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A REVISION OF THE GENUS
CHLOROSPATA (ARACEAE)^{1,2}

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ABSTRACT

This is the first revision of the genus *Chlorospatha* Engl. (Araceae) since Michael Madison's 1981 treatment. The genus consists of three sections, two of which are newly established: *Chlorospatha* sect. *Occidentales* Croat & L. P. Hannon and *Chlorospatha* sect. *Orientalis* Croat & L. P. Hannon. Included are 69 taxa (68 species and one variety) for Central and South America, of which 45 are new to science. These include 39 newly described species: *C. bayae* Croat & L. P. Hannon, *C. boosii* Croat & L. P. Hannon, *C. bullata* Croat & L. P. Hannon, *C. caldasensis* Croat & L. P. Hannon, *C. caliensis* Croat & L. P. Hannon, *C. carchiensis* Croat & L. P. Hannon, *C. cedralensis* Croat & L. P. Hannon, *C. chocoensis* Croat & L. P. Hannon, *C. congensis* Croat & L. P. Hannon, *C. engleri* Croat & L. P. Hannon, *C. giraldoi* Croat & L. P. Hannon, *C. grayumii* Croat & L. P. Hannon, *C. hannoniae* Croat, *C. hastata* Croat & L. P. Hannon, *C. huilensis* Croat & L. P. Hannon, *C. jaramilloi* Croat & L. P. Hannon, *C. limonensis* Croat & L. P. Hannon, *C. litensis* Croat & L. P. Hannon, *C. longiloba* Croat & L. P. Hannon, *C. maculata* Croat & L. P. Hannon, *C. mansellii* Croat & L. P. Hannon, *C. morae* Croat & L. P. Hannon, *C. munchiquensis* Croat & L. P. Hannon, *C. nambiensis* Croat & L. P. Hannon, *C. narinoensis* Croat & L. P. Hannon, *C. noramurphyae* Croat & L. P. Hannon, *C. oblongifolia* Croat & L. P. Hannon, *C. portillae* Croat & L. P. Hannon, *C. pubescens* Croat & L. P. Hannon, *C. queremalensis* Croat & L. P. Hannon, *C. risaraldensis* Croat & L. P. Hannon, *C. sagittata* Croat & L. P. Hannon, *C. sizemoreae* Croat & L. P. Hannon, *C. stellaris* Croat & L. P. Hannon, *C. sucumbensis* Croat & L. P. Hannon, *C. timbiquensis* Croat & L. P. Hannon, *C. tokiensis* Croat & L. P. Hannon, *C. yatacuensis* Croat & L. P. Hannon, and *C. yaupiensis* Croat & L. P. Hannon. Four additional and putative new species are described in detail at the end of the taxonomic treatment and are included in the key, but not formally named; they are labeled Species 1 to 4 and are assumed to be new. They were collected as sterile plants and will be formally described only after recollection in fertile condition. Two combinations are made: *C. plowmanii* (Madison) Croat & L. P. Hannon and *C. croatianae* Grayum var. *enneaphylla* (Grayum) Croat & L. P. Hannon. Species diversity of *Chlorospatha* is greatest in the Andes of Colombia and the western Andes of northernmost Ecuador, and diminishes from northernmost Colombia into Central America and from central Ecuador southward to the border with Peru. Costa Rica has two taxa (one species, one variety), Panama four taxa (three species, one variety), Colombia 45 taxa (44 species, one variety), and Ecuador 24 species. Endemism is

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² This manuscript is dedicated to Lynn P. Hannon who was born on July 8, 1948, and died on July 10, 2006. Lynn's strong interest and dedication to the genus *Chlorospatha* led to this revision. Lynn spent many hours in the field with the senior author who encouraged her to write this compilation of the plants with which she became so familiar.

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highest in Colombia, with 43 species currently considered endemic, followed by Ecuador with 23 endemic species, and Central America with two endemic species.

Key words: Araceae, Central and South Americas, *Chlorospatha*.

Chlorospatha Engl. is, after *Xanthosoma* Schott, the largest genus in the tribe Caladieae Schott, in subfamily Aroideae (Mayo et al., 1997, 1998), family Araceae, with 68 species involving 69 taxa (see Appendix 1). Numerous collections of what are presumably new taxa of *Xanthosoma* were examined during the current investigation, which would eventually bring the total number of *Xanthosoma* well above the current total of 66 species (Govaerts & Frodin, 2002). This is the first complete revision of *Chlorospatha* since that of Engler and Krause (1920), although Michael Madison's generic treatment in *Selbyana* (1981) served to update the genus and was very useful for our work. *Chlorospatha* occurs from approximately 10°20'N latitude to 4°16'S latitude and inhabits a wide range of mesic habitats from near sea level to 3000 m elevation, in life zones (Holdridge, 1967) ranging from tropical moist forest to montane rainforest, with premontane wet forest the predominant ecological zone. The genus is known from dark forest understory, frequently in wet to boggy areas, in wet ravines and in association with small streams, but because of its usually small to moderate size, it is often inconspicuous. Numerous species are quite attractive, but have proved to be short-lived and demanding in cultivation, possibly owing to specialized habitat requirements. During the course of fieldwork in Colombia and Ecuador, we observed that different species did not occur together or in close proximity, although they occurred in the same general areas. Species were found only as solitary or few individual plants and occasionally in small colonies, but rarely in abundance at any given site. This would suggest the possibility that microclimates, pollination strategies, or other requirements are responsible for segregation of species. Not all species were observed in the field; therefore, it could not be said with certainty that this segregation of species is typical of the genus without further study throughout the range of the genus.

Most species are members of *Chlorospatha* sect. *Occidentales* Croat & L. P. Hannon (see Infrageneric Relationships), comprised of 40 species from Colombia and Ecuador, only two of which occur on the eastern slopes of the Andes. *Chlorospatha* sect. *Chlorospatha* is comprised of 18 taxa, most of which are from Colombia, but includes the three taxa from Central America and one species from Ecuador.

