often present characteristic features, is a useful parameter in understanding interspecific and intergeneric relationships. In the case of Coix, such studies have been few (Venkateswarlu and Chaganti, 1973). We have studied and report here the pachytene chromosome morphology in populations of Coix representing the three species.

Materials and Methods

Samples of seeds from populations representing the three species were assembled from different regions of India. Some were collected in the field by the authors, while others were collected for them by colleagues in different parts of the country. In addition, two samples from Japan and one from Brazil (countries in which Coix is not native, but into which it has been introduced for use as a fodder, cereal or ornamental) were also obtained. The geographic origin and method of collection of all the seed material is listed in Table I. Plants were raised from these seeds in the experimental gardens of the Department of Botany of the Andhra University. Young inflorescences were fixed in 3:1 ethanol-acetic acid. After 24–48 hours of fixation, the fixative was replaced by 70% ethanol. The material was stored in this fluid at 4° C, until used for study.

Acetocarmine squash preparations were made of young anthers. Appropriate nuclei were photographed, and camera lucida drawings were made of them from temporary preparations. Chromosomes were measured from camera lucida drawings alone, and their lengths, which include the centromeric regions, are expressed in micron units. Numbers are assigned to chromosomes on the basis of decreasing order of length: thus chromosome 1 is the longest of the complement. Individual chromosomes are identified on the basis of their length, arm-ratio (length of long arm/length of short arm), and the pattern of distribution of heteropycnotic and eupycnotic region.

Observations

Coix aquatica Roxb. The chromosomes of this species are difficult to study at pachytene, because they are long and often intertwined. In addition, the chromosomes possess long heteropycnotic segments which often exhibit non-homologous association (Plate LV), thereby making it difficult to follow the chromosome from one end to the other. Deep staining heteropycnotic regions are present in the proximal regions of both arms. Additional heteropycnotic regions are present at other locations on the chromosome arms. The chromosome arms terminate in pronounced and dark staining chromomeres. Exact measurements of the heteropycnotic regions were not possible to obtain, because of variability in their extent (see Venkateswarlu and Chaganti, 1973). Camera lucida drawings of the five chromosomes are represented in Plate LVI, while the idiogram represented in Plate LX is based on mean values of length and arm ratio of five measurements for each chromosome (see Table II). The third longest chromosome of the complement has the nucleolus organizer in the long arm in a sub-terminal position (Plate LX).

TABLE I

Geographic origin and mode of acquisiton of seed material of the various populations belonging to the three species of Coix, viz., *C. aquatica* Roxb., *C. Lachryma-Jobi* L., and *C. gigantea* Koen, used in this investigation.*

Species**	Geographic Origin	Mode of Acquisition	Accession or Population Number
C. aquatica	Madhya Pradesh, India	supplied by: Prof. S.K. Pande, Saugar University	C.A.-6
"	Orissa, India	supplied by: Dr. G.V. Chalam, National seeds Corporation	C.A. 0-1
"	Andhra Pradesh, India	collected by one of the authors (RSKC)	C.A. 8
C. Lachryma-Jobi var. *typica* Walt.	Assam, India	supplied by: Regional Botanist, Botanical Survey of India	C-4a
"	Assam, India	supplied by: Regional Botanist, Botanical Survey of India	C-4b
"	unknown	unknown	C-7
"	Anantagiri in the coastal mountain range of southeastern Peninsular India (Eastern Ghats)	collected by one of the authors (RSKC)	C-8
"	Coimbatore, India	supplied by: Principal, Agricultural College	C-15
"	Campus Wild. A colony of plants growing wild on the Andhra University Campus. Could have started as escapees from cultures in the University Botanic Gardens. Primary source unknown.	collected by the authors	—

C. Lachryma-Jobi var. *monilifer* Walt	Dehra Dun, India	supplied by: Regional Botanist, Botanical Survey of India	C-10a
"	Dehra, Dun, India	supplied by: Regional Botanist, Botanical Survey of India	C-10b
"	Japan	supplied by: Dr. Harada, Crop Science and Breeding Laboratory, Department of Agriculture, Saikyo University, Kyoto	C-11
C. Lachryma-Jobi var. *stenocarpa* Stapf	Assam, India	supplied by: Regional Botanist, Botanical Survey of India	C-2
"	Japan	supplied by: Dr. Harada, Crop Science and Breeding Laboratory, Department of Agriculture, Saikyo University, Kyoto	C-3
C. Lachryma-Jobi var. *ma-yuen* (Romanet) Stapf	Assam, India	supplied by: Dr. Rolla S. Rao, Botanical Survey of India	C-5
"	Brazil	supplied by: Dr. R.V. Schaaffhauser, St. Amaro, Sao Paulo	C-1
C. Lachryma-Jobi Morphologically intermediate between vars. *monilifer* and *typica*.	Anantagiri, India	collected by one of the authars (PNR)	C-6
C. gigantea	Coastal mountain range of south-western Peninsular of India (Western Ghats)	supplied by: Dr. Rolla S. Rao, Botanical Survey of India	C.G. 1

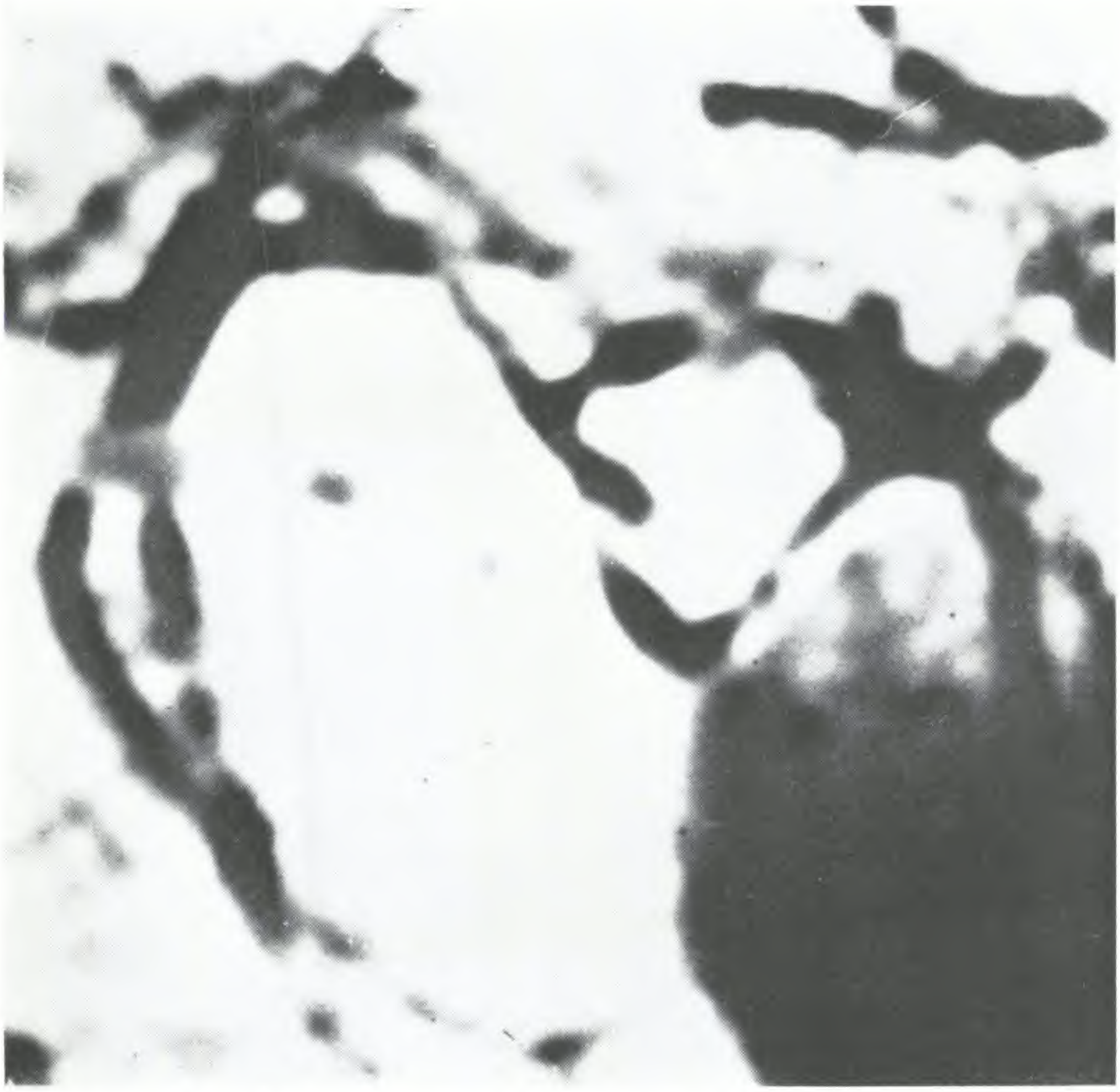
* We are grateful to the various people listed in column 3 who supplied us with seed samples.

** Herbarium specimens of all the species and varieties listed above have been deposited in the Andhra University Herbarium.

Coix Lachryma-Jobi L. Chromosomes of all the populations examined, with the exception of one (C-8 in Table I), show differential staining into eu- and heteropycnotic regions as in the case of *C. aquatica*. Heteropycnotic segments are always present in the proximal regions of both arms. In this species also the chromosome arms terminate in deep staining chromomeres. In addition, terminal as well as intercalary knobs are present. The sizes and numbers of knobs vary in the different populations. Thus, some populations are devoid of knobs (e.g., population C-4b), while others possess them (e.g., eight knobs are present in population C-4a). Detailed studies were not performed of knob frequencies in the various populations. A complete analysis of the pachytene chromosome morphology was achieved in one population (C-8), in which the chromosomes do not exhibit differential staining (Plate LVII, a, b). An idiogram (Plate LX) was constructed on the basis of average value of up to five measurements of lengths and arm ratios for each chromosome (see Table II). The sixth longest chromosome of the complement has the nucleolus organizer in the long arm in a nearly terminal position (Plate LX). Plate LVIII illustrates the nucleolus organizing chromosome in a population (campus wild) that shows differential staining of chromosome regions.

C. gigantea Koen. Of this species, populations have been reported by several investigators (Darlington and Janaki Ammal, 1945; Nirodi, 1955; Venkateswarlu and Chaganti, 1973) with chromosome numbers of $2n=20$ and $2n=40$. The population that we studied (C.G. 1, which is native to the mountain range on the west coast of peninsular India called the Western Ghats) exhibited variation in chromosome numbers ranging from $2n=18$ to $2n=22$. One of the plants with 18 chromosomes (which at meiosis forms nine bivalents) exhibited well

Plate LV



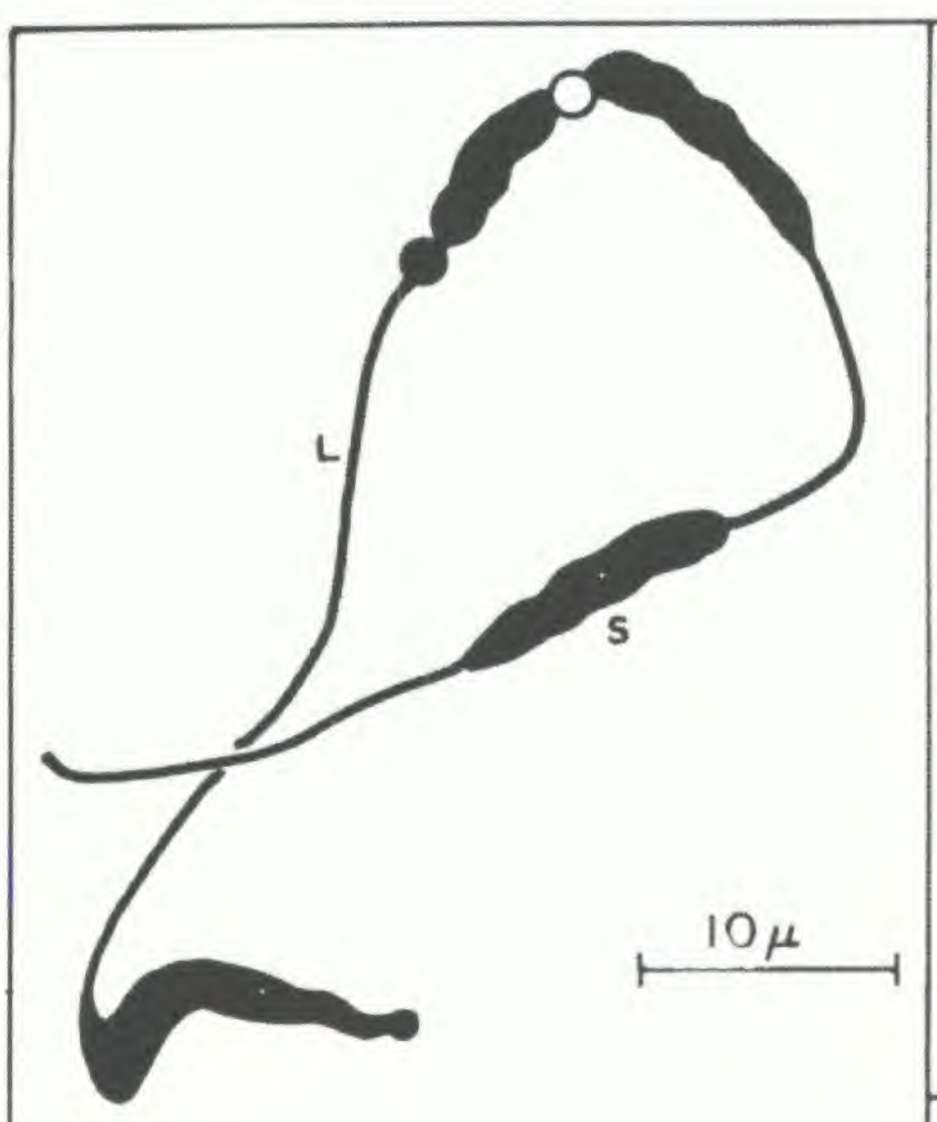
Portion of pachytene nucleus of *C. aquatica* showing non-homologous association of centromeres and heteropycnotic regions.

spread pachytene chromosomes (Plate LIX, a, b). All the chromosomes of this species, just as in the case of those of *C. aquatica* and *C. Lachryma-Jobi*, show differential staining into eu- and heteropycnotic regions, the latter being present in the proximal as well as interstitial regions of chromosome arms. Furthermore, the chromosome arms terminate in deep staining chromomeres. An idiogram constructed on the basis of mean values of at least ten measurements of lengths and calculation of arm ratios for each chromosome is presented in Plate LX (see Table II). The eighth longest chromosome of the complement has the nucleolus organizer situated almost terminally on the entirely heteropycnotic short arm (Plate LX).

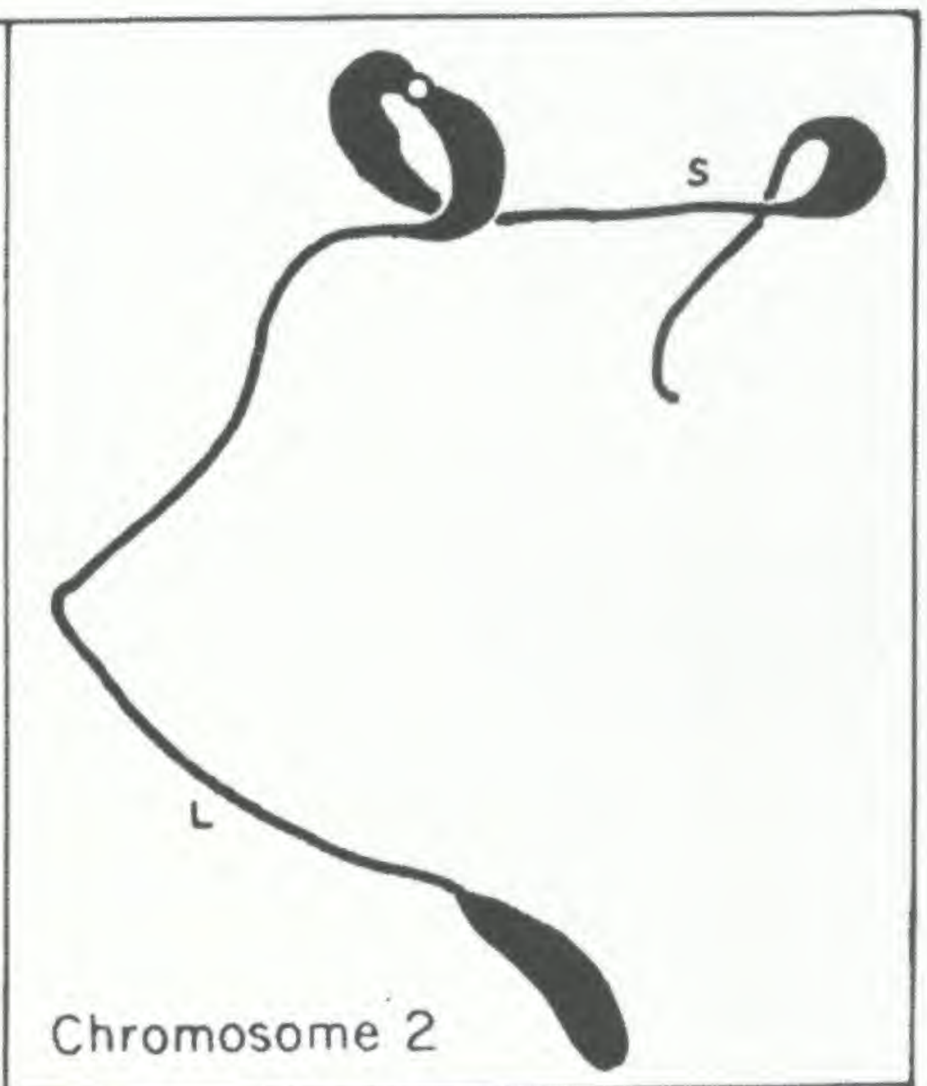
Discussion

Variation in chromosome morphology and knob numbers in C. Lachryma-Jobi: The species of Coix are predominantly outbreeding. Four to six varieties have been recognized in *C. Lachryma-Jobi* based on morphological features of the fruit case (Mimeur, 1951; Bor, 1960). The varieties interbreed readily if grown together and allowed to open pollinate and their identity is lost within a few generations. Hence, the varietal differences are based on gene mutations, and the varieties arose through geographic isolation of populations or through selection by man. The variation observed at the population level in the chromosome phenotype: namely, the degree of heteropycnosis in chromosome arms and the sizes and numbers of knobs; can also be considered part of the same evolutionary processes that lead to varietal delineation. A detailed study of the variation of the chromosome phenotype has not yet been accomplished, but available information points to existence of a considerable amount of it. The fact that, in one of the populations

Plate LVI

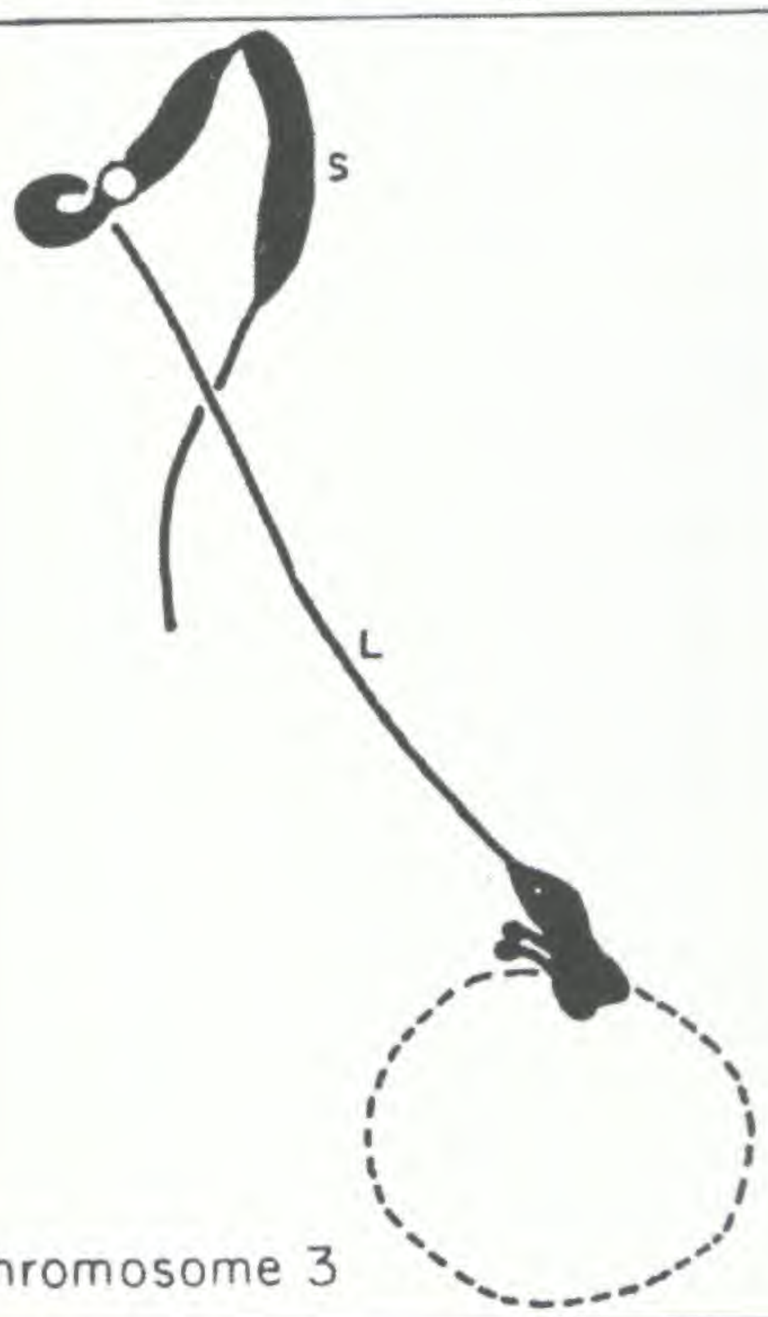


Chromosome 1



Chromosome 2

Chromosomes 4(A) and 5(B)



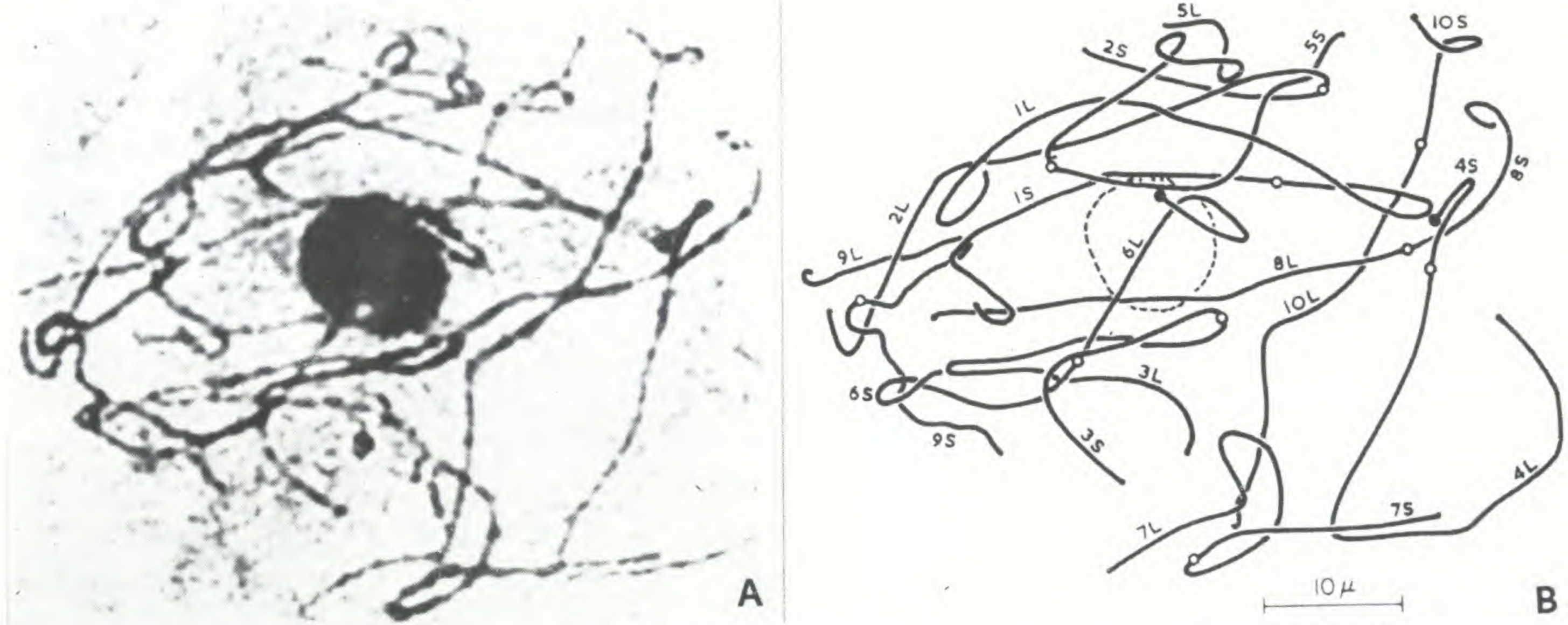
Chromosome 3

Camera lucida drawings of the five chromosomes of *C. aquatica* at pachytene.

(C-8), the chromosomes did not exhibit heteropycnosis might indicate that this feature is in some way controlled by the genotype. It is well known that several facets of chromosome form and behavior are under genotypic control (Rees, 1961; Chaganti, 1965). Knobs occur on the pachytene chromosomes of other members of Maydeae, e.g., Zea and Tripsacum. In these genera, numbers and positions at which knobs occur are characteristic features of populations. In *C. Lachryma-Jobi* var. *typica* collected at Coimbatore, a city in southwestern India, Nirodi (1955) observed five terminal and one interclary knobs. In a population (C-8) of the same variety collected at a different location (Anatagiri in the coastal mountain range in southern peninsular India called the Eastern Ghats), we found only two terminal knobs. In yet another population (C-4a) of the same variety originating from a different locality in India (Assam, a hilly province in eastern India), we found eight knobs. The relationship of knob variation to geographic distribution of the populations remains to be studied.

Non-homologous associations of centromeres and heteropycnotic regions in C. aquatica: In *C. aquatica*, at pachytene, non-homologous centromeres as well as non-homologous heteropycnotic regions are frequently associated (Plate LV). These associations, however, fall apart before diakinesis. The chromosomes of *C. Lachryma-Jobi* and *C. gigantea* exhibited none of these characteristics. The significance of such association is not known; however, it is likely that exchanges might take place in the associated regions and lead to reciprocal translocations as suggested by Venkateswarlu (1958). The genome of *C. aquatica* is characterized by a degree of instability; complex translocations are of frequent occurrence in natural populations (Venkateswarlu and Chaganti, 1973).

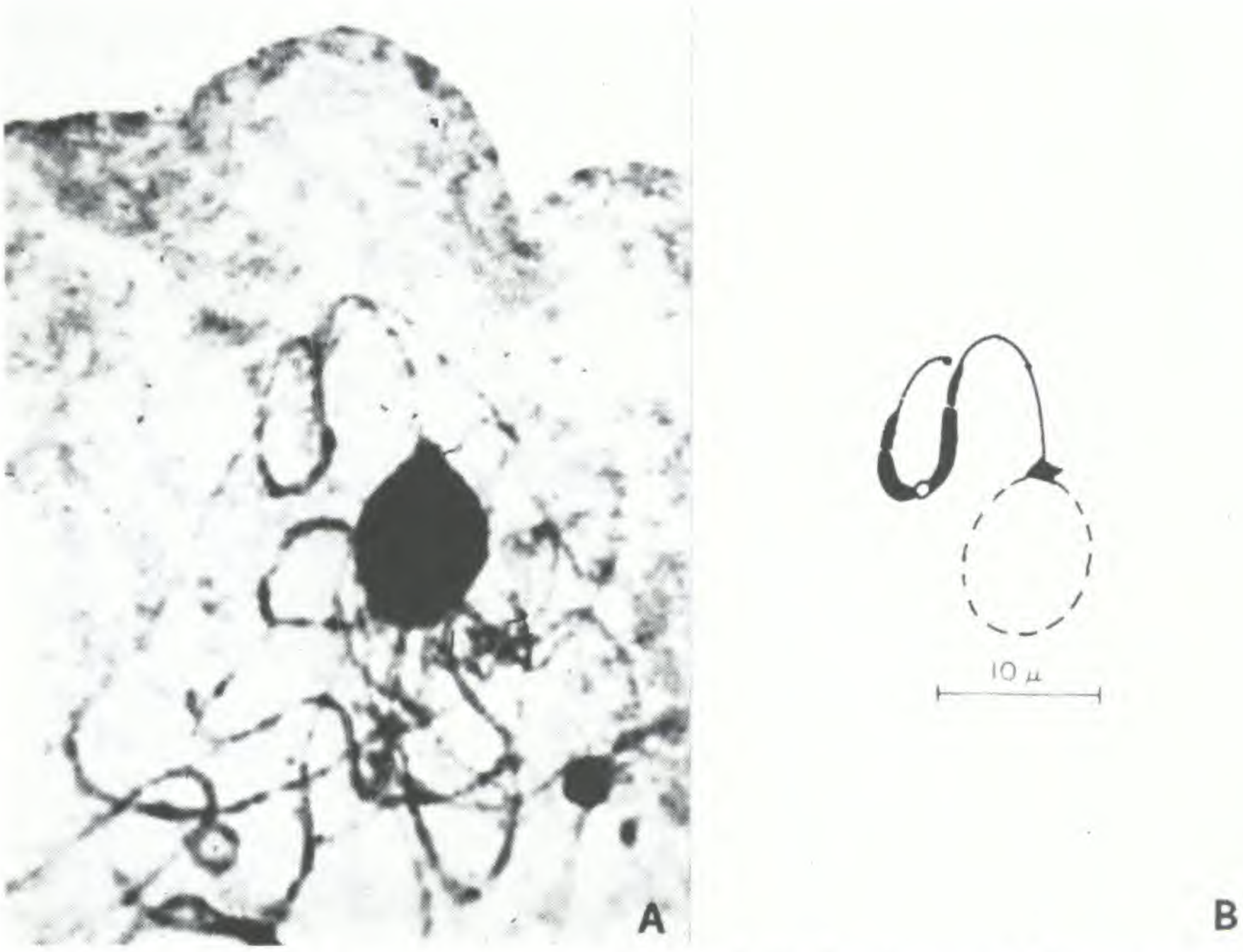
Comparison of the genomes of the three species: A com-



(a) The nucleus of a microsporocyce of *C. Lachryma-Jobi* var. *typica* (population C-8 in Table I) at pachytene. Differential staining of eu- and heteropycnotic regions is not evident. (b) A camera lucida drawing of the same nucleus. S = short arm; L = long arm; open circle = centromere; broken circle = nucleolus.

parison of the idiograms of the three species (Plate LX) reveals that, except for the nucleolus organizing chromosome, the chromosomes of the three species are quite dissimilar in their morphology. The length of each chromosome, its arm ratio, and the contribution its length made to the total length of the genome are given for the three species in Table II. *C. aquatica* has the longest chromosomes of the complement, with a genome which is 401.9μ long (mean chromosome length of 80.38μ). The genomes of *C. Lachryma-Jobi* and *C. gigantea* respectively are 582.0μ (mean chromosome length of 58.2μ) and 488.8μ (mean chromosome length of 54.31μ) long; thus *C. Lachryma-Jobi* and *C. gigantea* have genomes of approximately equal length. They are also shorter than that of *C. aquatica* by about 40%. The nucleolus organizing chromosomes of the three species, even though of widely differing lengths and arm-ratios, are similar; they are median to submedian, and the nucleolus organizer occupies a sub-terminal position. The dissimilar morphology of chromosomes between the presumably basic diploid *C. aquatica* and the derived polyploid species *C. Lachryma-Jobi* and *C. gigantea* must reflect, on the one hand, the effects of hybridity and chromosome doubling which presumably have been involved in the emergence of the species with higher chromosome numbers, and, on the other hand, the proneness of the genome of *C. aquatica* to re-patterning due to translocation (Venkateswarlu and Chaganti, 1973). Interspecific hybrids between *C. aquatica* and *C. Lachryma-Jobi*, *C. Lachryma-Jobi* and *C. gigantea*, and *C. aquatica* and *C. gigantea* are feasible, and the chromosomes in the F_1 hybrids exhibit intergenomic pairing (unpublished observations of Rao). Thus, at least one genome is common to all three species even though its presence cannot be detected by comparison of chromosome morphology alone.

Plate LVIII

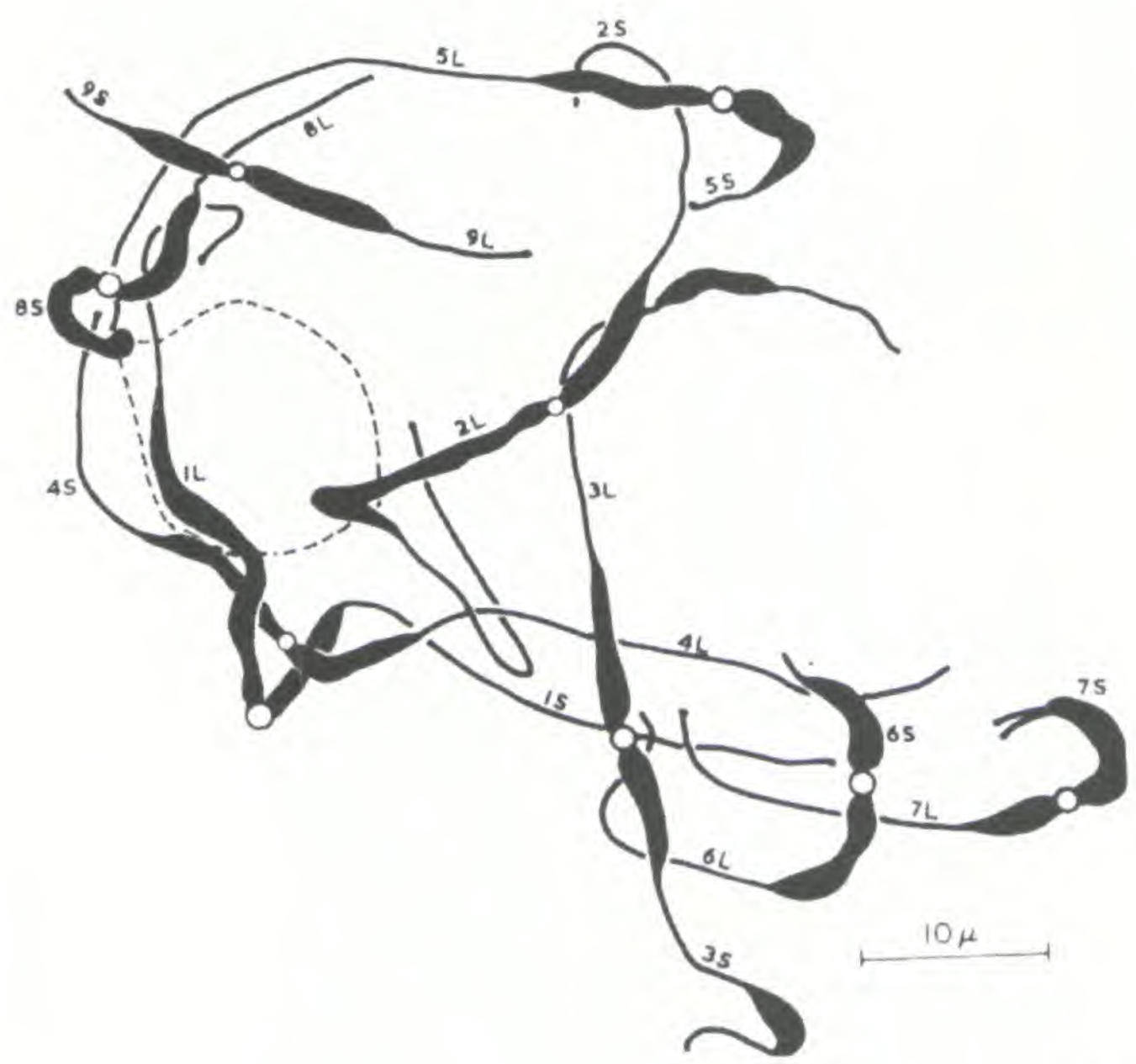


(a) Portion of a pachytene nucleus of *C. Lachryma-Jobi* var. *typica* (population Campus wild) showing the nucleus organizer chromosome. This population exhibits differentinl staining of eu- and heteropcynotic regions of the chromosomes which is evident in this cell. (b) A camera lucida drawing of the nucleolus organizing chromosome.

Comparison of the genomes of Coix, Sorghum and maize: The suggestion made by Anderson (1945) that maize originated in southeast Asia as an amphidiploid of a hybrid between species of Coix and Sorghum possessing a diploid chromosome number of 10, though rejected on a number of grounds (Mangelsdorf and Oliver, 1951; Chaganti, 1965), makes interesting a comparison of the morphology of the chromosomes of *C. aquatica* and species of Sorghum with a diploid chromosome number of 10. Pachytene chromosome morphology has been reported by other investigators in two species of Sorghum with a diploid chromosome number of 10: viz., *S. intrans* (Garber, 1947) and *S. purpureo-sericeum* (Reddi, 1958). The chromosomes of *S. intrans* are uniformly dark staining, and the centromeres are hard to locate in them. Three pairs are of one length; the remaining two are shorter and participate in nucleolus organization. The chromosomes of *S. purpureo-sericeum* are in the same size range as those of maize and possess dark staining chromomeres in the proximal regions of both arms, making the centromeres easy to locate. Neither species possess knobs. The genome of *C. aquatica*, at pachytene, is about 1.7 times longer than that of maize (data from this study compared to measurements of maize chromosomes at pachytene given in the publication of Rhoades, 1955), and the chromosomes themselves are quite dissimilar in morphology to those of maize. Chromosomes of *C. aquatica* show differentially stained eu- and heteropycnotic regions. They are also devoid of knobs. Maize chromosomes do not exhibit similar differential staining, and they possess knobs. Morphological comparisons, thus, do not reveal common features between the genomes of *C. aquatica*, *S. intrans*, and *S. purpureo-sericeum* on the one hand and maize on the other. This observation by itself, in the absence of

Plate LIX





B

(a) The nucleus of a microsporocyte of *C. gigantea* at pachytene. Differential staining of eu- and heteropycnotic regions is clearly seen. (b) A camera lucida drawing of the same nucleus. S = short arm; L = long arm; open circle = centromere; broken circle = nucleolus.

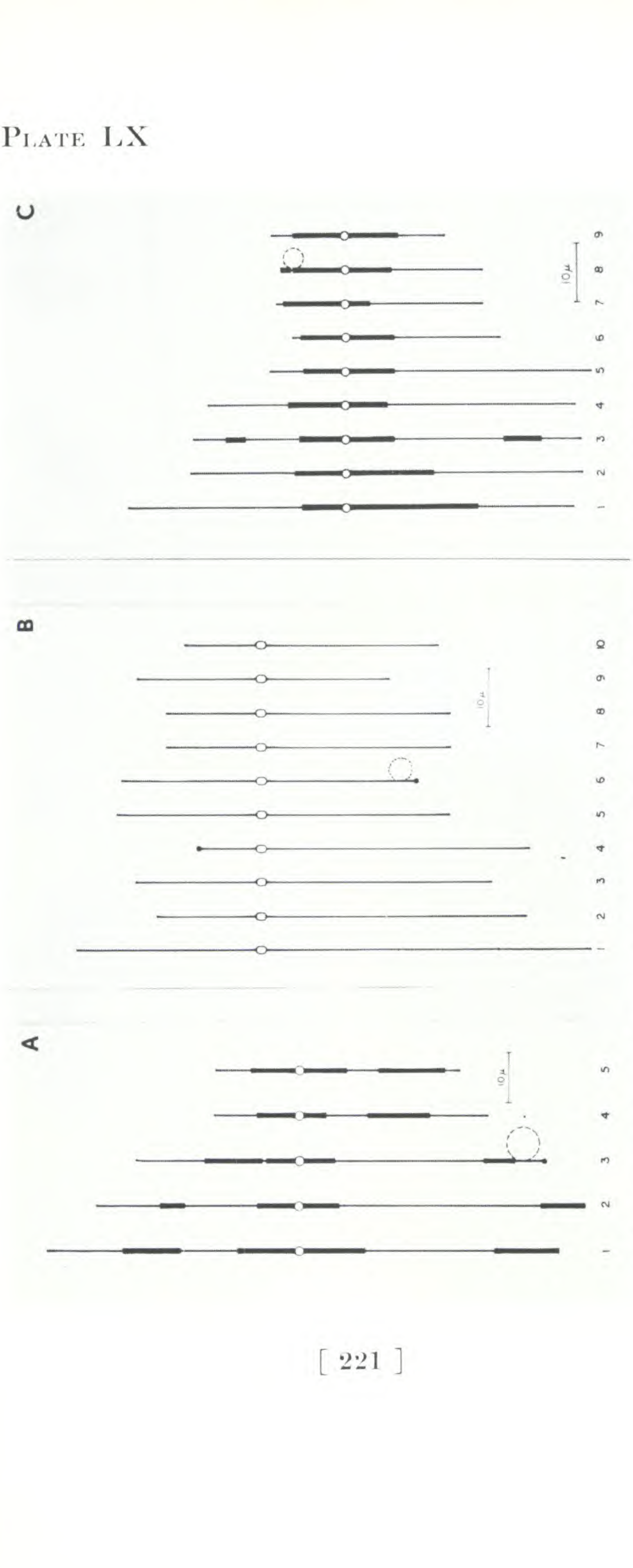
genome analysis based on hybridization, cannot be considered evidence against possible existence of true phylogenetic relationships between these species. As discussed earlier, even in the case of the genus Coix, comparison of the chromosome morphology of the three species does not indicate the presence of the common genome demonstrated by intergenomic pairing of chromosomes in interspecific hybrids.

Chromosomes of *C. Lachryma-Jobi* and maize exhibit a few similarities. They fall in approximately the same length range at pachytene (data from this study compared to measurements of maize chromosomes given in the publication by Rhoades, 1955) as well as at diakinesis and metaphase I (Longley, 1941). Knobs, the sizes of which and positions on chromosomes vary in different populations, are present in both species. There is, however, no evidence based on genome analysis to indicate that these similarities reflect true phylogenetic relationships. The many attempts made at producing viable hybrids between maize and Coix have so far met with failure (Mangelsdorf and Reeves, 1939; Venkateswarlu, 1963).

Summary

Lengths, arm-ratios, and other morphological features of chromosomes at the pachytene stage of meiosis are reported for three species of Coix, namely, *C. aquatica* (2n=10), *C. Lachryma-Jobi* (2n=20), and *C. gigantea* (2n=18). The genome of *C. aquatica* is the longest of the three species and is about 40% longer than that of either of the other two species. When stained with acetocarmine the chromosomes of *C. aquatica* show conspicuous differential staining into eu- and heteropycnotic regions. They also exhibit non-homologous association of centromeres and heteropycnotic regions. *C. Lachryma-*

Plate LX



Idiograms of the pachytene chromosomes of *C. aqualica*, *C. Lachryma-Jobi*, and *G. gigantea* prepared on the basis of mean values of lengths and arm-ratios presented in Table II.

TABLE II

Chromosome lengths*, arm ratios, and percent relative contribution of each chromosome to the total genome length at pachytene in three species of Coix, viz., *C. aquatica* Roxb., *C. Lachryma-Jobi* L., and *C. gigantea*.

Chromosome No.	Species								
	C. aquatica			*C. Lachryma-Jobi*			*C. gigantea*		
	Length	Arm ratio	Percent contribution to the total genome length	Length	Arm ratio	Percent contribution to the total genome length	Length	Arm ratio	Percent contribution to the total genome length
1	107.7	1.04	26.80	92.0	1.81	15.81	80.0	1.05	16.37
2	101.3	1.44	25.20	66.0	2.62	11.34	71.2	1.54	14.57
3	84.6**	1.50	21.05	63.2	1.89	10.86	70.0	1.55	14.32
4	56.9	2.33	14.16	59.2	4.58	10.17	67.2	1.70	13.75
5	51.4	1.97	12.79	59.2	1.32	10.17	58.0	3.41	11.87
6				52.0**	1.10	8.93	38.0	3.09	7.77
7				50.0	2.08	8.59	37.6	2.07	7.69
8				50.0	2.08	8.59	36.0**	2.22	7.36
9				45.6	1.04	7.84	30.8	1.39	6.30
10				44.8	2.44	7.70			

* In microns. Mean value of up to five separate measurements in the case of *C. aquatica* and *C. Lachryma-Jobi* and ten measurements in the case of *C. gigantea*.

** Nucleolus organizing chromosome.

Jobi exhibits variation in chromosome morphology between populations in two features: (a) the extent of differential staining into eu- and heteropycnotic regions: and (b) the numbers and positions on chromosomes of knobs which are present on the chromosomes of this species. The chromosomes of *C. gigantea* show differential staining as in the case of *C. aquatica* and some populations of *C. Lachryma-Jobi*. But they are devoid of knobs. Comparative chromosome morphology does not reflect the presence of the common genome (or genomes) detected by interspecific hybridization.

Comparison of chromosome morphology does not show similarities between *C. aquatica*, species of Sorghum with a diploid chromosome number of 10, and maize: whereas some similarities are evident between the chromosomes of *C. Lachryma-Jobi* and those of maize. Data on genome analysis based on intergeneric hybridization between Coix, Sorghum, and maize are not available in order to interpret in genetic terms the morphological comparisons made in this study.

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NEW CHIHUAHUAN UMBELLIFERAE

BY

LINCOLN CONSTANCE[1] AND ROBERT A. BYE, JR.[2]

Our knowledge of the Umbelliferae of the Mexican Estado de Chihuahua began apparently with Wislizenus' pioneer journey to northern Mexico just before the middle of the 19th Century, which yielded *Eryngium heterophyllum* Engelm. The activities of the 1880s' of those two doughty American collectors, Palmer and Pringle, led to the description of *Arracacia edulis* S. Wats., *Eryngium madrense* S. Wats., *Eulophus tenuifolius* S. Wats., *E. ternatus* S. Wats., *Museniopsis ternata* var. *filifolia* C. & R., *Prionosciadium madrense* S. Wats., and *P. Pringlei* S. Wats. A spate of field investigations at the turn of the century by Goldman, Nelson, M. E. Jones, and Townsend and Barber led to the discovery of *Conioselinum mexicanum* C. & R., *Eryngium fluitans* M.E. Jones, *E. Goldmanii* Hemsl., *E. medium* Hemsl., *Ligusticum Goldmanii* C. & R., *L. madrense* C. & R., *L. Nelsonii* C. & R., *Museniopsis pubescens* C. & R., and *Prionosciadium Townsendii* C. & R. In the 1930s' there was another wave of collecting by Gentry, LeSueur, Muller and Pennell. Gentry's intensive study of Río Mayo plants led to the description of *Eryngium calaster* Standl. Up to the present, some thirty taxa of Umbel-

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liferae are known to occur in the state, according to the taxonomic concepts of Mathias and Constance (1944–45). Since more than one-third of these taxa belong to the difficult genus *Eryngium*, this total is susceptible to change.

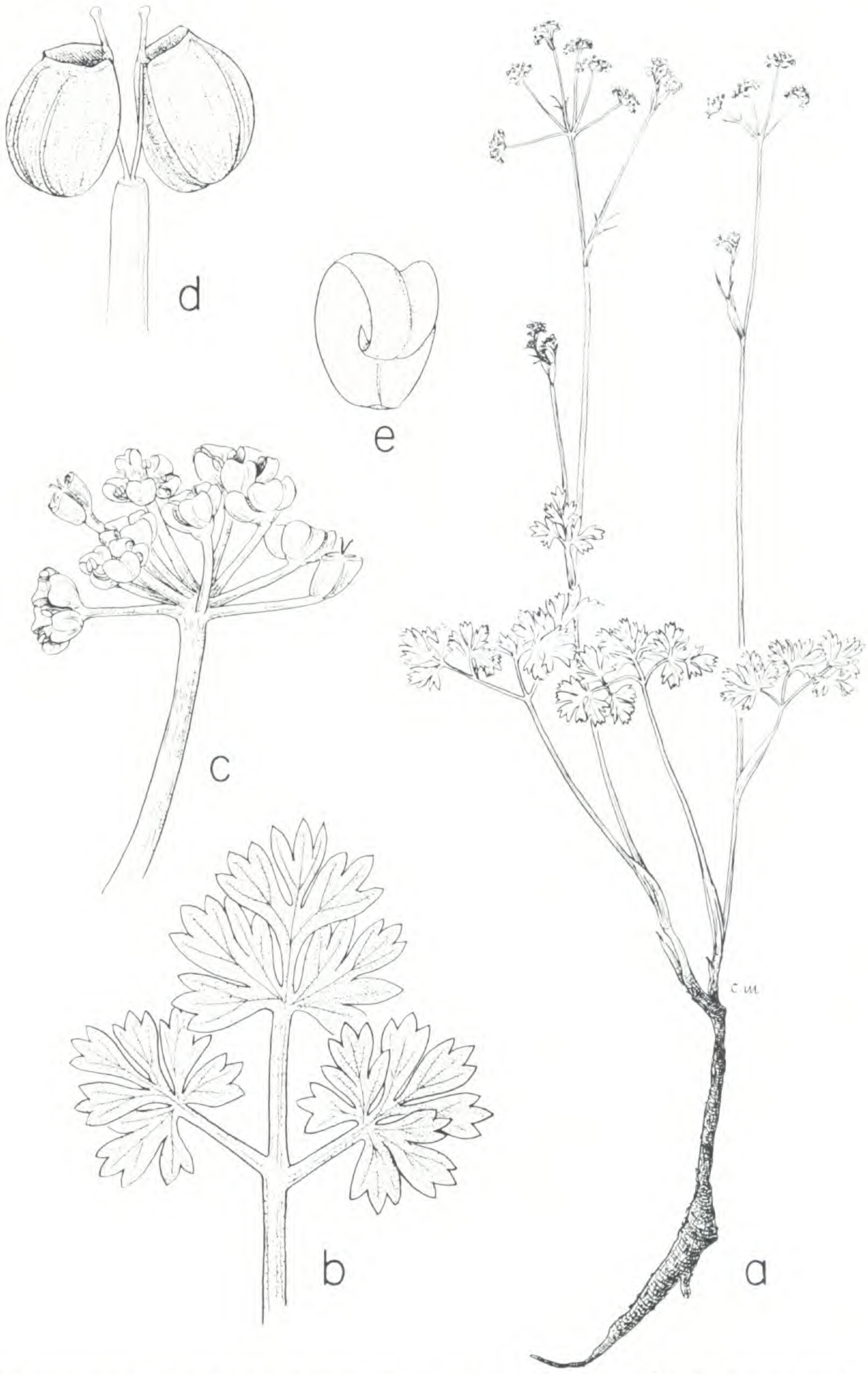
In his field studies[3] of the ethnobotany of the Tarahumara centered in the Sierra Madre of southwestern Chihuahua, the junior author has given particular attention to Umbelliferae. As a result, he obtained material of no fewer than twenty taxa (including cytological material of many of them). Four of the collections represent apparently undescribed species. The purpose of this paper is to put them adequately on record.