Chlorospatha sect. *Orientalis* Croat & L. P. Hannon is comprised of 10 species known only from the eastern slopes of the Andes in Ecuador.

MATERIALS AND METHODS

This revision is based on approximately 46 combined years (37 for the senior author and nine for the junior author) of field studies in Central and South America, between 1967 and 2004. All but 28 of the 72 taxa were studied in the field and/or in cultivation. Those known only from herbarium material are: *Chlorospatha amalfiensis* Croat & L. P. Hannon, *C. antioquiensis* Croat & L. P. Hannon, *C. betancurii* Croat & L. P. Hannon, *C. caldasensis* Croat & L. P. Hannon, *C. caliensis* Croat & L. P. Hannon, *C. callejasii* Croat & L. P. Hannon, *C. carchiensis* Croat & L. P. Hannon, *C. cedralensis* Croat & L. P. Hannon, *C. cogolloi* Croat & L. P. Hannon, *C. congensis* Croat & L. P. Hannon, *C. corrugata* Bogner & Madison, *C. cutucuensis* Madison, *C. gentryi* Grayum, *C. hastifolia* Bogner & L. P. Hannon, *C. jaramilloi* Croat & L. P. Hannon, *C. kressii* Grayum, *C. lehmannii* (Engl.) Madison, *C. luteynii* Croat & L. P. Hannon, *C. macphersonii* Croat & L. P. Hannon, *C. nambiensis* Croat & L. P. Hannon, *C. nicolsonii* Croat & L. P. Hannon, *C. noramurphyae* Croat & L. P. Hannon, *C. risaraldensis* Croat & L. P. Hannon, *C. stellasarreae* Croat & L. P. Hannon, *C. sucumbensis* Croat & L. P. Hannon, *C. timbiquensis* Croat & L. P. Hannon, *C. yatacuensis* Croat & L. P. Hannon, and *C. yaupiensis* Croat & L. P. Hannon. One species was published by Croat and Bogner as *Xanthosoma feuersteiniae* Croat & Bogner (Croat & Bogner, 2005) and later transferred to *Chlorospatha* by Bogner and L. P. Hannon (Bogner & Hannon, 2007). Finally, *C. hastifolia* was published in 2007 (Bogner & Hannon, 2007). Except for these, all descriptions have been prepared from both living and dried specimens. The use of "dried" preceding all or any part of the description is an indication that all that follows is based on herbarium material only. Many of the cultivated plants were based upon the living collections of Lynn Hannon from Odessa, Florida, and were disbanded upon her death.

Terminology and usage in descriptions in this revision are largely defined by Croat and Bunting (1979). Further definitions of petiole cross-sectional shapes are defined and illustrated in Croat (1983).

Ecological zones, although occasionally estimated from the first author's experience with Central and South American vegetation, are largely taken from Holdridge life zone maps (Holdridge, 1967; Holdridge et al., 1971). Holdridge life zones of areas where *Chlorospatha* occur are listed here, arranged in a generally drier to wetter order: tropical moist forest (T-mf); tropical wet forest (T-wf); tropical rainforest (T-rf); tropical moist forest transition to premontane wet forest (T-mf/P-wf); tropical rainforest transition to premontane rainforest (T-rf/P-rf); premontane moist forest (P-mf); premontane wet forest (P-wf); premontane rainforest (P-rf); premontane rainforest transition to tropical wet forest (P-rf/T-wf); lower montane moist forest (TLM-mf); lower montane wet forest (TLM-wf); lower montane rainforest (TLM-rf); montane moist forest (TM-mf); and montane rainforest (TM-rf).

Herbarium material has been widely distributed, and original field vouchers are cited for all herbaria whose material has been seen (Appendices 1, 2). Herbarium material may consist of one of three kinds: (1) complete original sets (wild collected); (2) sterile original material with an inflorescence added from a cultivated plant of the same number; (3) material collected entirely from cultivated plants. Specimens based entirely or in part on cultivated material are clearly indicated as such on the herbarium label. Herbarium specimens were borrowed from most herbaria including: AAU, B, CHOCO, COL, CUV, DUKE, F, GH, GUAY, HUA, JAUM, K, M, MO, NY, P, PR, QAME, QAP, QCA, QCNE, S, SEL, TULV, US, and WISC.

Morphological descriptions are mostly parallel and as complete as possible. Descriptions of pistils, vitally important in the infrageneric classification of *Chlorospatha*, are particularly detailed. In order to avoid repetition, description references are made to Style Types, which are discussed and illustrated (Fig. 1) in the section Morphology of Reproductive Structures—Gynoecium.

HISTORY OF THE GENUS *CHLOROSPATA*

The genus *Chlorospatha* was introduced by Engler in 1878, with the publication of the type, *C. kolbii* Engl., and later revised by Engler and Krause in 1920. Engler had published *Caladiopsis lehmannii* Engl. in 1905 and retained that genus as distinct from the monotypic *Chlorospatha* in the 1920 revision. After Engler's publication of *C. lehmannii*, almost 60 years would pass before Bunting's publication of *Caladiopsis dodsonii* G. S. Bunting in 1961, based on a Dodson and Thien collection made in that year. In 1978, Madison published two additional species of *Caladiopsis*, *C. atropurpurea* (Madison) Madison and

C. castula Madison, bringing the total number of *Caladiopsis* species to four. In his generic treatment, Madison (1981) recognized that there was no significant difference between *Chlorospatha* with deeply, pedately lobed leaves and *Caladiopsis* with sagittate, hastate, ovate, or ovate-cordate leaves, that character having no significance at the generic level in New World Colocasioideae (Grayum, 1986), and therefore he combined *Caladiopsis* with the older genus, *Chlorospatha*. At this time, he also assigned to *Chlorospatha* two species previously assigned to *Xanthosoma* or *Caladium* Vent.: *X. mirabile* Mast. and *C. longipodum* K. Krause. When *X. mirabile* was published in 1874, the genus *Chlorospatha* did not exist and Masters assigned the species to *Xanthosoma* with qualification, rather than describing a new genus (Masters, 1874). *Caladium longipodum* was published in 1940, based on a 1938 Schultze-Ronhof collection. *Xanthosoma mirabile* and *Caladium longipodum*, with their slender, elongated inflorescences and thin peduncles, were rightly assigned to *Chlorospatha* in Madison's treatment, as was *Caladium plowmanii* Madison (1978). With new material available from Ecuador, primarily from his fieldwork in the 1970s, Madison was able to publish three new species in his treatment of *Chlorospatha*: *C. besseae* Madison, *C. cutucuensis*, and *C. ilensis* Madison, thus bringing the total to 10 species known to science.