Donnellsmithia silvicola *Constance & Bye sp. nov.*

Plantae perennes caulescentes humiles condensatae; caules simplices vel pauciramosae sparsim foliati 8–25 cm. alti e radice palari tumida omnino glabrae; folia basalia deltoideo-orbiculata 1–3 cm. longa, 1.5–5 cm. lata, trifoliata, foliolis 3 ovalibus orbiculatisve, obtusis lobatis vel pinnatifidis diametro 1–2 cm.; petioli 1–8 cm. longi anguste scarioso-vaginantes; folia caulina ea basalia simulantia sed sursum reducta vaginis parum dilatatis; pedunculi usque ad 2 cm. longi pauci alternati graciles umbellis plerumque lateralibus sessilibus subsessilibusve; involucrum nullum; involucellum nullum; radii 2–5 filiformes patenti-adscendentes 6–25 mm. longi; pedicelli fertiles 0–2, 3–4 mm. longi; flores flavo-virentes; stylopodium depressum, stylis brevissimis; carpophorum usque ad basim bipartitum; fructus immaturus ovoideo-orbicularis 1.5 mm. longus, 2 mm. latus ad apicem ver-

[3] Financial support between 1971 and 1974 was generously extended by the Botanical Museum and the Department of Biology, Harvard University, the National Geographic Society and the National Science Foundation Grant GB-35047 for Improvement of Doctoral Dissertation Research.

Plate LXI



Donnellsmithia silvicola Const. & Bye. a, Habit, ×½; b, basal leaf, ×2; c, flowering umbellet, ×4; d, immature fruit, ×10; e, petal, ×10. All from Bye 6376.

sus truncatus basi rotundatus, costis humilibus filiformibus; vittae et seminum superficies non visae; chromosomatum numerus $n = 20$.

Small, compact perennials from a fleshy taproot, 8–25 cm. high, the stem simple or few-branched, very sparsely leafy, glabrous throughout; basal leaves deltoid-orbicular, 1–3 cm. long, 1.5–5 cm. broad, trifoliate with 3 oval to orbicular, obtuse, lobed to pinnatifid leaflets 1–2 cm. in diameter; petiole 1–8 cm. long, narrowly scarious-sheathing; cauline leaves like the basal but reduced upward, the sheaths slightly dilated; peduncles few, alternate, slender, up to 2 cm. long, but most umbels lateral and sessile or subsessile; involucre 0, or of a single trifid bract; rays 2–5, filiform, spreading-ascending, 6–25 mm. long; involucel 0; fertile pedicels 0–2 (many umbellets staminate), 3–4 mm. long; flowers greenish-yellow; stylopodium depressed, not evident; styles very short; carpophore 2-cleft to base; immature fruit ovoid-orbicular, 1.5 mm. long, 2 mm. broad, truncate at apex, rounded at base, the ribs low, filiform; vittae and seed face not seen; chromosome number $n = 20$.

Type. Chihuahua: Municipio de Guazapares, among *Pinus ponderosa*, *P. leiophylla*, *Quercus* sp. and *Arbutus* sp., on recently logged ridge, elevation 8100 feet, off road northwest of Estación San Rafael to Las Lagunitas, 21 July 1974, *Robert A. Bye, Jr. 6376* (GH: holotype; ECON, UC).

The plant was rather abundant but very local on slopes that had recently been disturbed by logging operations.

Donnellsmithia silvicola appears to be most closely related to *D. serrata* (C. & R.) Math. & Const. and *D. dissecta* (C. & R.) Math. & Const., both species of southern Mexico. It is unlike both in its lower stature and glabrous foliage. From the former, it differs also in its shorter rays; from the latter, in its lack of an involucel. The most striking disparity, however, is in its uniquely distinctive leaf form.

Tauschia bicolor *Constance & Bye sp. nov.*

Plantae brevi-caulescentes acaulescentesve glabrae, caulibus gracilibus 10–40 cm. altis e caudice gracili: folia basalia rosulata triangulari-ovata vel ovata 1.5–8 cm. longa, 2–6 cm. lata, profunde trilobata vel ternata vel imparipinnata foliolis 1–3-partibus late ovalibus vel anguste oblongis serratis lobatisque vel pinnatifidis, superne cinereis, inferne purpureis; petioli anguste vaginantes 1.5–10(–25) cm. longi; folia caulina pauca; pedunculi graciles 7–20 cm. longi; involucrum plerumque nullum; radii 8–12 eis exterioribus fertilibus 5–11 mm. longis; involucellum dimidiatum bracteolis 3–5 linearibus acutis 1–3 mm. longis; pedicelli crassi 1–2 mm. longi fructo centrali saepe subsesseli; flores purpurei, petalis intus albis extus purpureis; stylopodium nullum, stylis valde gracilibus; carpophorum bipartitum dimidiis bifidis; fructus ovoideus apice truncatus basi rotundatus, glaber, 2.5–3 mm. longus, 2 mm. latus, costis filiformibus acutis quam intervallis multo angustioribus; vittae in intervallis plures in commissuris 2; seminum superficies plana; chromosomatum numerus $n=22$.

Plants rather slender, short-caulescent to acaulescent, the stems slender, 1 or 2, 10–40 cm. high from a slender rootstock, glabrous; basal leaves rosulate, triangular-ovate to ovate, 1.5–8 cm. long, 2–6 cm. broad, deeply 3-lobed or ternate to pinnate with 1–3 pairs of broadly oval to narrowly oblong, serrate and lobed to pinnatifid leaflets 8–30 mm. long, 3–30 mm. broad, ashy-pale above, purplish beneath; petioles 1.5–10(–25) cm. long, narrowly sheathing; cauline leaves few, reduced upward; peduncles terminal, slender, 7–20 cm. long; involucre of a linear bract or usually 0; rays 8–12, 5–11 mm. long, apparently only the outer fertile; involucel dimidiate, the bractlets 3–5, linear, acute, 1–3 mm. long; pedicels stout, 1–2 mm. long, the central fruit often subsessile;

flowers purple, the petals white within, deep purple on the back; styles very slender, 1.5–2 mm. long, spreading, purple (contrasting with a white disc); carpophore 2-parted, the halves bifid; fruit ovoid, 2.5–3 mm. long, 2 mm. broad, truncate at apex, rounded at base, the ribs filiform, acute, much narrower than the intervals; vittae several in the intervals, 2 on the commissure; seed face plane; chromosome number $n=22$.

TYPE: Chihuahua: near boundary of Municipio de Batopilas and Municipio de Urique, between Quirare and Basigochic, elevation about 6900 feet, flowers red, 8 June 1973, *Robert A. Bye, Jr. 4068* (GH: holotype; ECON, UC). It was collected in the same locality on 31 May 1973, *Bye 3863* (ECON, UC), and 6 October 1975, *Bye 6965* (ECON, UC).

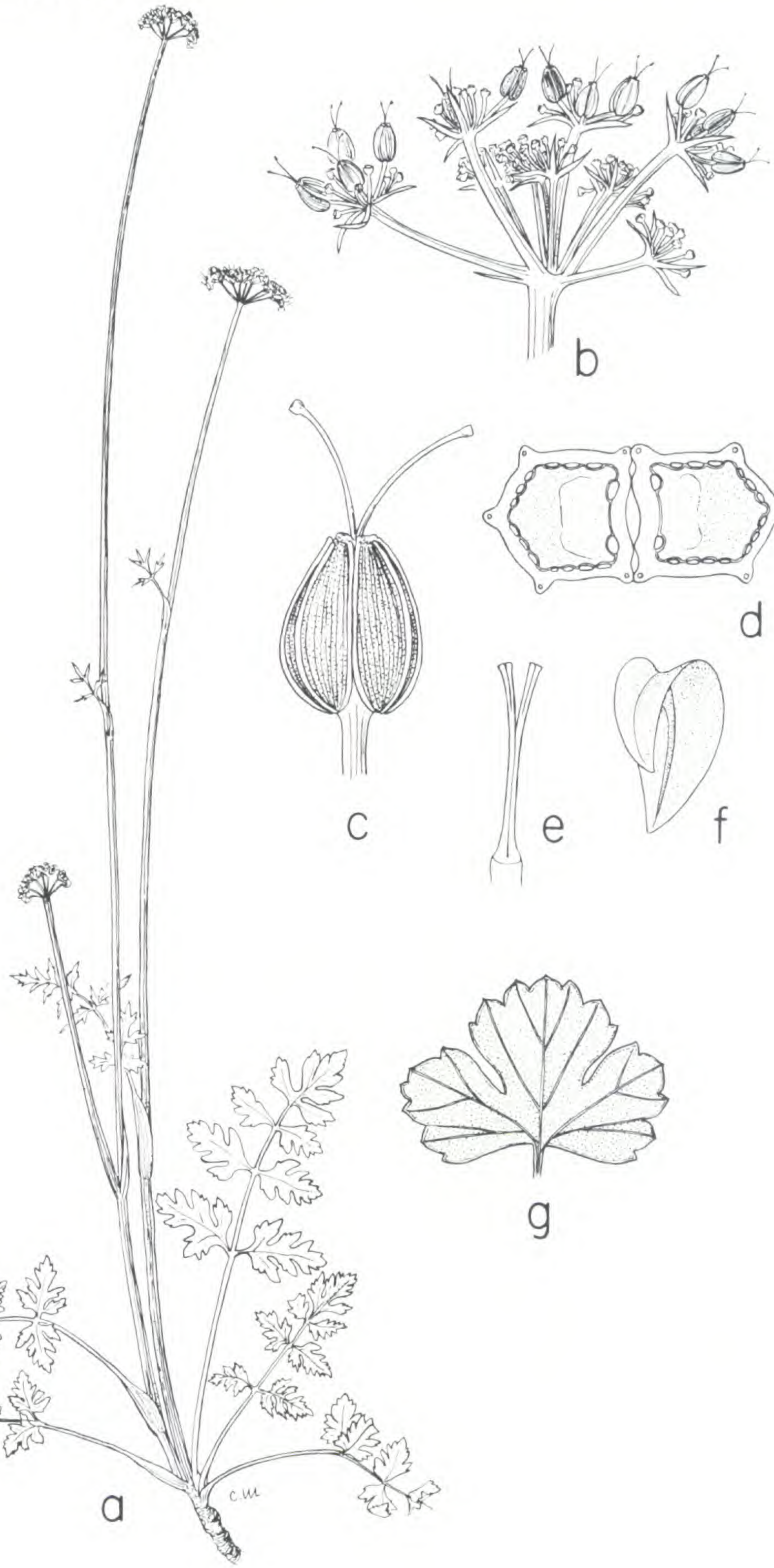
Tauschia bicolor, known to the Tarahumara as "masiáwari" (or "masiówari")[4], is considered a quelite or pot-herb, although it is not commonly consumed today. The young tender leaves can be collected during the fall as well as during the spring. To date, we know of only one locality for this herb, which is eagerly devoured by grazing goats and sheep. The plants are restricted to the western slopes above Arroyo Basigochic near an isolated stand of *Abies durangensis*. They are common on moist (not wet) eroded slopes of partially open pine and oak forest, where they often grow with *Chimaphila* and *Galium*, while scattered individuals can be found in crevices of white volcanic rock or in thin soil of the mixed wood forest. Due to heavy grazing pressure, few plants are able to produce mature fruits. The rhizomes appear to be important in the vegetative propagation of the

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PLATE LXII. *Tauschia bicolor* Const. & Bye. a, Habit, ×½; b, fruiting umbel, ×2; c, mature fruit, ×8; d, fruit transection, ×15; e, carpophore, ×8; f, petal, ×15; g, first basal leaf, ×½. a-d, f, from Bye 4068; e, from Bye 6965; g, from Bye 3863.

[4] One informant referred to this herb as "kurisove".

Plate LXII



population. Indeed, this characteristic may be the key to the survival of the population in the immediate future, because a road building program will destroy the site within the next year.

Although plants relatively similar to *Tauschia bicolor* in habit may be found in such genera as *Aletes* and *Arracacia* as well as in *Tauschia*, the combination of glabrous herbage, ternate or pinnate leaves with serrate to pinnatifid leaflets, fertile outer rays, dimidiate involucel, stout pedicels with an often subsessile central fruit, petals purple/red externally and white internally, very slender styles, and a bipartite carpophore with bifid halves appears to be unique.

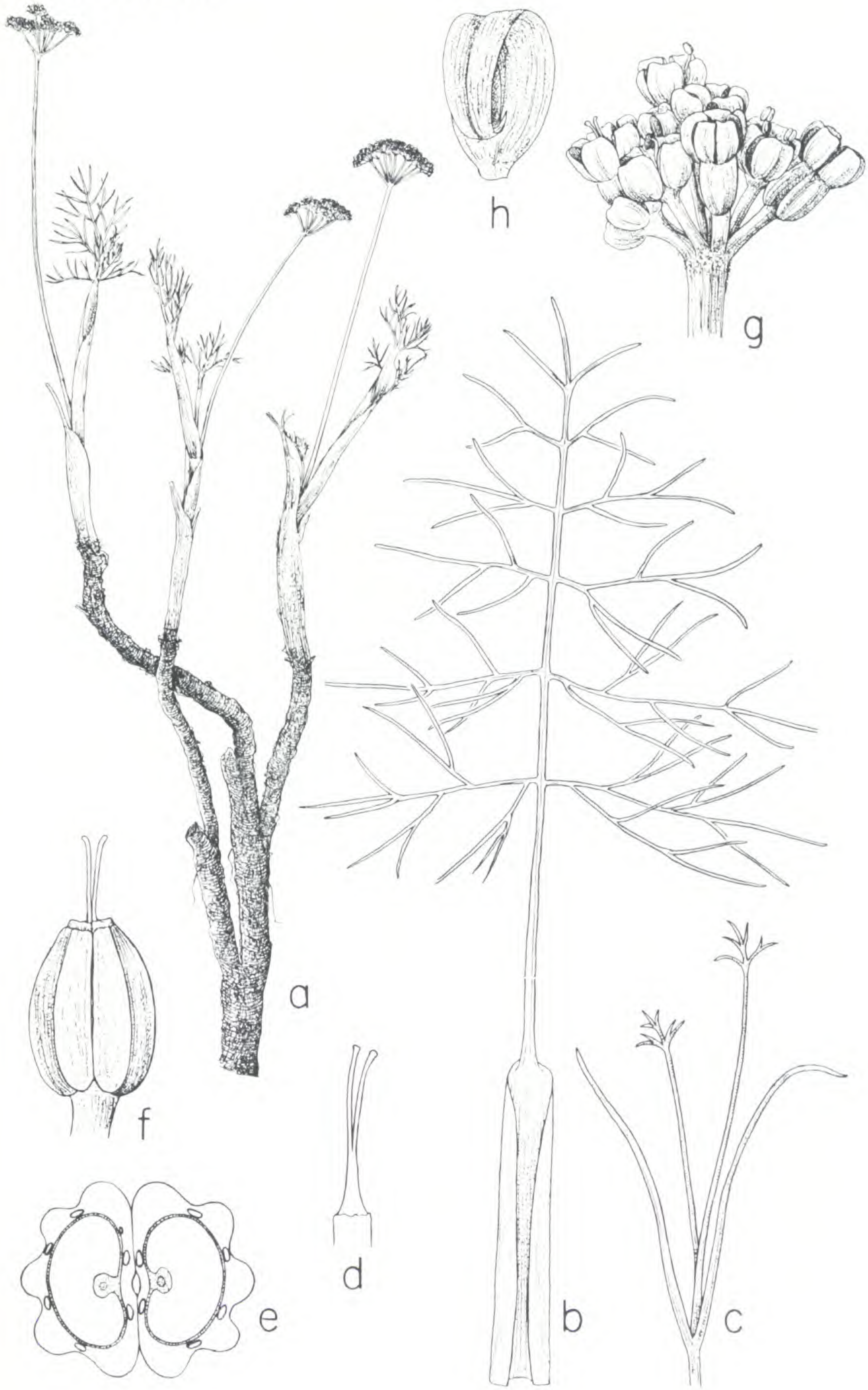
Tauschia tarahumara *Constance & Bye sp. nov.*

Plantae humiles breviter caulescentes glabrae, caulibus pluribus 12–30 cm. altis e caudice elongata ramosa carnosa, praeter inflorescentiam puberulentam; folia ovata 3–5 cm. longa, 2–4 cm. lata, 2–3-pinnata, divisionibus ultimis lineari-filiformibus breviter mucronatis 5–20 mm. longis, ca. 0.5 mm. latis; petioli 1–6 cm. longi graciles anguste scarioso-vaginantes; folia caulina reducta sessilia vaginis conspicue scariosis praedita; pedunculi 6–12 cm. longi plerumque terminales graciles sub umbella puberulentes; involucrum nullum; involucellum nullum; radii 6–12 usque ad 1 cm. longi puberulenti; pedicelli 1–3 mm. longi eis exterioribus fertilibus; flores rhodopurpurei; styli erecti ca. 0.5 mm. longi; carpophorum bifidum; fructus ovoideus 5–7 mm. longus, 3–5 mm. latus ad apicem versus truncatus basi rotundatus, costis humilibus rotundatisque quam intervallis latioribus; vit-

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Plate LXIII. *Tauschia tarahumara* Const. & Bye. a, Habit, ×½; b, basal leaf, ×1; c, seedling, ×1; d, carpophore, ×5; e, fruit transection, ×7; f, mature fruit, ×4; g, flowering umbellet, ×5; h, petal, ×20. a–b, g–h, from Bye 6288; c, from Bye 7027 (Const. 1918); d–f, from 7027.

Plate LXIII



tae magnae in intervallis una in commisuris 2; seminum superficies anguste sulcata; chrosomatum numerus $n = 44$.

Plants low, shortly caulescent, the stems several, 12–30 cm. high from a very elongate, branched, fleshy caudex, glabrous except for the puberulent inflorescence; leaves ovate, 3–5 cm. long, 2–4 cm. broad, 2–3-pinnate, the ultimate divisions linear-filiform, 5–20 mm. long, about 0.5 mm. broad, shortly mucronate; petioles slender, 1–6 cm. long, narrowly scarious-sheathing, the cauline leaves with conspicuous scarious sheaths and sessile reduced blades; peduncles mostly terminal, slender, 6–12 cm. long, puberulent beneath the umbel; involucre and involucel 0; rays 6–12, up to 1 cm. long, puberulent; pedicels 1–3 mm. long, the outer fertile; flowers deep red-purple; styles about 0.5 mm. long, mostly erect; carpophore bifid; fruit ovoid, 5–7 mm. long, 3–5 mm. broad, truncate at apex, rounded at base, the ribs low and rounded, broader than intervals; vittae large, solitary in the intervals, 2 on the commissure; seed face narrowly sulcate; chromosome number $n = 44$.

Type: Chihuahua: Municipio de Bocoyna, in wettest portions of grazed meadow with dark mucky soil, elevation ca 7300 feet, N of San Ignacio Arareco, E of Creel, 11 July 1974, *Robert A. Bye, Jr. 6288* (GH: holotype; ECON, UC). It was collected also in similar habitats in the general vicinity of San Ignacio Arareco, SE or E of Creel, on 14 July 1971, *Bye 1535* (ECON), 16 July 1972, *Bye 2369* (ECON), 5 July 1973, *Bye 4150* (GH, UC), and 19 July 1973, *Bye 4272B* (ECON, UC), 9 October 1975, *Bye 7027* (UC) and *7034* (ECON).

The older Tarahumara of San Ignacio call this herb "huve" and ascribe medicinal properties to the distinctive rhizome. It is ground, mixed with oil or fat, and rubbed on the affected parts of the body to treat rheumatism. Only a small piece of the rhizome is placed in a cavity in order to alleviate toothache, because it is said to be very strong. Some young Tarahumara in the San

Ignacio region claim it is an edible green and call it "sepe".

This deep rooted herb is restricted to a narrow interzone in the moist upland meadows, between the low, wet area (often occupied by standing water during parts of the rainy season) with *Plantago* and *Ranunculus* species, and the slightly elevated and drier area with *Tagetes lucida*. Even though this umbel has a deep, vertical rootstock (over 50 cm. long with a relatively constant diameter) which may be well adapted to environmental changes, such human-related activities as grazing, cultivation, gully and sheet erosion, draining and soil compaction in these accessible meadows threaten to destroy the few known populations of this curious plant.

In the published key to the species of *Tauschia* (Mathias & Constance, 1944, pp. 81–82), the new taxon would key to either *T. tenuifolia* (S. Wats.) Math. & Const., a little known Chihuahuan plant, or to *T. mariana* (S. Wats.) C. & R. ex Drude (= *T. decumbens* (Benth.) C. & R. ex Drude), which occurs from México to Michoacán. It differs from both, however, by its lack of an involucel and its smaller fruit with broad, obtuse costae. In addition, *T. tarahumara* is unlike *T. tenuifolia* in lacking a densely fibrous stem base and in its more numerous but shorter rays. From *T. decumbens*, *T. tarahumara* may be distinguished by its lower stature, broader leaves with narrower divisions, and red-purple flowers, in addition to its geographic range.

Eryngium Gentryi *Constance & Bye sp. nov.*

Plantae perennes graciles caulescentes haud ramosi 1.8–5 dm. altae ex caudice horizontali gracili; folia pauca alternata disticha lineari-lanceolata 3–20 cm. longa, 2–5 mm. lata, transverse septata, margine serrulato integrove, venis parallelis, vaginis amplexicaulibus latitudi-

nem laminae aequantibus vel longioribus; folia caulina summa opposita lanceolati-acuminata; inflorescentia cymosa reducta; capitula 1–3 globosa pedunculata subcaerulea diametro 5–10 mm.; bracteae involucrales 8–12 lanceolatae acutae integrae vel pauci-dentatae, inferne virides, superne argenteae, quam capitulum duplo longiores; bracteae florales lineari-acuminatae integrae fructum multo excedentes; sepala ovata ca. 2 mm. longa; petala lineari-oblonga 1–1.25 mm. longa apice fimbriata; styli graciles 2.5–3 mm. longi quam calyces longiores; fructus (immaturus) ovoideus diametro ca. 2 mm., superficiebus mericarpiorum dense squamatis, squamis ovatis subaequalibus complanatis; chromosomatum numerus $n=7$.

Plants slender caulescent perennials 1.8–5 dm. high from a slender rootstock, the stems solitary to several, weakly erect, unbranched below inflorescence; lower leaves few, alternate, distichous, linear-lanceolate, 3–20 cm. long, 2–5 mm. broad, remotely serrulate or entire, the venation parallel, transversely septate, amplexicaul-sheathing, the sheath as broad or broader than the blade; uppermost cauline leaves opposite, lanceolate-acuminate; inflorescence a reduced cyme of 1–3 pedunculate heads; heads globose, bluish, 5–10 mm. in diameter; involucral bracts 8–12, spreading-ascending, lanceolate, 8–25 mm. long, 2–5 mm. broad, acute, entire or with one or two pairs of short teeth, green beneath, silvery-white above, about twice as long as the head; bractlets linear-acuminate, entire, much longer than fruit; sepals ovate, about 2 mm. long, mucronate; petals linear-oblong, 1–1.25 mm. long, with a narrower fimbriate tip; styles slender,

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Plate LXIV. *Eryngium Gentryi* Const. & Bye. a, Habit, $\times\frac{1}{2}$; b, cauline leaf, $\times 1$; c, floral bractlet, $\times 10$; d, involucral bracts, $\times 2$; e, immature head (two bracts removed), $\times 2$; f, flower, $\times 10$; g, petal, $\times 20$. All from Bye 4766.

Plate LXIV



2.5–3 mm. long, longer than sepals; fruit (immature) ovoid, about 2 mm. long and broad, the squamae ovate, subequal, flattened, the dorsal faces densely squamose: chromosome number $n=7$.

TYPE: Chihuahua: Municipio de Ocampo, transition zone, pines, meadow, infrequent, marginal to streams, elevation 7500 feet, Memelichi, Rio Mayo, 16 September 1936, *H.S. Gentry 2770* (UC: holotype; K).

OTHER COLLECTIONS: Chihuahua: Municipio de Madera, lake near Chuichupa, 23 August 1936, *H. LeSueur 817* (UC); Chuichupa, 7000 feet, 21 September 1903, *I.E. Diehl s.n.* (POM); Municipio de Bocoyna, in moist meadow E of Gonogochi (on Continental Divide) E of Creel, associated with low, scrubby *Quercus*, grasses, *Ranunculus*, *Cacalia* and *Tagetes lucida*, elevation ca 7500 feet, 24 August 1973, *Robert A. Bye, Jr. 4766* (ECON, UC).

Eryngium Gentryi represents a third member of Sec. XXI. Madrensia Wolff, comprising Mexican species of wet habitats characterized by evidently transversely septate leaves, bluish or purplish ovoid-globose to ovoid-cylindrical heads, and involucral bracts conspicuously silvery above (Wolff 1913). The other two species, *E. madrense* S. Wats. and *E. fluitans* M.E. Jones (*E. mexicanum* sensu Wolff, *E. Wolffii* Mathias), are very similar in habit. There is a resemblance also to *E. phyteumae* Delar.f. (Sect. XXIV. Stellata Wolff), but this possesses well developed oblong to lanceolate, reticulately veined leaf lamina. In Sect. Madrensia, the leaves are usually bladeless or with a rudimentary lamina and not only the petiole but the entire leaf tends to be septate. The silvery upper surface of the involucral bracts suggests an affinity to both Sects. XXIV. Stellata Wolff and XXV. Carliniformia Wolff. Wolff notes that *E. phyteumae* "bildet einen deutlichen Übergang zu den Madrensia" (Wolff 1913, 61: 186). From its two allies in Sect. Madrensia, *E. Gentryi* differs in its possession of a rootstock, its fewer globose heads without a coma,

and in its broader involucral bracts that much exceed the head.

The type collection was associated by Standley with the unpublished herbarium name "*E. juncifolium* M.E. Jones", which Jones had applied to specimens of both *E. fluitans* and *E. Gentryi*. Gentry reported the collection in his Río Mayo flora (1942) as *E. phyteumae*, as erroneously determined by Mathias and Constance. The "*E. juncifolium* Jones" listed by LeSueur in his pioneer study of Chihuahuan vegetation (1945) and attributed to the Montane Forest, is also *E. Gentryi*. The invalid name, "*E. juncifolium* M.E. Jones", is not to be confused with the South American *E. juncifolium* (Urban) Math. & Const.

It is with great pleasure that we name this species in honor of Dr. Howard Scott Gentry, who has made such significant contributions to our knowledge of the flora of Chihuahua and other parts of Mexico.

Specimens

Duplicates of the Bye collections will be deposited in the Herbario Nacional del Instituto de Biología, Universidad Nacional Autónoma de México (MEXU).

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Mathias, M.E., and L. Constance. 1944–45. Umbelliferae: Fl. N. America 28B: 43–295.

Wolff, H. 1913. Umbelliferae; in Engler, Das Pflanzenreich 61 (4^{228}): 1–305.

CHROMOSOME NUMBERS IN CHIHUAHUAN UMBELLIFERAE

BY

LINCOLN CONSTANCE[1], TSAN IANG CHUANG[2]
AND ROBERT A. BYE, JR.[3]

In his ethnobotanical studies of the Tarahumara culture in the Sierra Madre of southwestern Chihuahua, Robert A. Bye, Jr., made a concerted and very successful effort to obtain material of Umbelliferae for chromosome counts. The results of these counts (made by Chuang) are shown in the accompanying table and Plate LXV, and some brief comments (by Constance) follow (Table I and Plate LXV, a–k).

Donnellsmithia C. & R. The report on *D. silvicola* is new: that of $n=20$ for *D. ternata* disagrees with one of $n=21$ for the same taxon (Constance, Chuang and Bell, in press). Chromosome numbers in this genus are still confusing. Counts made on eight specific taxa have yielded the following haploid numbers: 11, 14, 20, 21, 22, 40, 42, 44. Thus, both *D. silvicola* and *D. ternata* are probably tetraploid.

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EXPLANATION OF THE ILLUSTRATION

Karyotypes of Chihuahuan umbelliferae

a, *Donnellsmithia ternata* (S.Wats.) Math. & Const., Diak., Bye 4393; b, *D. silvicola* Const. & Bye, Diak., Bye 6376; c, *Tauschia bicolor* Const. & Bye, Diak., Bye 3863; d, *T. tarahumara* Const. & Bye, MII, Bye 6288; e, *Arracacia edulis* S.Wats., Diak., Bye 6753; f, *Eryngium fluitans* M.E. Jones, MI, Bye 4763; g, *E. Gentryi* Const. & Bye, Diak., Bye 4766; h, *E. heterophyllum* Engelm., Diak., Bye 4334; i, *E. Lemmonii* Coult. & Rose (*E. calaster* Standl.), MI, Bye 4463; j, *E. Lemmonii* Coult. & Rose (*E. calaster* Standl.), MII, Bye 4809; k, *E. phyteumae* Delar.f., MII, Bye 5905 (Const. 1906). (Diak.=Diakinesis; MI, MII-Metaphases I and II. All ca. ×1050).

Plate LXV



a



b



c



d



e



f



g



h



i



j



k

Tauschia Schlecht. Both *T. bicolor* and *T. tarahumara* were previously uncounted. Five other species of the genus have revealed only $n=11$ and $n=22$, so the count of $n=44$ for *T. tarahumara*, a probable octoploid, represents a new polyploid level for the genus.

Arracacia Bancr. There is no previous chromosome count for *A. edulis*, a species which has been placed alternately under *Tauschia*. The complement of $n=20$ is equally discordant in both genera. The fifteen specific taxa of *Arracacia* examined heretofore have all shown a haploid number of 22, except for one unexplained occurrence each of the numbers 14 and 32.

Ligusticum L. The count of $n=11$ for *L. Porteri*, which has been made before, agrees with findings on some 16 species of this circumboreal genus, all of which showed $n=11$, $n=22$, or $n=33$, save for an anomalous $n=12$ and one $n=27$.

Pseudocymopterus C. & R. The count of $n=11$ for *P. montanus* coincides with earlier findings for this genus and species.

Prionosciadium S. Wats. Of eight taxa of this genus counted, six have $n=22$, two have $n=21$. A count of $n=22$ for *P. madrense* conforms to earlier information.

Eryngium L. Of the six counts reported here, only that for *E. Gentryi*, $n=7$, is new. From some 100 species that have been counted in this very distinctive cosmopolitan genus, it seems clear that the basic number is $n=8$. However, there are descending aneuploid series extending to $n=7$, $n=6$, or even $n=5$ in both hemispheres, sometimes in what appears to be the same spe-

cies, as in *E. heterophyllum* and *E. Lemmonii*. Extensive polyploidy, particularly in the Americas, has arisen on the basic complement of 8 ($n = 16$, 24, 32, 40, 48), and smaller series based apparently on 7 in Eurasia.

LITERATURE CITED

Constance, L., T.I. Chuang and C.R. Bell. Chromosome numbers in Umbelliferae V. Amer. Jour. Bot., in press.

TABLE I

Chromosome numbers of Chihuahuan Umbelliferae.

Name	n=	Voucher Specimen*	Municipio and Locality
Donnellsmithia			
1. *ternata* (S.Wats.) C. & R.	20	*Bye 4393*	Guachochi, Cusárare
2. *silvicola* Const. & Bye	20	*Bye 6376*	Guazapares, San Rafael–Las Lagunitas
Tauschia			
3. *bicolor* Const. & Bye	22	*Bye 3863*	Batopilas–Urique, between Quírare and Basigochic
4. *tarahumara* Const. & Bye	44	*Bye 6388*	Bocoyna, San Ignacio Arareco
Arracacia			
5. *edulis* S.Wats.	20	*Bye 6753*	Guachochi, Cusárare
Ligusticum			
6. *Porteri* C. & R.	11	*Bye 6651*	Bocoyna, W of Creel
Pseudocymopterus			
7. *montanus* (A.Gray) C. & R.	11	*Bye 6637*	Bocoyna, W of Creel
Prionosciadium			
8. *madrense* S.Wats.	22	*Bye 6352*	Batopilas, S of Quírare
Eryngium			
9. *fluitans* M.E. Jones	7	*Bye 4763*	Bocoyna, W of Gonogochi
10. *Gentryi* Const. & Bye	7	*Bye 4766*	Bocoyna, E of Gonogochi
11. *heterophyllum* Engelm.	8	*Bye 4334*	Bocoyna, Gonogochi
12. *Lemmonii* C. & R.	8	*Bye 4463*	Batopilas, N of Quírare
	7	*Bye 4809*	Bocoyna, Creel–San Ignacio Arareco
13. *phyteumae* Delar.f.	7	*Bye 5905*	Bocoyna, W of Creel

* Voucher specimens are preserved in ECON, GH and UC.

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THE GENUS OECEOCLADES LINDL.

BY

LESLIE A. GARAY AND PETER TAYLOR*

In 1832 while describing *Oeceoclades*, as a genus different from *Angraecum*, Lindley offered the following observation: "The genus Angraecum. . . is known by its undivided lip, which is neither cucullate, nor articulate with the column; by its spreading perianthium, which never has the segments turned upwards as in Eulophia; by its long taper-jointed spur, which is rarely enlarged at the base; and finally, by all these characters being connected with coriaceous leaves that are never ribbed or plaited. Such being the definition of Angraecum, it will be apparent that, . . . such as our Angraecum maculatum and a few of those of Du Petit Thouars, must be excluded; these form a genus nearly related to Eulophia, from which they are to be distinguished by their coriaceous leaves, by the perianthium never being secund, and by the want of a crest upon the lip."

With this introduction Lindley also provided a separate generic description in Latin as well as a list of names —five under *Angraecum* and four under *Limodorum* — which he considered belonged to *Oeceoclades*, but without making the proper nomenclatorial transfers. The following year, in 1833, in his Genera and Species of Orchidaceous Plants, he treated *Oeceoclades* in a similar

* Orchid Herbarium, Royal Botanic Gardens, Kew, England.

fashion, but with a somewhat different content. On both occasions, however, he included the sympodial Eulophia-like *Angraecum maculatum* with the remainder, all monopodial orchids. At that time Lindley remarked: "Oeceoclades will probably comprehend all the Eulophia-like epiphytes. . . ; it is very near Eulophia, from which its coriaceous, not plaited leaves, distinguish it among other things."

Thus, from the very beginning Lindley considered *Oeceoclades* to represent Eulophia-like plants. He emphasized his conviction once more in 1859 (Journ. Linn. Soc. 3: 36) by saying " . . . it is probably that *O. maculata* is the only plant to which the generic name will attach." Since that time the remaining species of *Oeceoclades* have all been transferred to various angraecoid genera. Consequently the genus *Oeceoclades* must be typified by *O. maculata*, the only Eulophia-like plant.

In 1887, Pfitzer in his Entwurf einer natürlichen Anordnung der Orchideen p. 87–88 established the monotypic genus *Eulophidium* which he also based on *Angraecum maculatum*. It is difficult to understand why he chose to follow that particular course when he was fully aware of Lindley's suggestion that the name *Oeceoclades* be applied only to *O. maculata:* "Ich muss *Eulophidium maculatum* entsprechend Lindley's Vermuthung als den Typus einer besondren Gattung betrachten. . . "*

Since both genera, *Oeceoclades* Lindl. and *Eulophidium* Pfitz. are based on the same type—*Angraecum maculatum* Lindl.—*Oeceoclades* must be reinstated because of the rule of priority.

Summerhayes, in 1957, published a synopsis of the genus *Eulophidium* (Bull. Jard. Bot. Bruxelles 27 (3): 391–403). In that study he argued that Pfitzer and sub-

* In keeping with Lindley's supposition, I must regard *Eulophidium maculatum* as the type of a special genus."

sequently Schlechter, both in their studies emphasized the vegetative aspects of the plants without paying much attention to floral details, which resulted in a rather poor circumscription of the genus.

To augment this one-sided presentation, Summerhayes provides the following observations:

"For some time now I have been struck by the marked similarity in floral structure between typical members of *Eulophidium*, such as *E. maculatum* (LINDL.) PFITZ., on the one hand, and species which have always been retained in *Eulophia* such as *E. saundersiana* RCHB.F. and the Asiatic *E. macrostachya* LINDL., on the other. All these species have a marked quadrilobed labellum with two short parallel or slightly divergent calli at the base and no long keels or hair-like outgrowths such as are so widely distributed in *Eulophia*. The side lobes almost invariably have marked darker veins. . . Sometime the two lower lobes, or lateral lobes if you prefer to call them that, are much reduced, occasionally so much that the labellum is almost bilobed. The spur is relatively short and often swollen, sometimes it is more or less shortly bilobed at the apex.

"As regards the vegetative structure the aerial pseudobulbs may be heteroblastic with 1–3 leaves at the apex or homoblastic (with several elongated internodes) with one or more leaves at the apex. All intermediates can be found between a clearly heteroblastic condition with no cataphylls or leaves arising along the pseudobulbs, through forms in which the lower swollen internodes are quite short and other forms with only 2 elongated swollen internodes, to typical homoblastic conditions where there are clearly several well-defined elongated swollen internodes with cataphylls arising from the lower nodes and leaves from the uppermost.

"The great majority of species have markedly petio-

late leaves, but in a few cases the petiole is very short. It is almost invariably articulate with a number of sharp or blunt teeth at the joint, this articulation usually being some distance above the base of the leaf, and sometimes in the centre of the long slender petiole. Reichenbach and Schlechter, when dealing with some species, have treated the lower part of the petiole below the articulation as being the rostrate upper internode or prolongation of the pseudobulb, but this is clearly not a possible interpretation in plants like *E. saundersiana* where there are two leaves, both with their petioles articulate some distance above the base. The leaves are usually rather coriaceous and often banded or spotted with paler markings.

"As these variable characters are associated with very similar floral structures I feel that too much emphasis should not be placed on them and that all these species should be placed in an enlarged *Eulophidium*."

In no way diminishing the value of these important observations, we are compelled to reexamine some of its crucial points. We believe that the distinction between homoblastic and heteroblastic pseudobulbs is not clearly understood by many. Both types of pseudobulbs are derived from the common sympodial stem which consists of a set of nodes and internodes. In the case of the homoblastic pseudobulbs, each internode or most of the internodes are equally developed and enlarged throughout the entire length of the sympodium, at the nodes leaves or sheaths or cataphylls are produced. In the case of the heteroblastic pseudobulbs only one internode is fully developed and enlarged throughout the entire length of the sympodium. The nodes are closely approximate, often so congested that no visible separation is apparent; rarely the leaf-bearing nodes are separated by obvious distances, yet minimal in proportion to the internode that represent the true heteroblastic pseudobulb. The one to three

leaves produced at the top of a heteroblastic pseudobulb are originating independently from separate nodes, which may or may not be closely approximate. The misunderstanding of the nature of the heteroblastic pseudobulb caused Summerhayes to enlarge and alter the generic description of *Eulophidium*, which unfortunately now encompasses several criteria applicable only to *Eulophia*.

Likewise the similarities in floral structure, mentioned by him, we believe are produced through convergent evolution rather than through the processes of speciation.

Although florally *Eulophia macrostachya* is very similar to those found in many plants of *Oeceoclades*, the thin, plicate leaves and the homoblastic pseudobulbs immediately exclude it from that relationship. If *E. macrostachya* is to be admitted to *Oeceoclades*, then *E. graminea*, *E. euglossa*, *E. guineënsis*, and other related species would have to be included also. For additional names see the list of *Eulophia* Sect. *Pulchrae* Krzl. at the end of this paper.

Both Lindley and Pfitzer were explicit about such generic characters as the heteroblastic pseudobulbs, coriaceous, conduplicate leaves and Eulophia-like flowers. Consequently we adhere to the original circumscription of the genus in our assignment of the species.

Oeceoclades Lindl. in Bot. Reg. 18: sub t. 1522, Sept. 1, 1832.

Syn.: *Aeceoclades* Duch. in Orbigny, Dict. 9: 170, 1849.

Saccolabium Sect. *Oeceoclades* (Lindl.) Cordem., Fl. Reunion 197, 1895.

Lectotype: **Angraecum maculatum** Lindl.—Lindl. in Journ. Linn. Soc. 3: 36, 1859.

Eulophidium Pfitz., Entw. Natur. Anordn. Orch. 87–89, 1887.

Eulophia Sect. *Eulophidium* (Pfitz.) H. Perr. in Bull. Soc. Bot. Fr. 82: 147, 1935.
Lissochilus Subgen. *Eulophidium* (Pfitz.) H. Perr. in Humbert, Fl. Madag. Orch. 2: 17, 1941.

Type: **Angraecum maculatum** Lindl.—Pfitz. *ibid.*

Sepals and petals variously spreading; lip 3-lobed, basally produced in a spur, midlobe commonly lobulate or emarginate; disc either with a pair of approximate, quadrate or triangular calli at the entrance to the spur or with three variously thickened, parallel ridges which together with the lateral veins are sparsely but distinctly papillose or hirsute; column erect, rather short, oblique at base; stigmata confluent; rostellum short; anther cucullate to cristate; pollinia 2, on a short or rudimentary stipe; viscidium large.

Pseudobulbs more or less approximate, heteroblastic, one- to three-leaved at apex; leaves coriaceous, conduplicate, never plicate, commonly petiolate, rarely sessile, articulate with colliferous apex of pseudobulbs; inflorescence lateral, racemose or paniculate; bracts inconspicuous; flowers rather small and thin in texture, resupinate.

31 species native to tropics and subtropics of Seychelles, Madagascar, the Mascarene Islands, Africa, South America, West Indies and Bahamas.

Type of the genus: **Angraecum maculatum** Lindl.

Key to Species

1. Petals at most $\frac{1}{2}$ to $\frac{1}{3}$ the length of the sepals 2
1a. Petals and sepals more or less equal in length 6
2. Pseudobulbs ovoid to cylindrical; leaves lorate [at least 40 cm. long]; inflorescence diffusely branched 3
2a. Pseudobulbs globose to pyriform; leaves linear [at most 20 cm. long]; inflorescence racemose or rarely with few short branches 4

3. Pseudobulbs 2-leaved; sepals spathulate to oblanceolate, obtuse; petals elliptic, obtuse; spur of lip forward projecting under lip . . . . . *O. calcarata*

3a. Pseudobulbs 1-leaved; sepals and petals lanceolate-elliptic, acute to subacuminate; spur of lip projecting away from lip . . . . . *O. Hebdingiana*

4. Sepals spathulate, obtuse; spur globose . . . *O. spathulifera*

4a. Sepals obovate-oblanceolate, acute 5

5. Leaves sessile; sepals at least 14 mm. long; petals elliptic, acute; spur cylindric . . . . . *O. Decaryana*

5a. Leaves petiolate; sepals not more than 8 mm. long; petals suborbicular, obtuse; spur subglobose, ventrally compressed . . . . . *O. angustifolia*

6. Lip ecallose at base; basal halves of 3 parallel veins of disc somewhat carinate-thickened 7

6a. Lip with a bilobed callus, or bilamellate at or near base . . . 13

7. Pseudobulbs elongate, slender, fusiform to cylindric, 2–3 leaved, approximately the length of the petiolate leaves or longer 8

7a. Pseudobulbs short, ovoid, 2-leaved, much shorter than the petiolate leaves 10

8. Lip broadly elliptic; midlobe of lip rounded at base, overlapping with lateral lobes without a sinus; disc ecallose at junction of lateral and median lobes 9

8a. Lip narrowly ovate-oblong to elliptic-oblong; midlobe of lip cuneate at base, forming a distinct sinus with lateral lobes; disc with a pair of fleshy gibbosities at junction of lateral and midlobes . . . . . *O. ugandae*

9. Midlobe of lip suborbicular in outline, half as long as the entire length of the lip; lateral lobes subfalcate, obtuse at apex . . . . . *O. lanceata*

9a. Midlobe of lip reniform in outline, one-fourth the length of the entire lip; lateral lobes broadly rounded at apex . . . . . *O. seychellarum*

10. Lip lobate from middle; lateral lobes of lip truncate in front 11

10a. Lip lobate one-fourth from apex; lateral lobes of lip oblique in front 12

11. Lip wider than long; midlobe deeply emarginate to divaricately bilobulate in front . . . . . *O. Lubbersiana*

11a. Lip longer than wide; midlobe cuneate or with a distinct claw, at most retuse to indented in front *O. pandurata*

12. Inflorescence laxly racemose; flowers greenish-

yellow with maroon dots; sepals and petals ovate-oblong, acute . . . . . *O. atrovirens*

12a. Inflorescence with short branches; flowers white, sepals and petals linear-oblong, obtuse . . . . . *O. latifolia*

13. Blades of leaves narrow, linear 14

13a. Blades of leaves broad, ovate to elliptic 17

14. Leaves long-acuminate, lorate, 50 cm. or more long, gradually tapering to pseudobulb without a distinct petiole . . . . . *O. Perrieri*

14a. Leaves acute or obtuse, linear-oblong, 30 cm. or less long, petiolate or subpetiolate 15

15. Spur vesicular, longer than lip; median lobe of lip reflexed; disc in front of callus inornate . . . *O. quadriloba*

15a. Spur cylindrical, shorter than lip; median lobe of lip not reflexed; disc in front of callus 3-carinate 16

16. Pseudobulbs 2-leaved; leaves subpetiolate, 20–30 cm. long; inflorescence racemose; lateral lobes of lip rounded, larger than median lobe . . . . *O. sclerophylla*

16a. Pseudobulbs 1-leaved; leaves petiolate, less than 15 cm. long; inflorescence branched; lateral lobes of lip subquadrate with obtuse angles, equal to, or somewhat smaller than median lobe . . . . *O. analavelensis*

17. Plants caespitose; pseudobulbs aggregate, ecolliferous or with hardly any projections; leaves sessile or with conduplicate, short, petiole-like base 18

17a. Plants rhizomatous; pseudobulbs approximate, prominently colliferous, leaves distinctly petiolate 25

18. Pseudobulbs 2-leaved 19

18a. Pseudobulbs 1-leaved 20

19. Inflorescence profusely paniculate; lateral lobes of lip falcate, when expanded parallel with, and as long as midlobe; midlobe of lip wider than long; spur conical, acuminate . . . . . *O. gracillima*

19a. Inflorescence racemose or rarely with one or few short branches; lateral lobes of lip triangular to oblong, when expanded rectangular with midlobe; midlobe of lip as wide as long, subquadrate; spur vesicular, obtuse . . . . . *O. roseovariegata*

20. Leaves ovate, subcordate at base 21

20a. Leaves elliptic to oblong-elliptic, cuneate at base 22

21. Sepals and petals similar, elliptic to ovate-elliptic, obtuse; lateral lobes of lip much larger than mid-

lobe; column short, erect . . . . . *O. boinensis*

21a. Sepals and petals dissimilar, linear-lanceolate, acute; lateral lobes of lip as large as midlobe; column elongate, arcuate . . . . . *O. Rauhii*

22. Lip as long as or shorter than wide; terminal lobe separated from the lateral lobes by acute, indented or rounded sinuses 23

22a. Lip as long as or longer than wide; terminal lobe separated from the lateral lobes by a distinct isthmus . . . . . *O. monophylla*

23. Spur subglobose; callus of lip bilobed . . . . *O. ambongensis*

23a. Spur clavate to cylindric; callus of lip bilamellate 24

24. Sepals and petals acute: lip as long as wide; sinuses in middle of lip; inflorescence always racemose . *O. maculata*

24a. Sepals and petals obtuse; lip shorter than wide; sinuses one-third from apex of lip; inflorescence racemose or subpaniculate . . . . . *O. Mackenii*

25. Pseudobulbs narrowly cylindrical, often stem-like, terete, two-leaved; lateral sepals longer than dorsal sepal; lip equally 4-lobed . . . . . *O. Saundersiana*

25a. Pseudobulbs ovoid to conical, 1-leaved; sepals of same length; lip flabellate or unequally 4-lobed 26

26. Lateral lobes of lip larger than median lobe 27

26a. Lateral lobes of lip much smaller than median lobe, ear-like 28

27. Leaves lanceolate, long-attenuate, subacuminate; sepals and petals apiculate . . . . . *O. zanzibarica*

27a. Leaves lanceolate-elliptic or narrowly elliptic, acute to subobtuse; sepals and petals obtuse *O. alismatophylla*

28. Callus of lip and the disc in front of it puberulent 29

28a. Callus of lip and disc glabrous 30

29. Leaves broadly elliptic, large, 7-nerved, with petiole 30–50 cm. long; column-wing ciliolate-hirsute along margins; lateral lobes of lip rounded . . . *O. cordylinophylla*

29a. Leaves narrowly ovate-lanceolate, 1–3 nerved, with petiole 13–20 cm. long; column-wings glabrous along margins; lateral lobes of lip obliquely triangular-falcate . . . . . *O. analamerensis*

30. Lip constricted in middle, pandurate, basal part suborbicular, apical part divergingly bilobed with rounded lobes; disc bilamellate at base in front of which are 3 thickened veins . . . . . *O. petiolata*

30a. Lip not pandurate, 3-lobed; lateral lobes obtusely

angular, semiovate, terminal lobe divergingly bilobulate with rectangular-oblong lobules; disc without thickened veins in front of basal lamellae . . . . . *O. lonchophylla*

Enumeration of Species

Oeceoclades alismatophylla (Rchb.f.) Garay & Taylor, *comb. nov.*

Basionym: *Eulophia alismatophylla* Rchb.f. in Flora 68: 543, 1885.

Syn.: *Eulophidium alismatophyllum* (Rchb.f.) Summerh. in Bull. Jard. Bot. Bruxelles 27: 394, 1957.

Type: Madagascar, Forêt d'Ankaye. Coll. Humblot *s.n.!* (W).

Distribution: Madagascar.