During the 10 years following Madison's treatment, six species and one subspecies were published: one species by Josef Bogner and Madison (*Chlorospatha corrugata* Bogner & Madison, 1985); three species and one variety by Michael Grayum (*C. croatianae* Grayum subsp. *croatiana*, *C. croatianae* var. *enneaphylla* Grayum, and *C. gentryi* in 1986; *C. kressii* in 1991); one species by Grayum and Thomas Croat (*C. hammeliana* Grayum & Croat in 1986); and one species by J. Haager and J. Jeník (*C. madisonii* Grayum & Croat in 1984). The latter species was subsequently synonymized with *C. longipoda* (K. Krause) Madison by Bogner (1985). Until 2004, a total of 16 taxa were known to science. After Madison's treatment and Grayum's publication of *C. kressii*, a large number of undetermined collections were made in Colombia and Ecuador, resulting in the publication of eight species by Croat and Lynn P. Hannon in 2004: *C. amalfiensis*, *C. antioquiensis*, *C. betancurii*, *C. callejasii*, *C. cogolloi*, *C. luteynii*, *C. macphersonii*, and *C. nicolsonii*. One species was published by Croat and Bogner as *Xanthosoma feuersteiniae* (Croat & Bogner, 2005) and later transferred to *Chlorospatha* by Bogner and L. P. Hannon (Bogner & Hannon, 2007). Finally, *C. hastifolia* was published in 2007 (Bogner & Hannon,

2007). As predicted by Grayum (1986), the dramatic increase in the number of collections has resulted in the discovery of many new species.

COLLECTING HISTORY

The earliest collections of *Chlorospatha* date from the late 19th century, during the heyday of European collecting in the Neotropics, the first two resulting in the publication of the Colombian species *C. kolbii* in 1878 collected by Gustav Wallis, and *C. mirabilis* (Mast.) Madison (as *Xanthosoma mirabile* Mast.) in 1874, collected by Benedict Roezl. Carl B. Lehmann made six collections between about 1900 and 1906, two being *C. lehmannii* (Engl.) Madison (\equiv *Caladiopsis lehmannii* Engl.) and four that remained undescribed until the present work: *C. caliensis* Croat & L. P. Hannon, *C. congensis* Croat & L. P. Hannon, *C. grayumii* Croat & L. P. Hannon, and *C. timbiquensis* Croat & L. P. Hannon. Incredibly, only 11 collections of *Chlorospatha* were made by 11 collectors between 1906 and 1970. In 1913, G. Forget collected *C. mirabilis*. Tracy E. Hazen made the first collection of *C. bullata* Croat & L. P. Hannon in 1922, described here. *Chlorospatha croatiana* was first collected by Paul C. Standley in 1924 and later by Harley Harris Bartlett in 1940. In 1933, Alexander E. Lawrance was the first collector of what would later become the type for *C. croatiana* var. *enneaphylla*. Arnold and Hertha Schultze-Ronhof made the first collection of *C. longipoda* (K. Krause) Madison (\equiv *Caladium longipodum* K. Krause) in 1938, which would later serve as the type. Erik Asplund also collected this species in 1956. Elsworth P. Killip collected the type for *C. grayumii* in 1939, a species new to science. Julian A. Steyermark was the first to collect *C. ilensis*, in 1943. Callaway Dodson made the first collection of *C. dodsonii* (G. S. Bunting) Madison in 1961, which also served as the type. In 1958, Jesus Idrobo made the first collection of *C. huilensis* Croat & L. P. Hannon, a species new to science. Of these collectors, only Dodson made additional collections of *Chlorospatha* after 1970. There are several possible reasons why *Chlorospatha* has been infrequently collected until recently, the first being its small to moderate size and, except in the case of maculate or colorful species, its usually inconspicuous coloration and markings. It is usually found only in undisturbed forest and often overlooked on the forest floor, perhaps mistaken for immature plants of larger growing species of *Xanthosoma*, particularly when found in the sterile state. Collections of *C. croatiana*, the largest species in the genus, were misfiled for many years as *Xanthosoma* (Grayum, 1986). In fact, there are presently far

(55) than of any other *Chlorospatha*, perhaps because it is more conspicuous, owing to its larger size. The lack of roads into the wet areas where *Chlorospatha* occurs would certainly have been a limiting factor then, which is true even today, although more roads exist now.

Sixty-six collections of *Chlorospatha* were made in the 1970s, thus marking the beginning of a dramatic increase in collections, ultimately leading to Michael Madison's treatment of the genus in 1981. Most of these collections were made by Madison or Thomas B. Croat. Eleven of the 15 Croat collections made prior to 1980 were of Central American taxa that would not be recognized as *Chlorospatha* until the publication of *C. croatiana* by Grayum and *C. hammeliana* by Grayum and Croat in 1986, with a 1973 Croat collection serving as the type for *C. croatiana*. The remaining four Croat collections represent four species, three of which are new to science, *C. bullata* and *C. morae* Croat & L. P. Hannon from Colombia, and *C. pubescens* Croat & L. P. Hannon from Ecuador. Croat was also the first to collect *C. morae*. All of Madison's 28 collections of *Chlorospatha* were made in Ecuador between 1970 and 1981, except one collection of *C. croatiana* made in Panama. Madison was the first to collect specimens that served as the types for three species: *C. besseae*, *C. castula* (Madison) Madison, and *C. cutucuensis*. Additionally, his collections were the first made of four species and one combination new to science, *C. carchiensis* Croat & L. P. Hannon, *C. hastata* Croat & L. P. Hannon, *C. litensis* Croat & L. P. Hannon, *C. plowmanii* (Madison) Croat & L. P. Hannon (\equiv *Caladium plowmanii*), and *C. yaupiensis* Croat & L. P. Hannon, with his collections serving as the types for *C. carchiensis* and *C. yaupiensis*. Madison also collected *C. atropurpurea*, *C. dodsonii*, and *C. longipoda*, but made no additional collections of *Chlorospatha* after his treatment of the genus in 1981.

Other than Croat and Madison, only 12 individuals made collections in the 1970s, Callaway Dodson being the most prolific, having made seven collections in western Ecuador, two of which served as the types for *Chlorospatha atropurpurea* and *C. ilensis*. Dodson made only a few more collections in the 1980s, one being the first collection of a species new to science, *C. longiloba* Croat & L. P. Hannon, after which he made no additional collections of *Chlorospatha*. The combined collections of seven of the remaining collectors, Robert Dressler, James Folsom, Barry Hammel, James Luteyn, Paul Maas, John Shepherd, and Djaja Djendoel Soejarto represent 10 collections of *C. croatiana* in Panama and three

collections of a new combination, *C. croatianana* var. *enneaphylla* (Grayum) Croat & L. P. Hannon, in Colombia and Panama. Isidoro Cabrera made a collection in southern Colombia that later served as the type of *C. hastifolia*. Alwyn Gentry made three collections, two of which were the first collections of, and served as the types for, *C. gentryi* and *C. nicolsonii*. James Luteyn was the first to collect *C. antioquiensis*, with his collection serving as the type. Bernt Løjtnant made the only collection of *C. succumbens*, which serves as the type for this new species. Timothy Plowman collected the type for *C. plowmanii*. Olga de Benavides made one collection of what is possibly *C. ricaurtensis* Croat & L. P. Hannon, a new species from Colombia. Only de Benavides, Gentry, Hammel, Luteyn, and Plowman went on to make additional collections after 1979, during which time Gentry made only four collections, two of which are new. His was the first collection of *C. bogneri* Croat & L. P. Hannon and the only collection of *C. yatacuensis*, which serves as the type. Luteyn made the first collections of *C. luteynii*, *C. tokioensis* Croat & L. P. Hannon, and the only collection of *C. stellarreae*, with the collections serving as the types for these species, the last two being new to science, and also collected the type for *C. cogolloi*, a species new to science, and the type for *C. macphersonii*. Hammel made several collections in Panama and Colombia, one of which remains the only fertile collection of and served as the type for *C. hammeliana*. Two collections were made by de Benavides, one of which serves as the type for *C. planadensis* Croat & L. P. Hannon, a species new to science. Plowman made two collections, one of which is new to science, *C. pubescens*.

Prior to 1980, less than 100 collections of *Chlorospatha* had been made, most of these in Ecuador (44) or Central America (24), with only 22 collections having been made in Colombia. Subsequently, numerous collections were made in Ecuador, and it was not until after 1979 that considerable numbers of collections were made in Colombia (119 collections), 45 of which were made by the senior author, Thomas Croat, who also made 84 collections in Ecuador and 17 in Central America during this period. Of the 383 total collections of *Chlorospatha* included in the present treatment, approximately 41% (161) were made by Croat. After 1979, Croat collected extensively in Colombia, Ecuador, and Central America, alone or in conjunction with one or more collectors, and made 146 collections representing 42 species and one taxon, of which 35 species are new to science. Of these 35 species, Croat made the only collections of *C. bayae* Croat & L. P. Hannon, *C.*

chocoensis Croat & L. P. Hannon, *C. engleri* Croat & L. P. Hannon, *C. hannoniae* Croat, *C. limonensis* Croat & L. P. Hannon, *C. munchiquensis* Croat & L. P. Hannon, *C. queremalensis* Croat & L. P. Hannon, *C. ricaurtensis* Croat & L. P. Hannon, and *C. sagittata* Croat & L. P. Hannon, with these collections serving as the types for these species. Croat was also the first to collect *C. boosii* Croat & L. P. Hannon, *C. maculata* Croat & L. P. Hannon, *C. oblongifolia* Croat & L. P. Hannon, and *C. portillae* Croat & L. P. Hannon, with these collections serving as the types. Croat's collections served as the types for five additional new species: *C. hastata*, *C. huilensis*, *C. litensis*, *C. longiloba*, and *C. pubescens*. Since 1979, Croat has also collected *C. bogneri*, *C. bullata*, *C. giraldoi* Croat & L. P. Hannon, *C. jaramilloi*, *C. mansellii* Croat & L. P. Hannon, *C. nambiensis*, *C. nicolsonii*, *C. noramurphyae*, *C. planadensis*, *C. plowmanii*, and Species 1–3, all of which are new to science except *C. nicolsonii*.