Vegetatively the plants of this species are very similar to *O. analamerensis*, *O. petiolata* and *O. lonchophylla*, but readily distinguishable from them in the floral structure, especially in the shape of the lip with the lateral lobes being larger than the median lobe. We have seen only the type specimen.

Oeceoclades ambongensis (Schltr.) Garay & Taylor, *comb. nov.*

Basionym: *Eulophidium ambongense* Schltr. in Ann. Mus. Col. Marseille, ser. 3, 1: 182, t. 17, 1913.

Syn.: *Eulophia Schlechteri* H. Perr. in Bull. Soc. Bot. Fr. 82: 154, 1935.
Lissochilus Schlechteri (H. Perr.) H. Perr. in Humbert, Fl. Madag. Orch. 2: 27, 1941.

Type: Madagascar, Manongarivo (Ambongo). Coll. Perrier no. 1684! (P).

Distribution: Madagascar.

From the related species of the *O. maculata* alliance, the plants of this species are readily identifiable by the comparatively larger flowers, subglobose spur and the bilobed callus of the lip.

Oeceoclades analamerensis (H. Perr.) Garay & Taylor, *comb. nov.*

Basionym: *Lissochilus analamerensis* H. Perr. in Not. Syst. 8: 42, 1939.

Syn.: *Eulophidium analamerense* (H. Perr.) Summerh. in Bull. Jard. Bot. Bruxelles 27: 394, 1957.

Type: Madagascar, Province de Diégo-Suarez, Analamera, rive droite de la rivière Analabe, affluent du Rodo. Coll. Humbert no. 19247! (P, K).

Distribution: Madagascar.

The two small approximate lamellae near the base of the lip and the hirsute disc of the lip amply separate the plants of this species from the vegetatively similar *O. alismatophylla*.

Perrier gives Humbert no. 19020 as the type number, but the specimens in Paris as well as at Kew bear the number 19247!

Oeceoclades analavelensis (H. Perr.) Garay & Taylor, *comb. nov.*

Basionym: *Lissochilus analavelensis* H. Perr. in Not. Syst. 8: 41, 1939.

Syn.: *Eulophidium analavelense* (H. Perr.) Summerh. in Bull. Jard. Bot. Bruxelles 27: 395, 1957.

Type: Madagascar, Forêt d'Analavelona, au N. du Fiherenana. Coll. Humbert no. 14218! (P, K).

Distribution: Madagascar.

Florally the plants of this species are very similar to those of *O. sclerophylla*, both having three thickened ridges in front of the callus, but they are very dissimilar vegetatively.

Oeceoclades angustifolia (Sengh.) Garay & Taylor, *comb. nov.*

Basionym: *Eulophidium angustifolium* Sengh. in Adansonia ser. 2, 6: 558, 1967.

Type: Madagascar: near Diégo-Suarez. Coll. Rauh & Buchloch no. 7987 (HEID).

Syn.: *Eulophidium angustifolium* ssp. *diphyllum* Sengh. in Adansonia ser. 2, 6: 561, 1967.

Type: Madagascar, near Sakaraha, river Fiherenana. Coll. Rauh no. 10423 (HEID).

Distribution: Madagascar.

From the related *O. Decaryana*, the plants of this species are distinguished in having petiolate leaves as well as differently proportioned lips.

Oeceoclades atrovirens (Lindl.) Garay & Taylor, *comb. nov.*

Basionym: *Eulophia atrovirens* Lindl., Gen. and Sp. Orch. Pl. 184, 1833.

Syn.: *Graphorchis atrovirens* (Lindl.) O. Ktze., Rev. Gen. Pl. 2: 662, 1891.

Type: India, without proper locality. Coll. Wallich *s.n.!* (K).

Distribution: India orientalis.

This peculiar plant is known from a colored drawing prepared by Wallich in 1828 for the East India Co., now in the Kew Herbarium. Ironically, Lindley originally has written on the drawing "Oeceoclades", then at a later time he crossed it out. So far no specimens are known to exist of this plant. Judging from the drawing, especially the floral details, it is near *O. latifolia* from which it differs in having a simple raceme, rather pointed sepals and petals and a somewhat different lip.

Oeceoclades boinensis (Schltr.) Garay & Taylor, *comb. nov.*

Basionym: *Eulophidium boinense* Schltr. in Ann. Mus. Col. Marseille ser. 3, 1: 182, t. 17, 1913.

Syn.: *Lissochilus boinensis* (Schltr.) H. Perr. in Humbert, Fl. Madag. Orch. 2: 26, 1941.

Type: Madagascar, bords de la rivière Andranofasy (Boina). Coll. Perrier no. 1834! (P).

Distribution: Madagascar.

This species has its only relative in *O. Rauhii*, both having a more or less cordate base to the leaves. In floral structures they are, however, very different. The type number of *O. boinensis* is Perrier 1834! and not 1384 as given by Schlechter.

Oeceoclades calcarata (Schltr.) Garay & Taylor, *comb. nov.*

Basionym: *Cymbidium calcaratum* Schltr. in Ann. Mus. Col. Marseille ser. 3, 1: 181, t. 16, 1913.

Syn.: *Eulophia calcarata* (Schltr.) Schltr. in Fedde Rep. Beih. 32: 262, 1925.

Type: Madagascar, Manongarivo (Ambongo). Coll. Perrier no. 1681! (P).

Eulophia paniculata Rolfe in Gard. Chron. ser. 3, 38: 197, 1905, not *Oeceoclades paniculata* Lindl.

Lissochilus paniculatus (Rolfe) H. Perr. in Humbert, Fl. Madag. Orch. 2: 29, 1941.

Eulophidium paniculatum (Rolfe) Summerh. in Bull. Jard. Bot. Bruxelles 27: 399, 1957.

Type: Madagascar, without precise locality. Collector unknown. Flowered in cultivation at the Royal Botanic Garden, Glasnevin in June 1904! (K).

Distribution: Madagascar.

The forward-projecting spur under the lip is unique in the genus.

Oeceoclades cordylinophylla (Rchb.f.) Garay & Taylor, *comb. nov.*

Basionym: *Eulophia cordylinophylla* Rchb.f. in Flora 68: 541, 1885.

Syn.: *Lissochilus cordylinophyllus* (Rchb.f.) H. Perr. in Humbert, Fl. Madag. Orch. 2: 20, 1941.

Eulophidium cordylinophyllum (Rchb.f.) Summerh. in Bull. Jard. Bot. Bruxelles 27: 395, 1957.

Type: Comoro Islands, without proper locality. Coll. Humblot *s.n.* (W).

Eulophia lokobensis H. Perr. in Bull. Soc. Bot. Fr. 82: 153, 1935.

Lissochilus lokobensis (H. Perr.) H. Perr. in Humbert, Fl. Madag, Orch. 2: 22, 1941.
Eulophidium lokobense (H. Perr.) Summerh. in Bull. Jard. Bot. Bruxelles 27: 396, 1957.

Type: Madagascar, Forêt de Lokobe dans l'Ile de Nossi-Bé. Coll. Perrier no. 19013! (P).

Distribution: Comoro Islands, Madagascar.

The actual specimen of *Eulophia cordylinophylla* is missing. However, there is a sheet among Humblot's collections from the Comoro Islands with an unpublished name by Reichenbach, which agrees well with the original description. This specimen also is identical with the type of *E. lokobensis* from Ile de Nossi-Bé, near the Comoro chain. Perrier's description of the column-wing as being toothed is incorrect. The margins of the column are ciliolate-hirsute.

Oeceoclades Decaryana (H. Perr.) Garay & Taylor, *comb. nov.*

Basionym: *Eulophia Decaryana* H. Perr. in Bull. Soc. Bot. Fr. 82: 154, 1935.

Syn.: *Lissochilus Decaryanus* (H. Perr.) H. Perr. in Humbert, Fl. Madag. Orch. 2: 32, 1941.
Eulophidium Decaryanum (H. Perr.) Summerh. in Bull. Jard. Bot. Bruxelles 27: 395, 1957.

Type: Madagascar, without proper locality. Coll. Decary *s.n.* (P). Type is cultivated in Serres du Museum d'Histoire Naturelle de Paris (no. K 467).

Distribution: Madagascar, Mozambique, Rhodesia, Kenya.

Judging from the assortment of specimens we have examined, the length of the sepals varies with age. It may be separated easily from the related *O. spathulifera* by the shape of the spur. Because of the cylindrical spur, the illustrations published in Die Orchidee 18: 246, 1967, as *Eulophidium spatuliferum* are referable here.

Oeceoclades gracillima (Schltr.) Garay & Taylor, *comb. nov.*

Basionym: *Eulophia gracillima* Schltr. in Ann. Mus. Col. Marseille ser. 3, 1: 170, t. 14, 1913, not Ridl. 1886.

Syn.: *Eulophidium gracillimum* Schltr. in Fedde Rep. Beih. 33: 255, 1925, *nom. nov.*

Lissochilus gracillimus (Schltr.) H. Perr. in Humbert, Fl. Madag. Orch. 2: 28, 1941.

Type: Madagascar, bassin du Besafotra, affluent de Menavava (Boina). Coll. Perrier no. 1059! (P).

Distribution: Madagascar.

This species is closely related to *O. roseovariegata*, but the diffusely paniculate inflorescence and the shape of the lip and spur readily keep them apart.

Oeceoclades Hebdingiana (Guillaum.) Garay & Taylor, *comb. nov.*

Basionym: *Lissochilus Hebdingianus* Guillaum. in Bull. Mus. Nat. Hist. Nat. ser. 2, 35: 521, 1963.

Type: Madagascar, sous bois d'Anipanihy, Provenance Montagnac. Flowered in cultivation in Jardin Botanique "Les Cèdres". Collector unknown! (P).

Distribution: Madagascar.

Related to *O. calcarata* from which it differs primarily in the shape of the lip and not having a forward-projecting spur.

Oeceoclades lanceata (H. Perr.) Garay & Taylor, *comb. nov.*

Basionym: *Eulophia lanceata* H. Perr. in Bull. Soc. Bot. Fr. 82: 156, 1935.

Type: Madagascar, bois des pentes occidentales a Manerinerina sur le Tampoketsa, entre l'Ikopa et la Betsiboka. Coll. Perrier no. 16843! (P).

Distribution: Madagascar.

Perrier has reduced this species to a synonym of *Eulophia pandurata* Rolfe, but the two are amply distinct from one another in floral

details, especially in the shape of the lip. Vegetatively it is reminiscent of *O. seychellarum*. The flowers are rose-colored.

Oeceoclades latifolia (Rolfe) Garay & Taylor, *comb. nov.*

Basionym: *Eulophia latifolia* Rolfe in Bol. Soc. Broter. 9: 139, 1891.

Syn.: *Eulophidium latifolium* (Rolfe) Summerh. in Bull. Jard. Bot. Bruxelles 27: 396, 1957.

Type: Island of São Tomé. Coll. Quintas *s.n.!* (K).

Distribution: Africa—Island of São Tomé.

Florally the plants referable to this species are rather similar to *O. ugandae*, but vegetatively they are very different and more reminiscent of *O. atrovirens*. The lateral veins of the lip are papillose-ciliolate in this alliance to which *O. pandurata*, *O. seychellarum* and *O. lanceata* also belong.

Oeceoclades lonchophylla (Rchb.f.) Garay & Taylor, *comb. nov.*

Basionym: *Eulophia lonchophylla* Rchb.f. in Flora 68: 542, 1885.

Syn.: *Eulophidium lonchophyllum* (Rchb.f.) Schltr. in Fedde Rep. Beih. 33: 256, 1925.

Lissochilus lonchophyllus (Rchb.f.) H. Perr. in Humbert, Fl. Madag. Orch. 2: 26, 1941.

Type: Comoro Islands, without proper locality. Coll. Humblot no. 433! (P,W).

Eulophia tainioides Schltr. in Engl., Bot. Jahrb. 26: 339, 1899.

Eulophidium tainioides (Schltr.) Summerh. in Bull. Jard. Bot. Bruxelles 27: 403, 1957.

Type: Mozambique, between Morumben and Massinga, region of Inhambane. Coll. Schlechter no. 12106! (K,Z).

Eulophia dissimilis Dyer in Fl. Pl. Afr. 27: t. 1066, 1949.

Eulophidium dissimile Dyer in Fl. Pl. Afr. 27: t. 1066, 1949, *nom. altern. in obs.*

Type: Mozambique, Lourenco Marques District, Lebombo Mountains. Coll. Daintree *s.n.* (PRE).

Distribution: Mozambique, Comoro Islands.

We cannot find enough distinction between *E. lonchophylla* and *E. tainioides* to maintain them separately.

Humblot no. 433 is a mixture, containing material also referable to *O. cordylinophylla* and to *O. Perrieri*. In the Reichenbach Herbarium no. 6531 the original description and drawings by Reichenbach are mounted with a specimen with long, lorate leaves. This specimen does not belong to *O. lonchophylla*. We have chosen Herbarium Reichenbach no. 5902 as the holotype of Humblot no. 433, *O. lonchophylla*, for it agrees with the specimens under that name in Paris.

Oeceoclades Lubbersiana (De Wildem. & Laurent) Garay & Taylor, *comb. nov.*

Basionym: *Eulophia Lubbersiana* De Wildem. & Laurent in Rev. Hort. Belg. 26: 4, 1900.

Syn.: *Eulophidium Lubbersianum* (De Wildem. & Laurent) Summerh. in Bull. Jard. Bot. Bruxelles 27: 397, 1957.

Type: Zaïre, Sankur. Coll. Laurent *s.n.!* (BR).

Distribution: Zaïre, Uganda.

Vegetatively the plants of this species are very similar to *O. atrovirens*. The shape of the lip which is wider than long, however, is unique in the relationship to which also *O. latifolia* and *O. pandurata* belong.

Oeceoclades Mackenii (Rolfe ex Hemsl.) Garay & Taylor, *comb. nov.*

Basionym: *Eulophia Mackenii* Rolfe ex Hemsl. in Gard. Chron. ser. 3, 12: 583, 1892.

Syn.: *Eulophidium Mackenii* (Rolfe ex Hemsl.) Schltr. in Ann. Mus. Col. Marseille ser. 3, 1: 183, 1913.

Type: Natal, near Verulam. Coll. McKen no. 11! (K).

Distribution: Natal, Mozambique, Rhodesia.

Superficially the plants of this species are rather similar to *O. maculata*. However, the lip which is shorter than wide and the branched inflorescence afford easy recognition in both the field and the herbarium.

Oeceoclades maculata (Lindl.) Lindl., Gen. and Sp. Orch. Pl. 237, 1833.

Basionym: *Angraecum maculatum* Lindl., Collect. Bot. t. 15, May 1821.

Syn.: *Limodorum maculatum* Lodd., Bot. Cab. 5: t. 496, June 1821.

Aerobion maculatum (Lindl.) Spreng., Syst. Veg. 3: 718, 1826.

Eulophia maculata (Lindl.) Rchb.f. in Walp. Ann. 6: 647, 1863.

Eulophidium maculatum (Lindl.) Pfitz., Entw. Nat. Anordn. Orch. 88, 1887.

Graphorchis maculata (Lindl.) O. Ktze., Rev. Gen. Pl. 2: 662, 1891.

Type: Brazil, without proper locality. Introduced and cultivated by Loddiges no. 34.10.16! (BM).

Geodorum pictum Link & Otto, Ic. Pl. Sel. pt. 3: 35, t. 14, July 1821.

Lectotype: Brazil, without precise locality. Received from British Gardens and cultivated in Berlin. (Probably part of the original introduction by Loddiges). Holotype was destroyed during World War II. The published plate is designated here as the Lectotype.

Eulophia Ledienii Stein ex N.E. Br. in Kew Bull. 90, 1899.

Eulophidium Ledienii (Stein ex N.E.Br.) De Wildem. in Ann. Mus. Congo ser. 5, 1: 115, 1904.

Type: Zaïre, without precise locality. Coll. Ledien *s.n.* (WRSL).

Eulophidium Warneckeanum Krzl. in Engl., Bot. Jahrb. 33: 70, 1902.

Type: West Africa, Togo, near Lome. Coll. Warnecke no. 196! (K).

Eulophidium nyassanum Schltr. in Engl., Bot. Jahrb. 53: 593, 1915.

Lectotype: Tanzania, near Mbaka Kilambo. Coll. Stolz no. 1909! (BM, K).

Distribution: U.S.A.—Florida, Venezuela, Colombia, Guyana, Peru, Bolivia, Argentina, Paraguay, Brazil, Trinidad, Bahamas, Dominican Republic, W.I., Senegal, Guinee Bissau, Sierra Leone, Liberia, Ghana, Togo, Nigeria, São Tomé, Gabon, Zaïre, Congo-Brazzaville, Burundi, Sudan, Uganda, Tanganyika, Zanzibar, Pemba, Zambia, Rhodesia, Angola.

The plants of all three species, *O. maculata*, *O. monophylla*, and *O. Mackenii* are very similar in appearance. Yet the proportions of the lip in all are sufficiently distinct to allow easy recognition. The lip of *O. monophylla* always has a distinct elongate isthmus.

Oeceoclades maculata var. **pterocarpa** (Hauman) Garay & Taylor, *comb. nov.*

Basionym: *Eulophidium maculatum* var. *pterocarpum* Hauman in Anal. Mus. Hist. Nat. B. Aires 29: 381, 1917.

Type: Argentina, Formosa, Pilaya. Coll. Kermes no. 507. (BA).

Syn.: *Epidendrum connivens* Vell., Fl. Flumin. 9: t. 44, 1831.

Type: Brazil, Santa Cruz. Coll. Vellozo *s.n.* No specimen is known to exist. Vellozo's original drawing in Flora Fluminensis is regarded here as representing the holotype.

Distribution: Argentina, Paraguay, Brazil.

This variety differs from the typical form in having winged capsules. It is possible that when more material is at hand, especially fresh flowers, this variety may prove to represent a species sufficiently distinct from *O. maculata*. There is also a certain difference in the outline of the lip.

Oeceoclades monophylla (A. Rich.) Garay & Taylor, *comb. nov.*

Basionym: *Angraecum monophyllum* A. Rich. in Mem. Soc. Hist. Nat. Paris 4: 58, t. 9, 1828.

Syn.: *Eulophidium monophyllum* (A. Rich.) Schltr. in Ann. Mus. Col. Marseille, ser. 3, 1: 183, 1913.

Type: Mauritius Island, without proper locality. Coll. Commerson *s.n.!* (P).

Distribution: Mascarene Islands.

The distinction between the plants of this species and those of *O. maculata* have already been stated above. If the distance of articulation of leaves and pseudobulb is of specific importance, as Summerhayes seems to have thought, then *Eulophia Ledienii* now included in *O. maculata*, will probably be recognized on its own as a close relative of *O. monophylla*.

Oeceoclades pandurata (Rolfe) Garay & Taylor, *comb. nov.*

Basionym: *Eulophia pandurata* Rolfe in Journ. Linn. Soc. London 29: 52, 1891.

Syn.: *Lissochilus panduratus* (Rolfe) H. Perr. in Humbert, Fl. Madag. Orch. 2: 29, 1841.
Eulophidium panduratum (Rolfe) Summerh. in Bull. Jard. Bot. Bruxelles 27: 399, 1957.

Type: Madagascar, near Fort Dauphin. Coll. Elliot no. 2546! (K).

Distribution: Madagascar, Rhodesia.

The free, truncate lateral lobes of the lip are very characteristic for this species. The lateral veins on the disc are papillose-ciliolate.

Oeceoclades Perrieri (Schltr.) Garay & Taylor, *comb. nov.*

Basionym: *Eulophidium Perrieri* Schltr. in Fedde Rep. Beih. 33: 256, 1925, not *Eulophidium ambongense* Schltr.

Syn.: *Eulophia ambongensis* Schltr. in Ann. Col. Mus. Marseille ser. 3, 1: 169, t. 13, 1913.
Lissochilus ambongensis (Schltr.) H. Perr. in Humbert, Fl. Madag. Orch. 2: 19, 1941.

Type: Madagascar, Manongarivo (Ambongo). Coll. Perrier no. 1654! (P).

Distribution: Madagascar, Mozambique.

The long-acuminate, lorate leaves without a distinct petiole distinguishes the plants of this species from the related *O. quadriloba*, *O. sclerophylla* and *O. analavelensis*.

Oeceoclades petiolata (Schltr.) Garay & Taylor, *comb. nov.*

Basionym: *Eulophia petiolata* Schltr. in Ann. Mus. Col. Marseille ser. 3, 1: 175, t. 13, 1913.

Syn.: *Eulophidium petiolatum* (Schltr.) Schltr. in Fedde Rep. Beih. 33: 256, 1925.
Lissochilus petiolatus (Schltr.) H. Perr. in Humbert, Fl. Madag. Orch. 2: 25, 1941.

Type: Madagascar, Manongarivo (Ambongo). Coll. Perrier no. 478 bis! (P).

Distribution: Madagascar.

Vegetatively the plants of this species are practically identical with those of *O. alismatophylla*, but the shape of the lip is very different proportionately. From the related *O. lonchophylla* it differs in having a pandurate lip with three thickened veins in front of the calli.

Oeceoclades quadriloba (Schltr.) Garay & Taylor, *comb. nov.*

Basionym: *Eulophia quadriloba* Schltr. in Ann. Mus. Col. Marseille ser. 3, 1: 176, t. 12, 1913.

Syn.: *Eulophidium quadrilobum* (Schltr.) Schltr. in Fedde Rep. Beih. 33: 256, 1925.
Lissochilus quadrilobus (Schltr.) H. Perr. in Humbert, Fl. Madag. Orch. 2: 30, 1941.

Type: Madagascar, Manongarivo (Ambongo). Coll. Perrier no. 1696! (P).

Distribution: Madagascar, Rhodesia.

The unique structure of the lip in these plants is reminiscent of those belonging to the Asiatic genus *Grosourdya*. The vesicular, hanging spur is longer than the reflexed midlobe of the lip.

Oeceoclades Rauhii (Sengh.) Garay & Taylor, *comb. nov.*

Basionym: *Eulophidium Rauhii* Sengh. in Die Orchidee 24: 61, 1973.

Type: Madagascar, south of Anivorano. Coll. Rauh & Senghas no. 22865 (HEID).

Distribution: Madagascar.

Closely related to *O. boinensis* from which it differs in having lanceolate sepals and petals and an equally four-lobed lip.

Oeceoclades roseovariegata (Sengh.) Garay & Taylor, *comb. nov.*

Basionym: *Eulophidium roseovariegatum* Sengh. in Adansonia ser. 2, 6: 561, 1967.

Type: Madagascar, near Diégo-Suarez, "Montagne des Français". Coll. Rauh & Buchloch no. 7985 (HEID).

Distribution: Madagascar.

As it was stated above, this species is closely allied to *O. gracillima*. As a matter of fact, the plants were already known to Schlechter through a collection by Perrier no. 16224! (P), and was regarded by him as an undescribed species. The Perrier specimen has Schlechter's original drawings of the floral parts attached to the sheet. It was also collected on "Montagne des Français". Perrier identified it as *Eulophidium gracillimum* var., but cited it without a varietal name in his Orchids of Madagascar.

The photographs of *O. roseovariegata* in Die Orchidee 18: 24, 1967 show the spur as being distinctly bilobed. This is apparently due to the angle in photographing, revealing the ventrally compressed and slightly grooved tip.

Oeceoclades Saundersiana (Rchb.f.) Garay & Taylor, *comb. nov.*

Basionym: *Eulophia Saundersiana* Rchb.f. in Bot. Zeit. 24: 378, 1866.

Syn.: *Graphorchis Saundersiana* (Rchb.f.) O.Ktze., Rev. Gen. Pl. 2: 662, 1891.

Eulophidium Saundersianum (Rchb.f.) Sum-

merh. in Bull. Jard. Bot. Bruxelles 27: 401, 1957.

Type: Africa, West Coast, without precise locality. Coll. Mann *s.n.!* (W).

Lissochilus barombensis Krzl. in Engl., Bot. Jahrb. 17: 52, 1893.

Type: Cameroun, Barombi. Coll. Preuss no. 546! (K).

Eulophia Bierleri De Wildem., Not. Pl. Util. Congo 1: 311, 1904.

Type: Zaïre, Coquilhatville. Coll. Bierler *s.n.* (BR).

Eulophia Mildbraedii Krzl. in Engl., Bot. Jahrb. 43: 339, 1909.

Type: Zaïre, Ruwenzori Range, Semliki Plains. Coll. Mildbraed no. 275! (K).

Distribution: Sierra Leone, Liberia, Ivory Coast, Ghana, Nigeria, Cameroun, Gabon, Zaïre, Uganda, Kenya, Tanzania, Zambia, Angola.

The long cylindrical pseudobulbs with two leaves and the equally four-lobed lip of rather large flowers easily identify the plants of this species.

Oeceoclades sclerophylla (Rchb.f.) Garay & Taylor, *comb. nov.*

Basionym: *Eulophia sclerophylla* Rchb.f. in Flora 68: 542, 1885.

Syn.: *Eulophidium sclerophyllum* (Rchb.f.) Summerh. in Bull. Jard. Bot. Bruxelles 27: 402, 1957.

Type: Madagascar, Forêt d'Ankaye. Coll. Humblot *s.n.!* (W).

Eulophia Elliotii Rolfe in Journ. Linn. Soc. London 29: 52, 1891.