Fifty-nine collectors made collections of *Chlorospatha* between 1980 and 2004. Of those not previously mentioned, 22 worked exclusively in Colombia, 25 only in Ecuador, and only four exclusively in Central America. The most noteworthy collections from this period, other than those previously mentioned, were made by 12 of these collectors and include either the types or first collections of species new to science. Ricardo Callejas made nine collections in Colombia, representing three species: *C. antioquiensis*, *C. luteynii*, and the only collection of *C. callejasii* Croat & L. P. Hannon, which serves as the type. Michael Grayum made two collections of *C. croatianana* in Costa Rica, two collections in Ecuador of previously published species, and four collections in Colombia including the only collection of *C. kressii*, which served as the type, and three species new to science, *C. grayumii*, *C. maculata*, and *C. morae*. Alvaro Cogollo and John Pipoly each made five collections in Colombia, with Cogollo making the first collection of *C. cogolloi*, Pipoly, the type collection of that species, and both making collections of *C. nicolsonii*. Pipoly also collected *C. dodsonii* in Ecuador. Jaime Jaramillo also made five collections, all in Ecuador, two of which proved to be new, including the first collection of *C. jaramilloi*, which serves as the type, and a collection of *C. plowmanii*. The two Colombian collections of Jorge Giraldo serve as the types for two new species, *C. bullata* and *C. giraldoi*. Lynn Hannon made five collections in Ecuador, including *C. pubescens* and the type for *C. mansellii*, both of which are new. Julio Betancur made four collections, all in Colombia, including two species new to science, *C. narinoensis* Croat & L. P. Hannon, and the first collection of *C. risaraldensis*, which serves as the type, and the type for

C. betancurii Croat & L. P. Hannon. Honora Murphy and Gustavo Lozano each made one collection, each representing a species new to science, with the Murphy collection being the only collection of *C. noramurphyae* Croat & L. P. Hannon, which serves as the type, and the Lozano collection serving as the type for *C. morae*, the only fertile collection of that species. Mary Sizemore made the first and only collection of *C. sizemoreae* Croat & L. P. Hannon, which serves as the type. Jens Bittner collected the type of *C. bogneri*, a species new to science.

Each of 13 collectors made one to several collections of species new to science during this period, but these were neither the types nor the first collections of these species. Carlos Cerón, Ralf Leimbeck, Walter Palacios, and Patricio Yáñez collected *Chlorospatha plowmanii*, with Palacios also collecting *C. pubescens*, both Ecuadorian species, as did Ray Baker and Libby Besse. Cerón also collected *C. longipoda*. Four collections of two new species were made in Colombia by Pilar Franco, *C. litensis* and *C. nambiensis*. Both of Carla Restrepo's collections represent species new to science, *C. bogneri* and *C. planadensis*. The remaining collections were single collections made by Anders Barfod of *C. litensis*, J. L. Fernández-Alonso of *C. risaraldensis*, Jorge Ramos of Species 4, Daniel Rubio of *C. hastata*, and William Vargas of *C. giraldoi*, all species new to science.

The remaining 27 of the 59 collectors who were active during this period made one to several collections of previously published species or sterile specimens that could not be determined with certainty. These collectors are: Hugh W. Churchill, John Clark, Xavier Cornejo, Hermes Cuadros, Thomas Delinks, Linda Albert de Escobar, Romiro Fonnegra, Thassilo Franke, Alcira Gomez, George Haager, Gunnar Harling, Sandra Knapp, Marcela Mora, Felipe Cardona Naraño, Nigel Pitman, Axel Dalberg Poulsen, Carlos Quelal, Juan José Ramírez, Orlando Rangel, Jimena Rodríguez, Sari Roponen, Elaine Spear, Bertil Ståhl, Kenneth Sytsma, Sue Thompson, Galo Tipaz, and Milton Tirado.

These recent collections have provided additional specimens of both published species and previously unknown species, thus affording a richer and much broader view of the variation of species within local populations and across their known range. A better grasp of the distribution of individual species is now available as well. This is mainly due to the large number of collections made by more collectors during the last 20 years, particularly in Colombia, which was previously poorly represented. It is hoped that the increase in the number of collectors and collections continues to accelerate.

FOSSIL HISTORY

There are, as yet, no reports of fossil *Chlorospatha* in the literature.

INTERGENERIC RELATIONSHIPS

The last thorough taxonomic revision of the Araceae was that by Engler (1905–1920), conducted partly in collaboration with Krause (Engler & Krause, 1920). The final revision included eight subfamilies of Araceae, with *Chlorospatha* in the subfamily Colocasioideae, tribe Colocasieae, and subtribe Caladiinae. Colocasieae shared the subfamily with two other tribes, Syngonieae and Ariopsidae. The subtribe Caladiinae was one of five subtribes, the others being Steudnerinae, Hapalininae, Colocasiinae, and Alocasiinae. Subtribe Caladiinae was comprised of *Aphyllarum* S. Moore, *Caladiopsis* Engl., *Caladium*, *Chlorospatha*, and *Xanthosoma*. Bogner and Nicolson (1991) retained Engler's subfamily Colocasioideae, but eliminated the subtribe, thus raising subtribe Caladiinae to tribal status as Caladieae, which included *Chlorospatha*, *Xanthosoma*, *Caladium*, *Scaphispatha* Brongn. ex Schott, and *Jasarum* G. S. Bunting, with *Aphyllarum* placed in synonymy with *Caladium*. Grayum (1990) also retained the subfamily Colocasioideae and placed *Chlorospatha* in the tribe Caladieae, but retained subtribe Caladiinae, comprised of *Chlorospatha*, *Caladium*, *Xanthosoma*, and *Aphyllarum*, choosing to retain *Aphyllarum*. A comparison of the major systems of classification at the suprageneric level was made by Croat (1990) and included the systems of Hotta (1970), Grayum (1990), and Bogner and Nicolson (1991). In an attempt to bridge differences in the systems of Bogner and Nicolson, Grayum, and Hay and Mabblerley (1991), Mayo et al. (1995) conducted a sweeping survey and produced a cladistic analysis that maintained essentially the same alliances suggested by Grayum (1990), but placed all araceous genera with unisexual flowers in subfamily Aroideae. Keating (2003) sank Colocasioideae into Aroideae, but had two other unisexual subfamilies, Philodendroideae and Schismatoglottideae. The systems of classification of Mayo et al. (1995) and Keating (2003) have taken into account all evidence to date, including the extensive molecular studies of French et al. (1995). In the most recent revision (Mayo et al., 1997), *Chlorospatha* was placed in tribe Caladieae: *Scaphyspatha*, *Caladium*, *Jasarum*, *Xanthosoma*, *Chlorospatha*, *Syngonium* Schott, and *Hapaline* Schott.

The genus of Araceae most easily confused with *Chlorospatha* is *Xanthosoma*, which is closely

related, both having pollen shed in permanent tetrads (Madison, 1981; Grayum, 1984; Bogner, 1997) and a modified style, unlike the other genera within the subfamily Colocasioideae (Mayo & Bogner, 1988). However, the pollination biology is distinct in each, resulting in differences in floral and inflorescence characters. Mayo and Bogner (1988) suggested the possibility of pollen tetrads and a modified style as synapomorphies that would support an infratribal group comprised of *Chlorospatha* and *Xanthosoma*. The genera are palynologically distinct, the individual grains and tetrads of *Chlorospatha* pollen being, on average, more than 50% smaller than those of *Xanthosoma* (Grayum, 1984), basically binucleate and starchless, whereas the pollen of *Xanthosoma* is frequently trinucleate and always starchy (Grayum, 1985, 1986).

The differences between the genera were apparent even in the first two collections of *Chlorospatha*. Masters, obviously somewhat aware of the differences, published *Xanthosoma mirabile* in 1874, with reservations about the generic designation, and Madison (1981) later rightly assigned the species to *Chlorospatha*. Engler (1878) recognized the genus *Chlorospatha* as distinct from *Xanthosoma* in his publication of the type species, *C. kolbii*. At that time, taxa of *Xanthosoma* with cormose and caulescent stems were not considered distinct and were combined, without sectional distinction, in the genus *Xanthosoma*. Engler initially believed that the collection of what would be *C. kolbii* was possibly *X. helleborifolium* (Jacq.) Schott, a cormose species in what is now *Xanthosoma* sect. *Acontias* (Schott) Engl. Therefore, when the collection of *C. kolbii* flowered, he distinguished *Chlorospatha* from *Xanthosoma* only on the basis of floral characters, only one of which can now be maintained without qualification, that being the clear demarcation of the spathe tube and blade by a prominent constriction at and toward the apex of the tube in *Xanthosoma*. The inflorescence of *Chlorospatha* is small and delicate compared to the usually larger and more robust inflorescences of *Xanthosoma* in plants of comparable size, with the spathe weakly or not at all constricted between the tube and blade. In *Chlorospatha*, the spathe tube is narrow and elongated, less than 1.5 cm in diameter (pre-anthesis), even in the largest inflorescences, and usually 5 to 9 times longer than wide. The spathe tube in *Xanthosoma* is usually somewhat globose and is more than 1.5 cm in diameter, even in small inflorescences, and usually less than 2 times longer than wide. These differences would indicate the involvement of different pollinators. *Xanthosoma* is pollinated by euglossine bees, beetles of Nitidulidae

and Scarabaeidae (Mayo et al., 1997), and possibly other beetles. *Chlorospatha* is pollinated by beetles of Staphylinidae (Mayo et al., 1997), possibly by flies and other small beetles, these having been collected in the inflorescences (Madison, 1981). According to Madison (1981), beetles fly to the inflorescence of *Xanthosoma* at dusk, where they are trapped and remain in the spathe tube until the following evening, thus exhibiting a nocturnal pollination syndrome. In *Chlorospatha*, female anthesis occurs during the middle of the day, thus indicating a diurnal pollination syndrome (see Pollination Biology below). The more or less globose spathe tube of *Xanthosoma* (section *Xanthosoma*) opens broadly (laterally) at the apex at anthesis, allowing entry of the pollinators. Recent observations of 19 taxa of *Chlorospatha* in cultivation, and photographs of two additional species, revealed that in 11 of these, the entire spathe opened narrowly or broadly most of its length, with the margins of the tube directed forward or outward, a condition not observed in *Xanthosoma* sect. *Xanthosoma*. Observations in the field corroborated the existence of this condition in seven of these taxa (one from a photograph), and since the condition occurs across the known geographical range of the genus and in vegetatively and floristically diverse taxa, it would be expected to occur in other, perhaps numerous taxa. This condition would suggest a greater range in the size of possible pollinators than was previously assumed. Unfortunately, it is not possible to determine this condition in dried material.

Engler (1879) did not consider vegetative characters in his treatment, thereby implying that the two genera were indistinguishable in the sterile state, which is true only in some cases. Taxa with caulescent stems, in both genera, can appear to be acaulescent when initiating growth from bulbils, at or below the soil surface, or when the stem is epigaeous and obscured by detritus. However, *Chlorospatha* is never cormose and its invariably caulescent stem makes it easily distinguishable from the strictly cormose taxa in *Xanthosoma* sect. *Acontias*. Therefore, *Xanthosoma* sect. *Xanthosoma* is henceforth referred to simply as "*Xanthosoma*"; members of *Xanthosoma* sect. *Acontias* have no relevance in this discussion. In the sterile state, *Chlorospatha* is, in most respects, indistinguishable from the strictly caulescent taxa of *Xanthosoma*, in plants of comparable size. Taxa of *Chlorospatha* are usually of relatively small to moderate stature, usually less than 1 m tall, with the stem not exceeding 4 cm in diameter. Most mature taxa of *Xanthosoma* are large, arborescent plants that could not be confused with *Chlorospatha*, except perhaps in juvenile or less-

than-mature states. The diameter of the stems of these large *Xanthosoma* usually far exceeds the maximum observed in *Chlorospatha*.

The caulescent taxa of the two genera share the same broad range of leaf blade shapes, which can be entire, simple and ovate, sagittate, hastate, deeply lobed, or compound with no notable differences in venation. Although there are some distinguishing features in the vegetative characters of the two genera and an unquantifiable delicacy and form to the vegetative aspects of most *Chlorospatha*, which are apparent to the authors, it is still usually entirely on the basis of fertile characters that the two genera can be distinguished with certainty, as Engler maintained.