Lissochilus Elliotii (Rolfe) H. Perr. in Humbert, Fl. Madag. Orch. 2: 47, 1941.

Type: Madagascar, near Fort Dauphin. Coll. Elliot no. 2424! (K).

Among the plants with long, linear leaves *O. sclerophylla* may be compared with *O. analavelensis*, but the two-leaved pseudobulbs and the differently proportioned lips readily separate the two. Vegetatively it also resembles *O. quadriloba*.

Oeceoclades seychellarum (Rolfe ex Summerh.) Garay & Taylor, *comb. nov.*

Basionym: *Eulophia seychellarum* Rolfe ex Summerh. in Bull. Misc. Inf. Kew 363, 1928.

Syn.: *Eulophidium seychellarum* (Rolfe ex Summerh.) Summerh. in Bull. Jard. Bot. Bruxelles 27: 402, 1957.

Type: Seychelles, Mahé, Cascade Estate. Coll. Thomasset no. 38! (K).

Distribution: Seychelles.

Vegetatively the plants of *O. seychellarum* are identical with those of *O. lanceata*. The two may be kept apart on account of the differences in the floral structures, especially in the shape and proportion of the lip as shown in the key.

Oeceoclades spathulifera (H. Perr.) Garay & Taylor, *comb. nov.*

Basionym: *Eulophia spathulifera* H. Perr. in Bull. Soc. Bot. Fr. 82: 157, 1935, as *E. spatulifera, sphalm.*

Syn.: *Lissochilus spathulifer* (H. Perr.) H. Perr. in Humbert, Fl. Madag. Orch. 2: 33, 1941.
Eulophidium spathuliferum (H. Perr.) Summerh. in Bull. Jard. Bot. Bruxelles 27: 403, 1957.

Type: Madagascar, Ambongo-Boina. Coll. Perrier no. 15930 (P).

Distribution: Madagascar.

The distinctly spathulate sepals and petals combined with a globose spur easily separates the plants of this species from the related *O. calcarata* and *O. Hebdingiana*.

Oeceoclades ugandae (Rolfe) Garay & Taylor, *comb. nov.*

Basionym: *Eulophia ugandae* Rolfe in Bull. Misc. Inf. Kew 339, 1913.

Type: Uganda, Mabira Forest. Coll. Brown no. 443! (K).

Distribution: Zaïre, Ghana, Uganda.

Summerhayes considered this species to be synonymous with *O. latifolia*. As a matter of fact the shape of the lip superficially looks very much alike in both. Yet vegetatively the plants of these two species are closer to other members than to one another. The lip of *O. ugandae* is also provided with a pair of gibbosities at the junction of the lateral and midlobes, this character is absent in *O. latifolia*.

Oeceoclades zanzibarica (Summerh.) Garay & Taylor, *comb. nov.*

Basionym: *Eulophidium zanzibaricum* Summerh. in Bull. Misc. Inf. Kew 417, 1927.

Type: Zanzibar, without precise locality. Coll. Last s.n.! (K).

Distribution: Zanzibar, Pemba.

The lanceolate, long-attenuate leaf is rather unique in the genus. Florally the plants of this species are closest to those of *O. alismatophylla* from Madagascar, but differ from one another in the shape of the sepals and petals and in the proportions of the lip.

Excluded Species

O. falcata (Thunb.) Lindl. = Neofinetia falcata (Thunb.) Hu

O. flexuosa Lindl. = Cleisostoma ramosum (Lindl.) Hook.f.

O. funalis (Sw.) Lindl. = Dendrophylax funalis (Sw.) Benth. ex Rolfe

O. gracilis (Thou.) Lindl. = Chamaeangis gracilis (Thou.) Schltr.

O. javanica Teijsm. & Binn. = Hymenorchis javanica (T. & B) Schltr.

O. Lindleyana Regel. = Neofinetia falcata (Thunb.) Hu

O. Lindleyi Regel = Neofinetia falcata (Thunb.) Hu

O. paniculata Lindl. = Robiquetia succisa (Lindl.) Seidenf. & Garay

O. parviflora (Thou.) Lindl. = Angraecopsis parviflora (Thou.) Schltr.

O. pusilla Lindl. = Saccolabiopsis pusilla (Lindl.) Seidenf. & Garay

O. Retzii Lindl. = Chiloschista pusilla (Retz) Schltr.

O. tenera Lindl. = Trichoglottis tenera (Lindl.) Rchb.f.

The following list of names constitutes the **Section Pulchrae** Krzl. of the genus *Eulophia* (Gard. Chron. ser. 3, 22: 262, 1897). Some of these names have been referred to the genus *Eulophidium* (= *Oeceoclades*) previously.

Eulophia gracilis Lindl. in Bot. Reg. 9: t. 742, 1823.

Eulophia emarginata Bl., Fl. Java, n.s. 1: 152, 1858.

Eulophia guamensis Ames in Philipp. Journ. Sci. Bot. 9: 12, 1814.

Eulophia macrostachya Lindl., Gen. and Sp. Orch. Pl. 183, 1833.

Eulophia megistophylla Rchb.f. in Flora 68: 379, 1885.

Eulophia minimiflora Krzl. in Not. Syst. 4: 137, 1928.

Eulophia novo-ebudae Krzl. in Bull. Soc. Bot. Fr. 76: 301, 1929.

Eulophia pulchra (Thou.) Lindl., Gen. and Sp. Orch. Pl. 182, 1833.

Eulophia Rouxii Krzl. in Sarasin & Roux, Nova Caled. 1: 82, 1914.

Eulophia silvatica Schltr. in Engl., Bot. Jahrb. 53: 586, 1915.

Eulophia striata Rolfe in Journ. Linn. Soc. London 29: 53, 1891.

Eulophia Wendlandiana Krzl. in Gard. Chron. ser. 3, 22: 262, 1897.

Lissochilus ambrensis H. Perr. in Not. Syst. 14: 159, 1951.

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MANICARIA SACCIFERA AND ITS CULTURAL SIGNIFICANCE AMONG THE WARAO INDIANS OF VENEZUELA

BY

JOHANNES WILBERT

Within the tropical and subtropical belt that circles the earth, palms can truly be counted among the best friends of man. In several regions, the various parts of the palm are so thoroughly exploited for purposes of food, drink, basic materials, tools, and utensils that it assumes a pivotal position in the cultural life of the people. In South America outstanding examples are *Astrocaryum*, *Euterpe*, *Guilielma*, *Jessenia*, *Mauritia*, *Maximiliana*, *Oenocarpus*, *Orbignya*, and *Syagrus*. In addition, the Indians are known to utilize the products of at least a dozen other genera of palms.[1]

This paper focuses on *Manicaria saccifera*, the *temiche* palm, and its cultural importance among the Warao Indians of Venezuela (PLATE LXVI). Ethnobotanical information on this genus, except for descriptions in floras, is slight, and the fact that *Manicaria saccifera* is used as a source of sago has, heretofore, gone unrecorded in the scientific literature.[2]

As an ancient food-quest activity of man, the recovery of palm starch "appears to be a pantropical phenomenon that is most highly developed on the mainland of Southeast Asia and in the West Pacific. In that region starch extraction involves, principally, palms of the genus *Metroxylon*, Sago Palms (Burkill 1935: 1460–1462; and Barrau 1959: 151–159). Palms

Plate LXVI



Manicaria saccifera in the forest of the Intermediate zone of the Orinoco Delta.

of other genera are also used to a lesser extent" (Heinen and Ruddle 1974: 116).[3]

In South America, the Indians recover starch from at least four genera of palms: *Syagrus*, *Copernicia*, *Mauritia*, and *Manicaria*, the most important being *Syagrus* and *Mauritia*.[4] *Syagrus Romanzoffianum* and *Copernicia cerifera* are exploited for sago by the Tupí-speaking Guayakí Indians of Paraguay and by several Guaranian and non-Guaranian tribes of the Gran Chaco. *Mauritia flexuosa* and *Manicaria saccifera* are utilized for sago recovery by the Warao Indians of the Orinoco Delta in Venezuela and in the adjacent easterly regions of Guyana.

Syagrus Romanzoffianum, the Paraguayan coconut or queen palm, has a southeasterly distribution in South America, where it is known by its Guaraní name *pindó*. The Guayakí call the palm *tói* (*töi*, *täi*) and refer to its sago as *krakú* (Cadogan 1960). Because of the many uses to which its different parts are put, *Syagrus Romanzoffianum* plays an outstanding role in the lives of the autochthonous and rural populations of this part of the New World. In fact, for the different Indian tribes of the area it represents probably the most important economic plant of their environment.

The extraction of sago from *Syagrus Romanzoffianum* and *Copernicia cerifera* is known to be practiced in South America by such tribes as the Guayakí, Mbyá (Cainguá), Kaingán, Toba, Lengua, and Chamacoco. But it is highly probable that this practice was diffused much more widely in earlier, pre-agricultural times. Writes Vellard (1934–35: 240–241) concerning the Guayakí:

> . . . it is the flour extracted from the pindo palm (*Cocos Romanzoffiana*) which, along with the game and honey, constitutes their basic diet. . . . To prepare the flour . . . the Guayakí cut open the trunk with an axe. The fibers are pounded and crushed on the spot with the help of an old piece of bow or with the back of the axe, then they are roughly strained on a square frame with loose straw or lamellas of bamboo bark. After being moistened with water the flour is used for making cakes which are eaten raw or dried near the fire.

Vellard (ibid., p. 240) points out that *krakú* starch is prepared not only by the Guayakí but also by the Mbyá, a subgroup of the Guaraní-speaking Cainguá. They fall back on it as an emergency food. "To obtain the starchy pith of palm trees, the Mbyá extracted the long fibers imbedded in starch from the lower part of the trunk. They either pounded them in a mortar and sucked them or else dried them on a platform in the sun or over the fire, pounded them, sifted them through a net, and then made them into loaves or cakes" (Métraux 1946a: 262). Even the Paraguayans resorted to eating *krakú* "after the disastrous war against the Triple-Alliance (1866–1870)" (Vellard ibid. p. 240).

For the Kaingán (Caingang), a non-Guaraní-speaking tribe of southern Brazil, the sago of *Syagrus Romanzoffianum* was an important food before it was replaced by manioc flour. (The Indians crushed the pith in a mortar and sifted the flour before roasting it in a pan, just as is done now with manioc flour.) (Métraux 1946*b*: 445–453.)

Métraux (1946*a*: 248, 261) also describes the Toba, the Lengua, and the Chamacoco tribes of the Gran Chaco as recovering the palm starch of *Copernicia cerifera*. The Toba pound the pith in a mortar and boil it as a mush, whereas the Lengua grate it into flour for cakes. *Carandaipe* starch is a principal vegetable food for the Chamacoco.

The best documented case by far of palm-starch extraction for any South American Indian tribe comes from the region of the Warao, where chroniclers, missionaries, travellers, and anthropologists have become aware of its existence and where, on numerous occasions over the past twenty years of intermittent field work, I witnessed at first hand the process of recovery of sago from *Mauritia*.[5] The ethnobotanical data available on this palm are too abundant to be treated here. Suffice it to say that *Mauritia* sago, *ohidu aru*, has been the staple food for most Warao until very recently, when it was supplanted by ocumo (*Xanthosoma sagittifolium*) and, to a lesser extent, by manioc (*Manihot esculenta*).

The practice of extracting sago from *Manicaria saccifera*

(*yahuhi aru*) came to my attention only recently, and I was able to witness the procedure for the first time in the summer of 1975.

In a process that may have taken more than a thousand years, the Warao have adapted their life and culture to the rather difficult outer world of the Orinoco Delta, situated in eastern Venezuela between 8° and 10° north latitude and between 59° and 62° west longitude. The Delta is a large fan of alluvial deposits occupying 17,000 square kilometers and bounded on the south by the Orinoco River proper and on the west by the Manamo which branches off the main river at Barrancas, where the apex of the Delta is situated. Most of this low-lying triangle is a tidal swamp lacking in dry ground and stone and extending inland from 50 to 100 kilometers (Liddle 1928: 20–24).

Manicaria does not grow throughout this vast area but is restricted mainly to regions immediately within the Intermediate Delta zone behind the Lower Delta, most of which is covered by a belt of mangrove. Typical of such environments, the soil is almost always inundated, thus providing along the perimeter of the swamp the ideal condition for the pioneering *Rhizophora Mangle*. The feature characteristic of mangrove forests of growing on the periphery while dying at the core is of primary importance to the Warao. The clearing that results from the decomposing inner parts of the mangrove forest is invaded by many kinds of trees important to the Indians, among them useful palms such as the *Mauritia*, *Euterpe*, and *Manicaria*. Thus, within and behind the coastal mangrove belt of the Lower and Intermediate Delta zones there developed the echonich of a palmetum that has amply served the Warao as an abundant food basket and as a secure home.

The average mean temperature of the Delta is 26° C, the humidity 60 to 80 percent. The rainy season lasts roughly from May to October and the dry season from November to April, but rainy days with more or less intensive showers occur throughout the year. The annual precipitation ranges

from 100 to 200 centimeters (Heinen and Lavandero 1973: 4–11).

Twice daily the tide washes over the palmetum, encouraging the growth of the trees. The annual flooding of the Orinoco is felt only indirectly in the Intermediate Delta; the flooding of the palm groves during the wet season is actually due to rainfall. In the dry season, when the waters of the Orinoco recede, sea water penetrates into the Intermediate Delta, salinates the rivers, and temporarily causes a potable water problem. Within the palmetum, *Manicaria* appears to seek out not only places under the influence of the tides but also those exposed to the northeasterly trade winds that sweep over the Delta almost incessantly.

Warao culture is particularly adapted to life in this palm-rich environment. For the pre-agricultural Warao, the sago primarily of *Mauritia* and secondarily of *Manicaria* provided the staple food as well as a superabundance of edible fruits during much of the year. The *Euterpe* (*E. edulis*), too, yielded fruit and an especially tasty and rich palmito. *Manicaria* milk and *Mauritia* (unfermented) wine helped solve any drinking water problem, and the fat grubs of the palm borer (*Ryncophorus palmetum*), collected in overwhelming quantities from fallen *Mauritia* and *Manicaria*, was an important added source of protein to their diet. That the palms are a blessing is clearly recognized by the Warao, and these plants permeate their entire culture: its technological, socio-economic, and religious systems. The Indians refer to *Mauritia* sago, especially in combination with fish, as the "true food" of man; *Manicaria*, to a lesser degree, falls into the same category. Sago was more than a vital source of human sustenance; it came to be elevated to a position of ritual significance which has helped the Warao to cope psychologically with the hardships imposed upon them by a refuge environment little amenable to human life and culture.

Other palms found in the Orinoco Delta, but mostly outside the palmetum of the Lower and Intermediate zones, are *Astrocaryum*, *Jessenia*, *Maximiliana*, *Socratea* and others.

The study of *Manicaria* began in 1791, when the German botanist Joseph Gaertner (1791: 468, Pl. 2) founded the genus on the basis of the spathe, spadix, rachilla, and flowers of the plant (PLATE LXVII). Apparently, its trunk, foliage, and fruit remained largely unknown to the scientific world until sixty-two years later, when Wallace (1853: Plates II and XXVI) furnished his illustration of this "unique and handsome palm" (PLATE LXVIII). Wallace and other field workers have added much information to the original description,[6] although the genus, its speciation and distribution remain relatively little understood even today.[7]

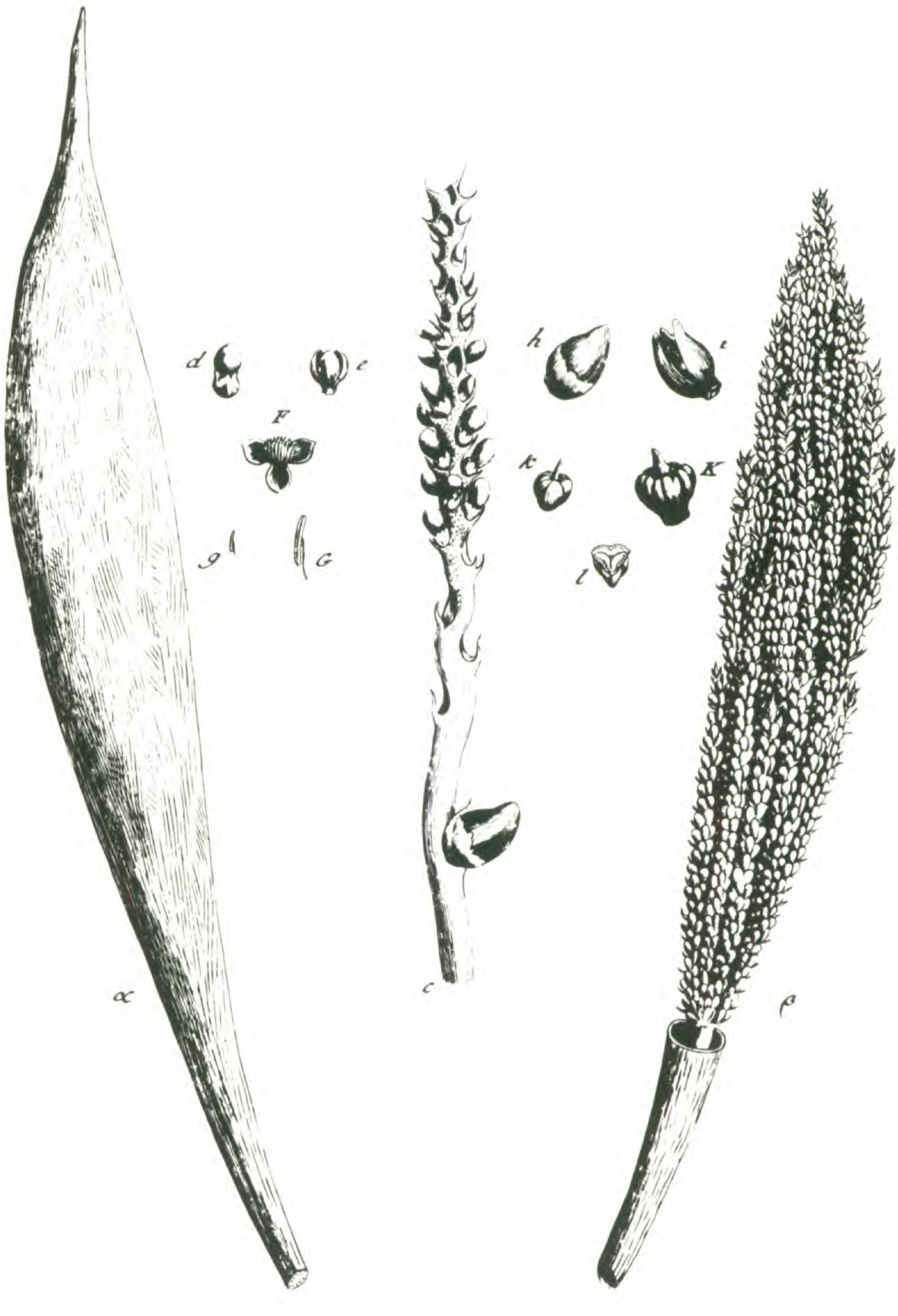
Standley and Steyermark (1958: 271) have published a concise summary of our present knowledge on the genus:

MANICARIA Gaertner

Reference: Burret, Notizbl. Bot. Gart. Berlin 11: 389. 1928.

Plants very robust, tall, or low, unarmed, the caudex stout, annulate, often curved or flexuous, covered with old leaf sheaths; leaves terminal, very large, suberect, lanceolate, acute, plicate-nerved, serrate at first and finally pinnatisect, the costa thick and stout, the petiole slender, the sheath cleft, its margins with many coarse fibers; spadices several, erect-spreading, tomentose, the branches strict, rather thick, foveolate; spathes 2, the upper fusiform, terete, mucronate, fibrous, tardily rupturing; bracts subulate; flowers monoecious, borne in the same spadix, this inserted among the leaves, simply branched, the flowers immersed in pits in the branches, the upper ones staminate, crowded, the lower ones scattered, pistillate; staminate flowers oblong trigonous, the sepals ovate-rounded, coriaceous, with scarious margins, imbricate, the petals thick-coriaceous, obovate-oblong, valvate; stamens 24–30, the filaments filiform, connate at the base, the anthers narrowly linear, erect, bifid at the base, emarginate; pistillate flowers larger, ovoid, the perianth little enlarged after anthesis, the sepals rounded, their margins finally lacerate, broadly imbricate, the petals longer, covolute-imbricate at the base, acute and valvate at the apex; ovary sulcate, 3-celled, the stigmas 3, sessile; fruit large, globose, 1-seeded, or depressed-globose and 2-3-seeded, the stigmas terminal, the pericarp corticate, the cortex corky, angulate-echinate, the endocarp vitreous-crustaceous, fibrous within;

Plate LXVII



Spathe, spadix, rachilla, and flowers that served Gaertner to establish the genus *Manicaria*, 1791.

Plate LXVIII



MANICARIA SACCIFERA Ht 40 Ft

First depiction by Wallace of *Manicaria*, 1853.

seeds globose, erect, the hilum oblong, the testa very hard, the branches of the raphe closely reticulate and involving the seed, the endosperm corneous, uniform, the embryo basal.

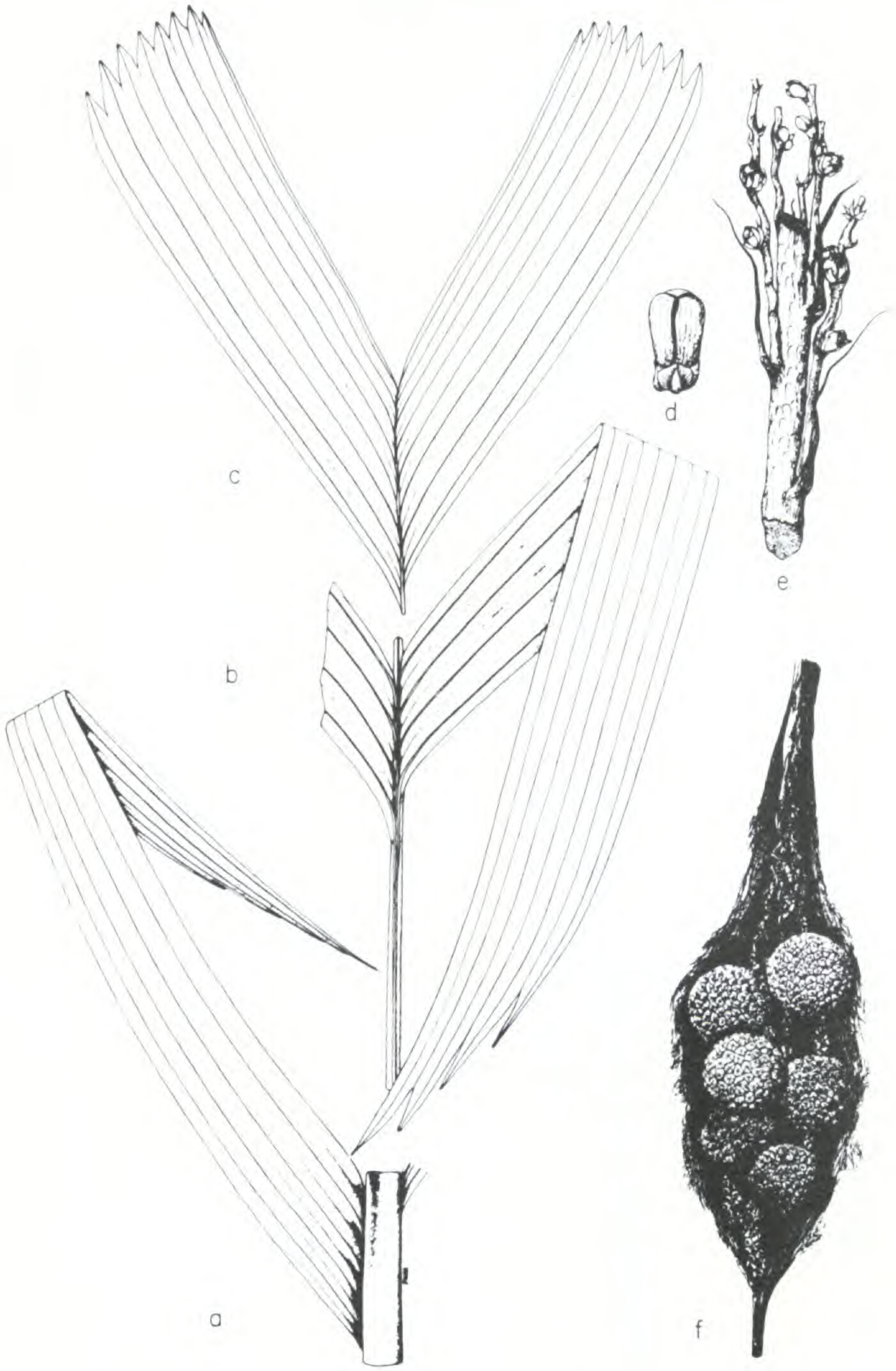
The genus has become known from Central America (Bailey 1943: 392–393; Standley and Steyermark 1958: 271–273), Trinidad (Bailey 1933: 409–413) and northern South America: from Colombia, the Orinoco Delta, the Guianas (Wessels Boer 1965*a*, *b*) to the mouth of the Amazon (Burret 1928: 389). It also occurs on the Rio Negro and the Upper Amazon (Wallace 1853: 70).