Engler maintained that the spadix of *Xanthosoma* differed from that of *Chlorospatha* in having the female and sterile male flowers densely arranged (the fertile male flowers are densely arranged in both genera). He further implied that the sterile staminate portion of the spadix in *Xanthosoma* is comparatively short. Some of these differences clearly apply in the case of *C. kolbii*, in which the sterile portion of the spadix is long, relative to the lengths of the other two portions, and the pistils and sterile male flowers are laxly arranged; however, these character states do not pertain throughout *Chlorospatha*. As currently understood, the fertile staminate portion of the spadix in *Xanthosoma* is usually long, relative to the lengths of the other portions, with the sterile flowers densely arranged, as Engler maintained. In *Chlorospatha*, this portion can be either long, as in most *Xanthosoma*, or much shorter than any observed in that genus, occasionally comprising only a small fraction of the total length of the spadix. Sterile flowers can be either laxly or densely arranged in *Chlorospatha*, but are more laxly arranged than in *Xanthosoma* in most taxa, with those of *C. kolbii* representing an extreme but not unique condition in the genus. Engler maintained that the sterile flowers of *Xanthosoma* differed from those of *Chlorospatha* in always being morphologically similar to the synandria and presumably prismatic (as viewed from above). Sterile flowers of *Chlorospatha* can also be prismatic, though in only a few taxa, as well as subprismatic in numerous taxa, or irregularly lobed, fungiform, or prominently branched (see Sterile Flowers). However, even when the fertile portion of the spadix is relatively long and the sterile flowers prismatic or subprismatic in *Chlorospatha*, it is easily distinguishable from *Xanthosoma*, because the sterile portion is more or less cylindrical, with the flowers comparatively weakly elongated in the direction of the axis (or not at all). In *Xanthosoma*, this portion is usually more or less attenuated toward

the apex, with the associated flowers prominently elongated in the direction of the axis and the basal flowers conspicuously wider and thicker, appearing swollen.

The spadix of *Xanthosoma* is more robust, with the pistillate portion usually shorter than either the sterile or fertile staminate portions, frequently markedly so, and usually adnate to the spathe only at the base or not at all. The spadix of *Chlorospatha* is delicate and narrow, with the pistillate portion longer than the sterile portion (not always in *C. atropurpurea*), occasionally longer than the fertile staminate portion, and in part or entirely adnate to the spathe. Only in a few species of *Chlorospatha* is the spadix adnate only narrowly at the base or only along the stipe (when present). The pistillate portion of the spadix of *Chlorospatha* is narrow and comparatively laxly flowered, with no more than six flowers across the axis (as viewed from above) and usually only three to four. The pistillate portion in *Xanthosoma* is comparatively broad and densely flowered, with no fewer than seven flowers across the axis, usually many more. The pistils are so densely arranged in *Xanthosoma* that they are prismatic in appearance (this probably only a matter of crowding), a condition that does not typically occur in *Chlorospatha* and is diagnostic on the generic level, being directly related to morphological differences in the ovaries and stylar regions of the two genera. One collection of *C. mirabilis* (Croat & Mora 83686) is the only exception. In that collection, the pistils in the central three fourths of the pistillate portion of the spadix appear to be prismatic, most ovaries being coherent most of their lengths; however, the styles are morphologically distinct from those of *Xanthosoma* and not at all coherent with adjacent styles.

Engler described the ovaries of *Xanthosoma* as ovoid or cylindrical and the styles as disklike and connate at the margins, as opposed to the subglobose or cylindrical ovaries of *Chlorospatha kolbii*, which also has somewhat disklike styles, but with the margins neither connate nor coherent. Ovoid and cylindrical ovaries occur also in *Chlorospatha*, as well as subglobose and obtusely conical or obconical ovaries, and although these can be more densely arranged than in *C. kolbii*, they are as densely arranged as in *Xanthosoma* in only one collection of *C. mirabilis* (see above). In *Xanthosoma*, the sides of the ovaries are entirely coherent. The styles in *Xanthosoma* are not connate (fused) as Engler maintained, although they appear to be so, but are coherent (J. Bogner, pers. comm.), as are some styles in some *Chlorospatha*. Typically, the ovaries and, therefore, the pistils, appear separate and distinct in

Chlorospatha, the sides of the ovaries being either free or coherent only at some points along the sides, i.e., weakly coherent. Similarly, the margins of the styles of *Chlorospatha* are usually either free, weakly coherent or coherent on some styles and otherwise free or weakly coherent on the remaining styles (on a single spadix).

The morphology of the style in *Chlorospatha* easily serves to separate it from *Xanthosoma*, regardless of the size of the plant. Mayo and Bogner (1988) rightly maintained that the two genera were distinctive in having modified (thickened) styles. Although the style is clearly modified in all *Chlorospatha*, the style in all species, except 11 of the 12 species from the eastern slopes of the Andes in Ecuador, could not be considered analogous to that of *Xanthosoma*. In view of the diversity of styler morphology exhibited within *Chlorospatha*, its disparity in *Chlorospatha* and *Xanthosoma* and the currently limited knowledge of the complexities of this morphology, it would seem best to apply the terminology of Mayo et al. (1997), wherein the style is referred to as the “styler region,” in recognition of the fact that a “style” is, by definition, attenuated, a condition which clearly does not apply in *Xanthosoma* or all *Chlorospatha*. The styler region in *Xanthosoma* is prominently thickened and tough (Madison, 1981; Mayo & Bogner, 1988), usually the same diameter as or slightly broader than the ovary (Mayo & Bogner, 1988; Mayo et al., 1995, 1997), with the styles and ovaries more or less coherent with those of adjacent flowers. The styler region of *Chlorospatha* is usually expanded into a thin, fragile, spreading mantle that is, for the most part, free from the ovary and is frequently broader than the ovary apex, occasionally as much as 3 times broader. In some *Chlorospatha*, the mantle is disklike, usually somewhat thicker but equally fragile and approximately as wide as or narrower than the ovary apex. Neither the apex nor sides of the ovary are completely coherent with those of adjacent ovaries in *Chlorospatha* except in some flowers of one collection of *C. mirabilis* (Croat & Mora 83686). In the 11 eastern Ecuadorian species mentioned above, the style is not expanded into a mantle, but is exceedingly thin and not coherent with adjacent styles. More than half of *Chlorospatha* species have the style more or less attenuated, thus elevating the stigma, a condition not observed in *Xanthosoma*, in which the stigma is sessile.