A very complete description of the species *Manicaria saccifera* was written by Wessels Boer (1965a: 21) PLATE LXIX:

Trunk solitary, up to 6 m. tall, about 3 dm. in diameter, in the upper part covered with dead leaf-bases, at base with prominent leaf-scars. About 10 contemporaneous suberect leaves; dead leaves persistent for some time and hanging down on the trunk; sheath with fibrous ventral part enclosing young leaves about 7 dm. long; petiole stout, about 12 dm. long and 8 cm. in diameter, grooved, leaf-blades very large, simple or irregularly pinnatisect through the action of the wind, also in leaves of juvenile plants, up to 7½ m. long and 23 dm. wide, bifid at apex, margin serrate; about 120 primary veins, 3–4 cm. distant at the middle of the blade, secondary veins inconspicuous; petiole, costa, and the lower surface of the blade at first more or less brown-tomentose, soon glabrescent.

Spadices almost erect, about 17 dm. long, with 2 spathes; outer spathe about 7 dm. long, flattened, invisible between leaf-sheaths, inner spathe about 11 dm. long, fusiform, mucronate, consisting of densely interwoven fibers without any suture, enclosing the inflorescence completely till long after anthesis; peduncle about 10 dm. long, rachis about 6 dm. long with up to 45 simple rachillas or rarely a few rachillas bifurcate, several large bracts along the peduncle within the inner spathe, smaller bracts at the base of the rachillas. Male flowers densely crowded in the upper part of the rachillas (and 2 laterally adjacent to each female flower), sunken in small pits and subtended by bracts 7–12 mm. long; sepals ovate, imbricate, 3–4 mm. long, petals lanceolate, valvate, ligneous-incrassate, 6–7 mm. long; stamens many (20–34), densely congested, filaments about 1½ mm. long, anthers 3 mm. long, the central ones usually misshapen. Female flowers few,

Plate LXIX



Depiction in Standley and Steyermark (1958: Fig. 45) of details of leaf, flower, and spathe of *Manicaria saccifera*.

(*Courtesy* Chicago Natural History Museum)

near the base of the rachillas between 2 male flowers, subtended by bracts; sepals ovate, imbricate, 7 mm. long, 8 mm. wide, petals ovate, valvate, acute at apex, ligneous-incrassate, 10 mm. long, 6 mm. wide; pistil globose, 4 mm. in diameter, stigma 3-fid, sessile, erect, 3–4 mm. long, strongly papillose. Fruit depressed-globose, 3-seeded or by abortion 1- or 2-seeded; exocarp corky, angulate-echinate, tubercles rather hard and not easily rubbed off; seed globose, about 4 cm. in diameter; embryo basal . . .

In this account of the genus, the most recent, Wessels Boer goes on to identify four species of *Manicaria*, very conspicuous and abundant swamp plants. The *Manicaria* occur in forests interspersed with other trees but also form colonies, or *temichales*, of great density. *Manicaria saccifera* is known in Venezuela as *temiche* (*timiche*, *timití*), an Arawakan noun; in Guyana as *truli*, a Cariban term; and in Brazil as *ubussú*, a Tupian word meaning "big leaves" (Civrieux 1957: 195–232). The Warao refer to it poetically as *yahuhi* (*yawihi*) meaning "plumes of the sun," descriptive of the leaves that look like giant bird feathers.

The Origin Myth of the Temiche Palm

Long ago there was an old woman who followed her husband to live in the lowlands of the Delta. Life was easier for the old couple there than where they had come from, and they greatly enjoyed the cool water of the bogland and the sea breeze that incessantly fanned their new home. The name of the old woman was Yahuhi.

As time went by, the woman felt a strange transformation taking place all over her body. First her eyes began to clear up so that she could see well again. Then the wrinkles in her face disappeared, her body firmed up like that of a girl, and her complexion became healthy and youthful looking. Even the voice of the old woman changed back to that of a maiden, and she began to sing with happiness over her regained youth.

The husband of the woman was equally taken by surprise

and wondered what the cause of this miraculous transformation might have been.

"I have changed because my body was exposed to the cool northwind," said the woman. "Let's remain here forever."

One day, the man told his youthful wife that he had to leave the house for a short while. He wanted to go to the field and do some gardening.

"Fine," said the woman. "I shall cook dinner and wait for you. But don't be later than you said."

Time passed, and the man failed to return within the set period of time. While his wife was waiting, she suddenly saw a handsome young man approaching the house from the North. He greeted her kindly and wanted to know where her husband had gone. "He has gone to the field and is overdue."

So then the visitor took advantage of the man's absence and seduced the youthful woman.

When the husband finally got home, the suitor had long since left the house, but the husband noticed that something was wrong. Questioning his wife, she finally confessed that a young man had visited and embraced her during his absence. It was his fault, she said. He had left her alone for so long.

This made the old man very angry. He prepared a rope and whipped the poor woman so mercilessly that marks began covering her body from head to foot. Days went by, and the woman became very ill. Because of the pain, she could neither sleep nor eat and, finally, she died.

Since there were no people living in the neighborhood who might have helped the old man bury his wife, the husband tied the corpse to a pole in an upright position. It looked as if the woman was just standing there, alive. And even after a full moon had passed, the woman's body still looked youthful and uncorrupted.

After that, however, the dead woman began to change into a tree. The husband left her, and upon looking back a final

time, saw that his wife had become a *temiche* palm. He said to himself: "Once the Warao will come to be on this earth, they will have to call this palm yawuhi, because that was her name as a woman."

The etiological intent of this simple narrative is clear: a prolific palm bearing fruit practically continuously is identified with a fertile young woman. Her fertility is miraculously caused by the wind of the north, whence also her youthful lover puts in an appearance.

For a Warao listener, the introduction of the northwind heralds doom. While the cool *nortes* in the Delta are certainly invigorating winds, they also bring catarrh and other respiratory ailments to the Warao. Furthermore, they blow from the direction where Haburi, the culture hero, lives in a world mountain-tree. As a youth, he had unwittingly seduced his own mother. The association of Haburi with the woman's paramour from the north is most certainly not lost on a Warao listener. In addition, Haburi himself had been made miraculously youthful and mature through the agent of an old frog-woman, who wanted him for a lover. Both the youthful *temiche* woman and Haburi were placed into a fateful triangle by virtue of their newly acquired sexual prowess. Adultery and incest were the inevitable consequences, since the partners of both the *temiche*-maiden and Haburi were infertile and no match. Consequently, the woman transformed into a palm as did Haburi into a world tree.

This sacrifice of metamorphosis results in enormous benefits for mankind: from the transformed woman, the ever producing *temiche* palm; and from the transformed hero, the dugout canoe, a *sine qua non* of human life in the Delta. So while the Warao listener can predict the tragedy that will inevitably result from the action of the *dramatis personae*, he can also anticipate the great benefits that will accrue to him from this primordial drama of the *temiche*-maiden, the old husband, and her paramour from the North.

The myth also explains why the *temiche* favors coastal

swamps with their tidewaters and sea breeze. Besides explaining the remarkable fertility of the palm, subject not to an annual flowering and fruiting season but to continuous yield and the swamp habitat of the *temiche*, the myth also offers an explanation for the exceptionally prominent leaf scars (*ya esoara*) that cover the entire stem of the palm. Similar explanations are given in Warao mythology for the rings of *Euterpe* and of trees like *Calophyllum*. Finally, as we shall see, different parts of the palm are used as medicine against respiratory illnesses. This blissful property of the plant may possibly find its explanation in the love of the tree-maiden for the *nortes* that commonly cause such ills.

Utilization of the Palm

The leaves. It is well to commence the discussion of the cultural significance of *Manicaria* for the Warao Indians with the plant's most outstanding characteristic, its leaves. The "plumes of the sun," *yahuhi*, as the Warao call them, are the largest entire leaf among palms and the largest in the plant kingdom. The palm studied for purposes of this paper had seventeen contemporaneous sub-erect leaves with two persistent dead leaves hanging down. The informant happened to know that the palm was between 30 and 35 years old. Along their entire axis, large leaves of the *Manicaria saccifera* measured 5–8 m. long and 1.5–1.8 m. wide, with petioles measuring 1.20–2 m. Braun (1968: 111) reports leaves 9 m. in length, and leaves of 10 m. are frequently mentioned in the literature. Through exposure to wind, the blades of large outer leaves tend to become irregularly pinnatisect, but younger inner blades remain undivided.

It is precisely this latter quality coupled with their size that make *Manicaria* leaves especially suited for house thatch wherever the plant grows (PLATE LXX). As Im Thurn (1967 [1883]: 209) observed, "each gigantic undivided leaf of the troolie palm (*Manicaria saccifera*) is really a shelter in itself; and a few of these laid, without further preparation,

Plate LXX



Warao houses with *Manicaria* thatch. *Mauritia flexuosa* in the background. (*Courtesy* P. T. Furst)

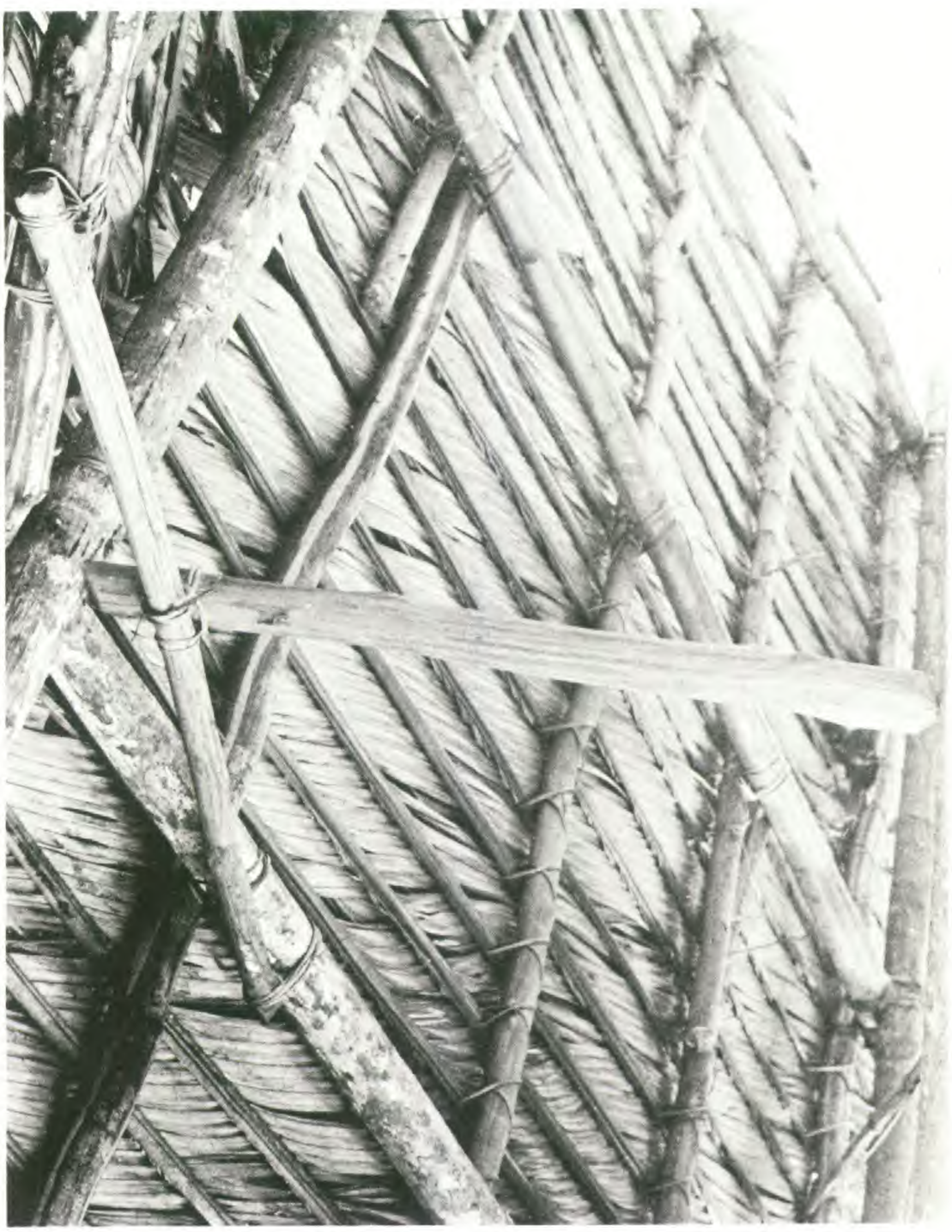
so as to overlap like tiles, make a most perfect roof. Indeed, before corrugated zinc was introduced for the purpose, a large trade was carried on between the Indians and the planters on the coast in these troolie-leaves, with which most of the buildings on the sugar estates were thatched."

For weather protection, the Warao implant single leaves or a whole line of them into the soft ground near their working areas. They also cover their heads with leaf segments when traveling on foot or by boat, calling these makeshift umbrellas *aroko a kuasimara*, leaf capes.

To thatch their houses, the Indians fold the leaves in half along the rachis and lash them in overlapping fashion, each rib 25 cm. from the next, vertically onto the infra-structure of the roof, "so that each frond forms a long tile reaching from ridge to eaves" (Spruce 1908, 1: 59) (PLATE LXXI). The house of my main informant had been covered in this way in 1969 and did not begin to leak until 1975, testimony of the durability of *temiche* thatch. To keep the rain from drifting in with the sea breeze, the Warao install a screen of *temiche* (*dara yawihi*) on the windward side of their otherwise wall-less houses[8] (PLATE LXXII). Sometimes they construct a tunnel-like roof over the midsection of their dugout canoes to protect themselves from the weather during long journeys.

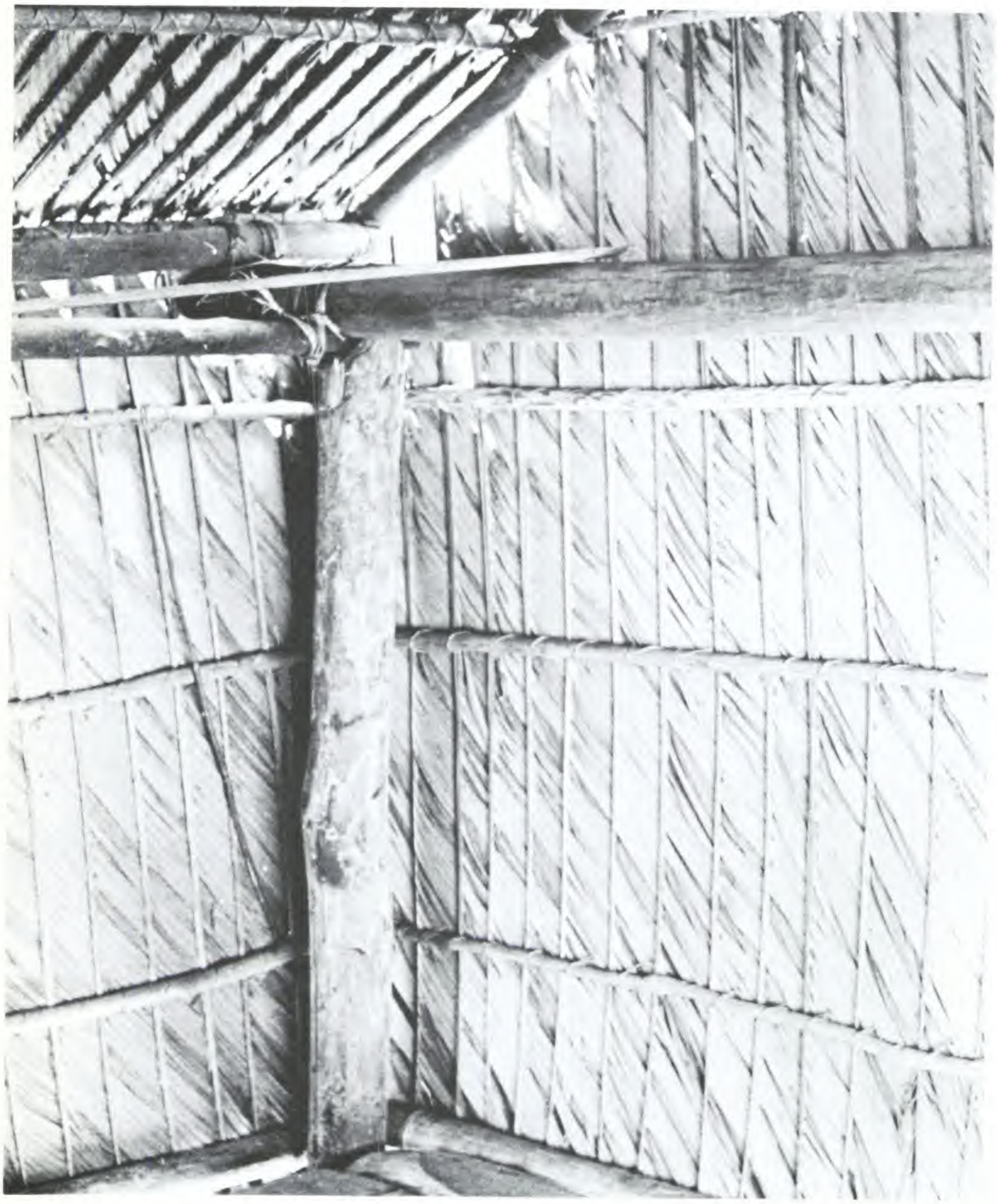
An ingenious naval invention is making sails (*yawihi wera*) from large *Manicaria* leaves. On the open windswept *caños* of the Delta, Warao canoes go by at high speed under full sail. Two or three crew members each hold up a *Manicaria* leaf for sails, bracing it at the bottom against the foot and holding it with one arm (PLATE LXXIII). A helmsman keeps the course by means of a paddle held vertically as a rudder. I have clocked canoes 6 m. long with two paddlers but no sails going 3 kph, their full speed. Canoes with *temiche* "sails" go that fast, or faster, and, of course, for a longer period of time. Consequently, in terms of primitive navigation, the *yawihi wera* of the Warao represents critical navigational tackle. Despite its Spanish-derived

Plate LXXI



Detail of roofing of a Warao house. (*Courtesy* P. T. Furst)

Plate LXXII



Detail of weather screen on the windward side of a Warao house.
(*Courtesy* P. T. Furst)

Three canoes with some fourteen passengers and a heavy load of fire wood are being propelled by holding up three leaves of *Manicaria saccifera*. Warao Indians of the Intermediate zone of the Orinoco

(*Courtesy* P. T. FURST)

name (*wera*=*vela*, sail), I wonder whether, in view of its simplicity, sailing by *yawihi wera* does not antedate the arrival of the white man in northeastern South America. Since *Manicaria* is ubiquitous in the Lower and Intermediate Delta zones, a "sail" can be picked up at practically any point of departure and simply tossed away upon arrival at the destination. In other words, *Manicaria* leaf-sails are handy, free, and uncomplicated.

Manicaria leaves, or certain parts, are put to other uses by the Warao Indians. The tips of the leaves are improvised for use as fans (*yami*); several, 2 m. long pieces of rachises of leaves are tied together in the form of a Venetian blind to serve as fish weirs (*noba*); sections of midrib are rubbed together to produce fire by rotation (Im Thurn 1967: 257). The "plumes of the sun" represent a *materia prima* of great importance to Warao technology.

A final comment on the etymology of the Warao term "plumes of the sun." It is derived from far more than the shape of leaves that flicker in the sun (as some authors seem to suggest). The *Manicaria* leaves obviously resemble over-sized bird feathers; but why they are linked to the sun is less evident. *Manicaria*, like many other palms, are closely connected with a symbolism of light and darkness, day and night, and I discuss this aspect below.

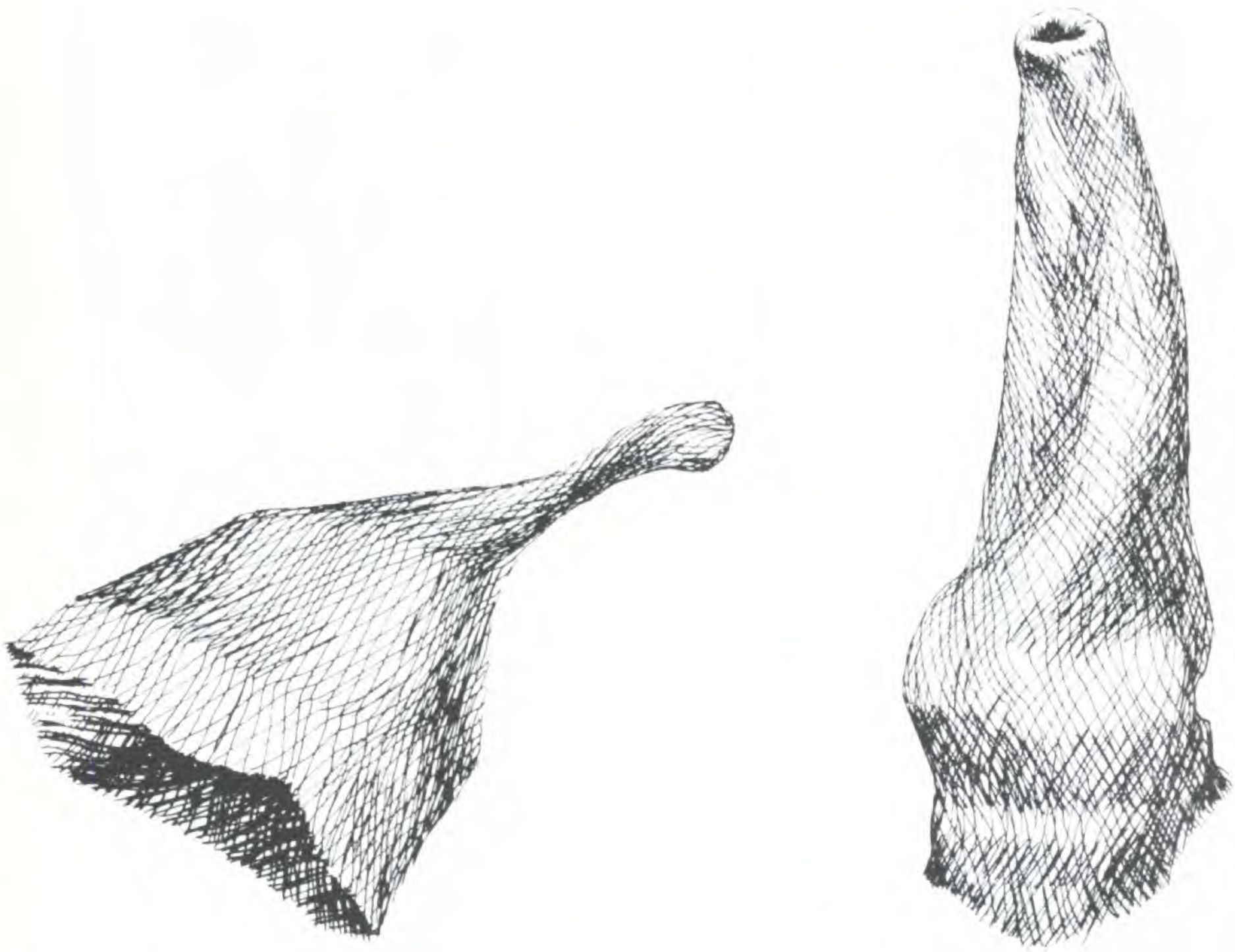
The spathe. Next in importance are the pouch-like spathes that cover the entire inflorescence and the large pendant infructescence (PLATE LXXIV). The brown spathes from which the genus and the species derive their names [9] are from 40 to 60 cm. long, "of fine, closely woven texture, and are used by the natives to make soft brown caps without seams or joinings" (McCurrah 1960: 129). The Warao refer to these hood-like caps as *yasi nona*. After carefully peeling the spathe off the fruit cluster, the Indians wet and stretch it on the head to give it the desired fit (Appun 1871: 479; Wilbert 1963: 9). By pleating them and decorating them with bast ribbons the long-peaked caps sometimes acquire a bizarre appearance (PLATES LXXV–LXXVII). They are

Plate LXXIV



Spathe

Plate LXXV



Hats made from spathe of *Manicaria saccifera*.
Drawn by Helga Adibi

Plate LXXVI



Warao Indian with hat made from spathe of *Manicaria saccifera.*
(*Courtesy* P. T. Furst)



Warao Indian (on the left) with hat made from spathe of *Manicaria saccifera*.
(*Courtesy* P. T. Furst)

worn in many shapes and forms by natives, Creoles, and tourists in Mesoamerica (Standley and Steyermark 1958: 273) and in Brazil (Wallace 1853: 70). I have not seen them used by the Warao as bags and wrapping cloth (ibid.) or as loin cloths (Braun 1968: 111).

The fruit. The fruits (*yawihi aukwaha*) serve the Warao as food and drink. One specimen of infructescence that I examined weighed 12 kg; the clear liquid inside the nuts accounted for approximately one-third, i.e., 3.75 liters (PLATE LXXVIII). The entire bunch was 87.5 cm. long and 25 cm. wide and was composed of 67 fruits: 22 one-seeded, 25 two-seeded, and 20 three-seeded ones.[10] The single fruits measured between 7 and 8 cm. in diameter, twins and triplets 9.5 cm. All a Warao needs do to satisfy his thirst, whether in the jungle, along the coast, or in the field, is to cut just one bunch of *temiche* fruit and drink his fill. In times of non-potable water, the Indians take along a load of fruit clusters in their dugouts (Turrado Moreno 1945: 92). To get at the water, the Indian bites into the corky exocarp (*nakoro ahoro*) or cuts a hole in it and drinks the water from a calabash or from its natural cup. The fleshy homogeneous endosperm of the as yet immature fruit (*nohi*) is greatly relished by the Indians; the fruit is opened with a blow of a heavy stick and the jelly-like substance scraped out with the thumbnail. Fully matured fruits, which resemble miniature coconuts (*ya umo*) fall to the ground. They get buried in the detritus or are washed out to the rivers and the sea. In this state, they are hard and inedible, but find use as whorls in the manufacture of toy tops for boys (PLATE LXXIX).

The seedlings. Seedlings (*emukohoko*) are sought after by the Indians, young and old. If the germination results obtained by Braun (1968: 54) for cultivated *Manicaria saccifera* are any indication, the seeds of this palm germinate in four months, more or less. The Indians search for seedlings that are developed enough to have grown their characteristic bifid eophylls up to 30 cm. above the ground.[11] They pull

Plate LXXVIII



Fruiting spathe and infructescence.

Photograph by Johannes Wilbert

Plate LXXIX



Top made of *Manicaria* seed. *Drawn by* Helga Adibi

them out and crack the hard shell of the seed with a heavy stick, exposing the white spongy haustorium. It has a mildly sweet taste, and as many as twenty at a time can be consumed without fear of digestive complications. Only children who eat primarily a diet of ocumo and fish are said to suffer occasionally from diarrhea.

Ethnomedicine. Several parts are believed to have medicinal properties and are used as remedies against catarrh: that is, cough and fever; and against symptoms of other respiratory problems. An Indian woman prepared some medicines in my presence, so that I can verify the following recipes – if not attest to their effectiveness.

To alleviate coughing and to repress fever, the water of *Manicaria* fruit is carefully strained through a cloth to eliminate impurities. The patient drinks a cup three times a day.

Fever and cough are alleviated with a potion made of the green juices from the fresh eophylls of *Mauritia* mixed with *Manicaria* water. Added to the slimy chlorophyllous liquid is the urine of a child of opposite sex of the patient. The preparation is set aside for forty-eight hours and then applied to the patient's body, especially his temples and forehead. The treatment is repeated three times a day. I found the remedy to have a definite cooling, hence soothing effect. Small children are washed in the liquid from head to foot to stop diarrhea accompanied by fever. Occasionally, they are also given a small quantity to imbibe.

The anti-asthmatic and anti-catarrhal effect of the liquid endosperm of *Manicaria* has been mentioned by previous investigators. Since asthma does not seem to afflict the Warao, I could not verify this assertion, although all informants assured me that the fruit water of the palm facilitates breathing in congested patients. Most effective in this respect is a concoction made of grated *Manicaria* palmito mixed with fruit water. The remedy is imbibed.

Indirect benefits. An indirect benefit accruing to the Indians from *Manicaria* relates to the fact that the ripe,

fallen fruit attract certain mammals like deer, peccary, paca, monkey, and agouti; turkey birds, like the *paují*, are also fond of them. Traditionally, however, the Warao avoid the large species of mammal, like deer and peccary, and refrain from eating monkey altogether; but they like agouti, paca, and *paují*. The agouti and the paca are ambushed at sunrise by the hunter who hides in the vicinity of the palm. The birds are best shot in the early afternoon hours, when they give themselves away by the crashing noises that they produce moving around among the leaves of the plant.

I have mentioned the important protein supplement to the diet of these Indians provided by the rich supply of fatty larvae that are laid in *Mauritia* and in *Manicaria* by the palm borer.

Recovery of sago. In the summer of 1974, while collecting data on Warao ethnomedicine in the forests of the Orinoco Delta, one of my informants volunteered that, in addition to providing the Indians with a remedy against fever, catarrh, and diarrhea, *Manicaria* also produced a starch similar to that from the *Mauritia*. He added that the extraction of *temiche* sago had fallen out of practice, but that it had formerly been common. Realizing that when a Warao speaks of palm starch he knows what he is talking about, I asked him to produce some *temiche* starch for me when I returned the following summer. What follows is a report on the process of sago recovery from *Manicaria saccifera* as witnessed by me in August 1975. PLATES LXXX–XCVIII illustrate the process.

Throughout an area of dense pluvial forest scattered individuals of *Manicaria* grew at distances from each other of 4 to 6 m. Their trunks (*akabaho*) were mostly erect and of varying heights, from 2 m. to 8 m. They were dark brown with very prominent circular leaf scars 2 to 3 cm. thick. Most of the palms seemed to be growing on small mounds 30 to 50 cm. high, but their roots (*ya ahokonamu*) were not exposed, or only minimally so.

After felling the palm, the Indian established how far

Plate LXXX



Felling the *Manicaria saccifera*. *Photograph by* Johannes Wilbert

Plate LXXXI



Removing the bark for sago extraction.
Photograph by Johannes Wilbert



Making a trough from a section of *Mauritia flexuosa*.
Photograph by JOHANNES WILBERT

down from the crown it contained sago. The testing was done by driving an axe into the trunk at various intervals. When the axe was withdrawn, with starch sticking to its blade, it signified contact with starchy pith.

According to the Warao, *Manicaria*, unlike *Mauritia*, has no annual flowering and fruiting period and contains starch the year round. The specimen used for the experiment contained sago in the upper 3 m. of the 6 m. long and 30 cm. thick trunk. To obtain for me a unit measurement of the volume of sago in one palm, the Indian removed with his axe the bark of a 1 m. long section below the crown, exposing in the opening a beige to light brown fibrous interior, not pithy like *Mauritia* but somewhat ligneous.

The Indian then stood on top of the trunk and shredded the pith with an adze or hoe (*nahuru*).[12] The hoe is a composite tool which the Warao claim to have adopted, in remote times, from cannibalistic neighbors, called Siawani. It consists of three basic parts – blade, handle, and binding. The blade (*nahuru ateho*) is carved from the bark of a mature *Mauritia* and is 3 cm. thick. Its length varies between 40 and 60 cm. according to the height of its user. The working end (*ahi*) of the wooden blade is about 15 cm. wide and grooved to form a double cutting edge. Laterally, the blade is carved concavely and provided with notched shoulders (*arokuaha*) near the end opposite the cutting edge to facilitate securing the blade to the cleft end of the handle.

The handle (*aka*) is a round piece of wood 3 cm. thick. Any hard wood will do, and the length of the handle is roughly equal to the length of the blade. A cleft is made in one end, into which the non-cutting end of the blade is firmly wedged; the junction is lashed together with two-ply cordage made of *Mauritia* bast. A second string of this kind (*ahutu*) connects the blade with the handle like the crossbar of the letter A. To prevent this binding from slipping, two notches (*iwiri*) are made on the sides of the blade about 20 cm. below the cutting edge (PLATES LXXXIV–LXXXVI).

The Indian had made a new hoe the day before. As it

Plate LXXXIII



V-shaped trough made from a section of the trunk of *Mauritia flexuosa*.
Photograph by Johannes Wilbert

Plate LXXXIV



Using a hoe to crush the starch. *Photograph by* Johannes Wilbert

Plate LXXXV



The opened *Manicaria saccifera* is lying on top of leaves to prevent the shredded pith from falling on the swampy soil. Close-up of the hoe used in the process of crushing the pith.

Photograph by Johannes Wilbert

turned out, inexperience with extracting sago from *Manicaria* prompted him to make a cutting edge as wide as that used for extracting starch from *Mauritia*, which has a much larger trunk. The space between the hard bark on either side of the opening measured only 26 cm., much less than the trunk of a *Mauritia* customarily utilized for starch recovery. Thus, the edge proved to be too wide to be efficiently used. The Warao hoe bears close resemblance to sago hoes used in southeast New Guinea for the same purpose (Stöhr, 1972, Fig. 35).

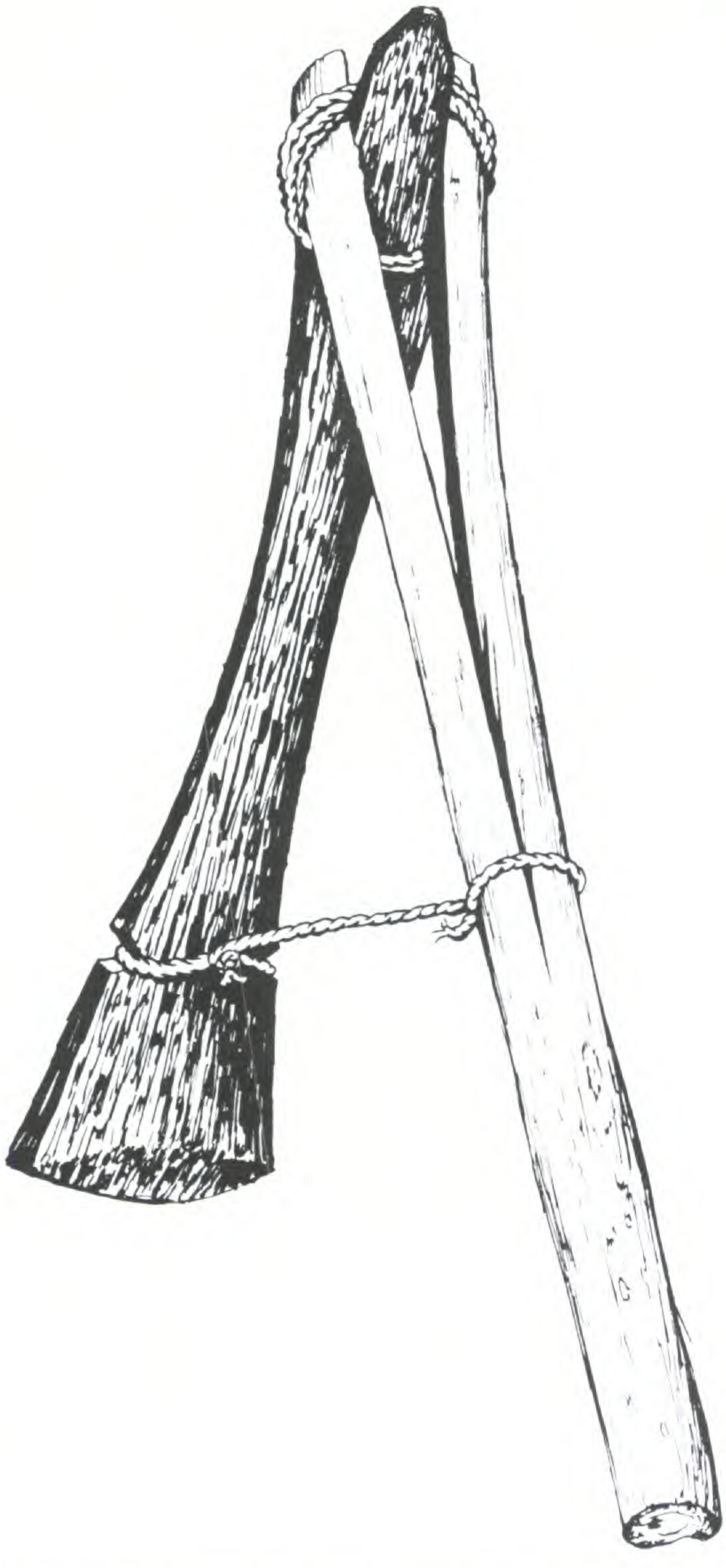
After the pith was crushed, a woman washed it in a trough made from a piece of the trunk of a *Mauritia* 1.25 m. long. About 25 cm. at either end of the trough (*canoa arua*) was left untouched and the centre section excavated by means of an axe, so that a cross section was V-shaped (PLATE LXXXIII).

After the men had placed the trough in a north/south direction (it must never be in the direction of the course of the sun), the woman drove four 1.20 m. long petiole sections of *Mauritia* (*namoru*) halfway into the water-logged ground next to the hollowed-out *Manicaria* (PLATE LXXXVIII). Two uprights 75cm. apart stood on either side of the trough, and on top of these uprights the woman placed a dish-like strainer (*bihi*) made of strips of *Ischnosiphon*. Immediately below the strainer she positioned, at a steep angle, the fleshy end of a *Mauritia* leaf stem (*wate buaka*) for the purpose of collecting the washed pith below the strainer and channeling it smoothly into the trough without splashing.

The woman collected the crushed pith from the trough, transferred it onto the strainer by means of a calabash (*Cresentia Cujete*), poured water over the pith, and began kneading it. From time to time, she scooped out some water from the trough and poured it over her hands and the pith. The water turned milky in the process, and the sago began settling on the bottom of the trough (PLATES LXXXIX–XCIII).

The moment the woman started kneading the pith, she

Plate LXXXVI



Warao hoe used in palm starch extraction from both *Mauritia flexuosa and Manicaria saccifera.* *Drawn by* Helga Adibi



Trough with sieve resting on four uprights ready for the washing of *Manicaria saccifera* pith extracted from the palm in the foreground of the picture. Notice fleshy end of a *Mauritia* leaf stem below the strainer to channel the water into the trough without splashing. *Photograph by* JOHANNES WILBERT



Trough filled with starch containing water after the woman finished washing the pith.
Photogrph by JOHANNES WILBERT



Woman collecting shredded *Manicaria saccifera* pith into her calabash.
Photograph by JOHANNES WILBERT

Plate XC



Calabash filled with shredded *Manicaria saccifera* pith resting on palm from which it has been extracted.

Photograph by Johannes Wilbert

observed to me that it was rich in sago which, she said, one is able to determine by the viscid quality of the pith (PLATE XCIV). She observed, too, that it felt exactly like processing sago-rich *Mauritia* pith, except that she had to exert more pressure kneading the pith of *Manicaria*, because it was more ligneous than the other. Another difference between processing the two starches was that she had to wait longer for the *Manicaria* starch to settle at the bottom of the trough. She said that the resulting meal was of a lighter quality. After waiting for ten minutes in the shade of a windscreen (made of two *temiche* leaves stuck in the ground), the woman began to drain the water carefully by ladling it out of the trough with her calabash (PLATE XCV). She then shaped the meal into a ball of light brown sago and, in doing so, proved conclusively that *Manicaria saccifera* must be counted among the sago-producing genera of the palms (PLATE XCVI).

The total process of crushing, washing, and collecting the sago took approximately thirty working minutes.

Upon completion of her work, the woman painstakingly washed her strainer to remove all particles from between the basketry strands (PLATE XCVII). This act would prevent the strainer from rotting. Next, she pulled the four uprights out of the ground and tossed them to the side (PLATE XCVIII). This would prevent malignant shamans from blowing on them, causing her arms to hurt. Finally, the man picked up the heavy trough and carried it a short distance away. This would make it more difficult for youngsters to poke inside with their machetes. People after mischief might do this to afflict the sago washer with ailing arms and shoulders.

From the opening in the trunk, which was 1 m. long, the woman collected two calabashes packed to the brim with pith. The calabash used was 25 cm. long, 17.5 cm. wide, and 12 cm. deep. From that much pith, the woman washed out 750 gr. of sago. It had been ascertained that the trunk of the felled *Manicaria* contained starch within 3 m. of its upper

half, the total sago yield from that plant would amount to 2.250 kg. I suggest adding at least another 750 gr. to account for the fact that the wide blade of the hoe prevented the Indian from extracting all of the available pith. A close approximation of the potential yield of the tested *Manicaria* is 3 kg. Even at that, *Manicaria* must be considered a low yield sago palm for the purpose to which the Warao put it: emergency food.[13]

In order to assess the nutritional value of *Manicaria* starch, I had the procured sample analyzed at laboratories in Caracas. The results of these tests are summarized in Table I.

TABLE I
Composition of *Manicaria saccifera* Starch

pH (sol. 2%)	5.75	
Humidity	63.51%	63.51%
Fat *	0.55%	
Dextrose *	5.07%	
Protein *	1.62%	
Starch *	4.57%	
Fiber **	24.68%	
	36.49%	36.49%
		100.00%

* Calculation based on dry material
** By balance

Ethnobotanical lore. The process of producing starch from *Mauritia* is a highly ritualized affair when done in preparation for the annual harvest festival *nahanamu* or in connection with any other propitiatory offering. The implements used in *Manicaria* starch extraction are also subject to certain taboos, but, for several reasons, *Manicaria* sago is considered less appropriate for these sacrificial purposes than the other.

In the first place, the production yield of *Mauritia* is far greater (Heinen and Ruddle 1974). For instance, the amount of sago needed for a well prepared *nahanamu* festival varies



Transporting a calabash full of shredded *Maniacaria saccifera* pith to the washing stand. *Photograph by* JOHANNES WILBERT



Woman pours the *Manicaria saccifera* pith onto the sieve.
Photograph by JOHANNES WILBERT

from 500 to 1,500 kg., allowing from 2 kg. to 4 kg. per participant. Families are engaged from six to ten weeks in its production. To produce this amount of sago from *Manicaria* would be almost impossible in terms of time and labor. The Warao insist, however, that *Manicaria* sago is acceptable to the Supernaturals and that it can be offered to them in propitiation.

A decisive factor in making palm starch acceptable to the gods is that, in its fresh state, it is practically odorless. Odors play an important role in communicating with the Supernaturals who accept as pleasing only the smell of tobacco smoke and that of carana (*Protium heptaphyllum*). Both types of sago available to the Warao fulfill this condition, but, besides relative abundance, *Mauritia* outdoes *Manicaria* on one other important score – it is colorless. When fresh, *Mauritia* sago is as white as plaster of Paris; whereas *Manicaria* starch is beige to light brown. White is the color of predilection of the directional world gods who supposedly feel much less attracted by the color of *Manicaria* starch, which turns a dark brown several days after production.

The color makes it much more appropriate for the *Manicaria* to serve a secondary god, that of the dark Underworld. This spirit is known as *Kanishabarao* and is believed to dwell below the earth in company with his people, right next to the abode of *Ya ahuba*, the Temiche Master Snake.

All palms, major trees, and most animals depend for their existence upon a master snake. The snake of *Manicaria* is a night spirit, appearing on earth only around midnight, when it comes to move softly the beautiful leaves of the palm. Thus, *Manicaria* pertains to the midnight sun as *Mauritia* belongs to the gods of the zenith and the world mountains at the cardinal and intercardinal points of the universe (Wilbert 1973).

This aspect recalls the day and/or night association of palms in other cultures. As Schultes (1974:7) pointed out, similar beliefs prevail among the Kuripako of Colombia in connection with *Leopoldinia Piassaba*. Fiber gatherers "are often bitten by poisonous snakes that infest the thick clumps

of hanging fiber — a danger that probably underlies in part the natives' belief that the evil spirit, the *curupira*, inhabits *piassaba* groves and wanders around at night." The same *curupira*, we should add, is the central Master-of-Animals figure in South America who functions as the patron spirit of the trees and the forest (Zerries 1954: 18). *Kanishabarao* of the Warao is obviously a cousin of the Amazonian *curupira.* Furthermore, there exists also a sun-palm relationship among the Yukuna Indians of Colombia, whose *kai-ya-tee* festival resembles the annual sago festival, *nahanamu*, of the Warao, and "basically celebrates the harvest of the *pupunha* palm which was given to the Yukuna people by the 'Sister of the Sun' as one of their major cultivated foods" (Schultes 1974: 16).

That the *Manicaria* belongs to the midnight sun rather than to the day sun becomes apparent in the belief that, while its sago may be unsuitable for a *nahanmu* festival in honor of the cardinal gods, it is, nevertheless, used for this purpose by *Kanishabarao* and his people of the underworld. Annually they prepare a feast of *temiche* sago, and that is why the Indians may come across hollowed-out trunks of the palm in the forest. *Kanishabarao* and his people also eat the nuts and all the parts of the palm that humans enjoy.

Finally, *Manicaria* sago is believed to be extracted by the monkey (*naku*) for purposes of celebrating an animal *nahanamu* palm festival. Monkeys are supposedly very fond of the starch and are believed to be yet other "people" that hollow out the palms one happens across in the forest. Instead of fish or crab, monkeys are said to prefer large spiders (*abunamoko*) with their starch.

The custom of recovering palm starch from *Manicaria* is essentially a feature of the past with the Warao. It came to my attention when an elderly informant remembered hearing his uncle and other elders send workers out to prepare *Manicaria* sago. It was done occasionally, he said, when the people were away from the *Mauritia* groves fishing on a major river. To supplement their diet, they relied on *Manicaria* sago which was always close at hand in the Intermediate

Plate XCIII



Beginning the process of washing starch out of the shredded pith of the *Manicaria saccifera*. Highly contaminated water is taken directly from the swamp.

Photograph by Johannes Wilbert

Plate XCIV



Woman kneading the pith with both hands.
Photograph by Johannes Wilbert



After the starch has settled down at the bottom of the V-shaped trough the woman starts ladling out the water. *Photograph by* JOHANNES WILBERT

Plate XCVI



Starch is scooped with hands from the bottom of the trough into a calabash. *Photograph by* Johannes Wilbert

Plate XCVII



After processing the pith woman washes the strainer very carefully to avoid rotting of the basketry material.

Photograph by Johannes Wilbert

Plate XCVIII



Woman dismantles the washing stand after extracting enough starch.
Photograph by Johannes Wilbert

zone of the Delta. The wife of my informant, who comes from a different region than her husband, said she also distinctly remembered having seen people collect and eat *temiche* starch. Those who still know about it are in their fifties and older. The younger people in the village had never seen or even heard about it.

One need not invoke prophetic insight to predict the disappearance, in the near future, of palm-starch production from all of South America. The majority of southern tribes referred to in the introduction have already either given it up or are so reduced in number that the practice of starch recovery will soon come to an end. Among the Warao, even *Mauritia* extraction is declining rapidly and will soon become a rarity. Yet, in South America, as elsewhere, recovery of starch from different genera of palms represents the survival of a once more common tradition that reaches back into the remote, prehistoric past. It survived the Neo-Indian revolution of subsistence agriculture only among a small number of marginal tribes, but it is giving way increasingly to agricultural staples even among them. In any event, for the Warao this form of traditional aboriculture provided a measure of economic stability not unlike that achieved by other indigenous societies through agriculture. The entire man-palm relationship as it developed among these people over many centuries can be fully understood only in the context of *Manicaria*, *Mauritia*, and *Euterpe* ethnobotany. Realizing this and going a little beyond the scope and evidence of the present paper, may I suggest in concluding that economic stability is not the only benefit that the Indians have derived from gathering around these regal plants. As their ethnobotanical lore reveals, the palms have nurtured among the Warao an exquisite partnership between man and nature — a symbiosis that, in addition to a viable socio-economic blueprint, generated an ideological matrix that gave meaning to the world and purpose to life. Surely, achievements of this sort must rank among the finest that mankind has made anywhere.

ENDNOTES

1. Cf. Lévi-Strauss 1950: 469–472; Fuerst 1970: 114–122.
2. The only previous mention that I could find was Barral (1949: 150), who said: "Pero el "*aru*" propiamente tal, el "*aru*" guaraúno [Warao], es la torta hecha con la fécula extraida de la "Mauritia flexuosa", o también del temiche (Phitalephas temiche), no tan ponderada como la de moriche, pero tan real."
3. Among the secondary palms, the authors (ibid., 116) list: *Acrocomia*, *Caryota*, *Coelococcus*, *Corphyra*, *Eugeissona*, *Phoenix*, and *Pholidocarpus*.
4. I am using the so called ethnographic present, although the practice of palm-starch production may very well have been discontinued now among some of the tribes of southeastern South America.
5. Gumilla 1791, 1: 145; Schomburgk 1848: 49; Turrado Moreno 1945: 73–83; Suárez 1966; Wilbert 1972: 81–82; Heinen and Ruddle 1974.
6. Cf. Dahlgren 1936: 202 and references since then (1936): Bailey 1943: 392–393 Dugand 1940: 43; McCurrach 1960: 129–131; Wessels Boer 1965*a*, *b;* Braun 1968: 111.
7. If it is any consolation to botanists, *Manicaria* is ethnobotanically all but unknown; the snatches of information, frequently repeated, are restricted largely to the usefulness of the leaves for thatch and of the spathe for "monkey-caps." In estimating migration and settlement patterns, for instance, archaeologists and ethnologists may have underestimated the effect of palm exploitation on the relative stability of autochthonous peoples in South America and elsewhere. I would like to thank Mr. August Braun and Drs. Harold E. Moore, Jr., Richard Evans Schultes, and Julian A. Steyermark for advice and assistance with the botanical aspects of this paper.
8. Von Spix and von Martius (1823–1831: 3, 989) observed the same custom practiced on Marajó Island in the mouth of the Amazon.
9. Lat. *manica* = sleeve; *saccifera* = sack-bearing.
10. The ratio of single to multilobed fruits seems to vary markedly. In a second sample examined, I counted a total of 72 fruits with 42 one-seeded, 27 two-seeded, and three 3-seeded ones.
11. The apical incision in *Manicaria* eophylls results in two opposite terminal leaflets, each segment with an acute apex and smooth margins.
12. The hoe and all the other tools and techniques employed in the recovery of *Manicaria* starch are the same ones that the Warao use for the extraction of sago from *Mauritia*.

13. I am taking the Indians' word for the fact that *Manicaria* has no annual flowering period and that the palm carries starch the year round. If incorrect, the result of a single test ought not to be generalized, since it is known that the starch content in *Mauritia* of the Orinoco Delta, for instance, may vary seasonally from 2 kg. to 60 kg. per palm (Heinen and Ruddle 1974: 122).

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