Engler (1879) maintained that axile placentation in *Xanthosoma* also distinguished that genus from *Chlorospatha*, the placentation in *C. kolbii* being subaxile. As presently circumscribed, placentation in *Chlorospatha* can be axile, subaxile, pseudoaxile, sub-

basal, or basal. The ovules per locule in *Chlorospatha* with plurilocular ovaries are usually few, (three)four to 10(to 12), with three species occasionally having as many as 14, and two species which rarely have as many as 15 to 16(to 20) in unilocular ovaries. The ovaries of *Xanthosoma* have (12 to)20 to very numerous ovules per locule (Mayo et al., 1997).

The peduncle of *Xanthosoma* is usually comparatively short, occasionally long, usually more than 5 mm in diameter and is not held within the petiole sheath its entire length. The peduncles of *Chlorospatha* are usually long, occasionally longer than the petioles, or much shorter, and always exceedingly slender, usually less than 4 mm in diameter, and only to 5(–6) mm in diameter in a few more robust taxa with both long peduncles and petioles. The entire length of the peduncle is usually held within the petiole sheath, thus giving the inflorescence an erect habit despite the slender peduncle; rarely is it held only weakly within the sheath toward the base, e.g., *C. hammeliana*.

The infructescence of *Chlorospatha* is elongated, usually much longer than broad, with a maximum diameter of 1.5 cm (on drying). The infructescence of *C. corrugata* had the least elongated of those examined, and was 3.5 times longer than wide, the infructescence typically being 4 to 10 times longer than wide in *Chlorospatha*. The infructescence of *Xanthosoma* is usually subglobose to globose and even when somewhat elongated, it is usually less than 2 times longer than wide. As would be expected, considering the small number of pistils visible across the axis of the spadix in *Chlorospatha*, there are few berries across the axis and comparatively more in *Xanthosoma*, with the berries depressed-globose and somewhat flattened apically in *Chlorospatha* and more or less cylindrical and more elongated in *Xanthosoma*.

MORPHOLOGY OF VEGETATIVE STRUCTURES

ANATOMY

Vegetative anatomy. (Contributed by R. C. Keating; vouchers cited by Keating, 2003).

Leaf surface. Cuticle smooth on both surfaces. Epidermis cells polygonal with straight anticlinal walls on both surfaces (1–2:1 length-to-width ratio). Stomata abaxial and brachyparacytic. Subsidiary cells broad or narrow, rounded or angular. Venation: midrib and basal lobe primaries arising from summit of petiole. Midrib prominent, secondary veins acute or narrowly acute, curved and apically ascending, widely spaced or irregular. Tertiary veins variable, sometimes parallel with secondary veins or reticulate.

Higher orders reticulate and merging marginally at more or less straightened collective vein.

Leaf cross-section. Structure dorsiventral. Cuticle thin. Epidermis with adaxial cells large, rounded; abaxial cells small to large, variably shaped, occasionally papillate. Stomata level with surface. Mesophyll with two columnar palisade layers (4–6:1 length-to-width ratio), forming 25% of mesophyll area; spongy zone of ca. five layers of irregularly shaped, short-armed cells forming an aerenchyma of large, rounded, usually substomatal air cavities, some aerenchyma cells with 1-seriate partitions, one partition cell between corner cells. Air cavities forming about 80%–90% of spongy layers. Collenchyma as small strands subtending peripheral bundles.

Vascular bundles. In midrib, ca. 12 around abaxial periphery and ca. eight scattered in center; bundles not large or well-differentiated; xylem with one protoxylem cell with one metaxylem cell occasionally present phloem as a circular strand. Laticifers one or two anastomosing tubes lateral to each vascular bundle; branches may penetrate palisade tissue, ending at epidermis. Tannin cells with dark contents common in palisade layer. Crystals as raphides rare in single bundles in narrow, rounded ended, thin-walled bifurcate idioblasts oriented across aerenchyma partitions, or in rounded cells and uncommon: raphides subepidermal in midrib; druses large, very common in mid-mesophyll, often bordering large vascular bundles; small druses common in palisade cells; crystal sand in abaxial guard cells of stomata.

Petiole cross-section. Cuticle thin and striate. Epidermis cells large and rounded. Collenchyma as peripheral rounded strands, ca. 12 layers deep, one to three layers beneath epidermis. Chlorenchyma: chloroplasts sparse in outer six to eight layers of ground tissue, ground tissue cells mostly compact. Vascular bundles scattered, two sizes, largest mixed with very small bundles comprised almost entirely of phloem. Sclerenchyma: fibers in one to three layers capping phloem in one specimen of *Chlorospatha plowmanii* (= *Caladium plowmanii*) (in Keating 2003, this specimen, *Plowman et al.* 3979, was cited as *Chlorospatha longipoda*). Laticifers anastomosing, two to three lateral to vascular bundles and ramifying throughout ground tissue. Tannin cells occasional in ground tissue. Starch granules occasional in outer ground tissue. Crystals: druses common in compact ground tissue and at margins of air cavities.

Habit and growth patterns. Growth is continuous throughout the year in *Chlorospatha*. In the absence of any known observations of growth over time in *Chlorospatha* in habitat, a few observations made of plants in cultivation will be presented here. In cultivation (at ca. 28°N, ca. 20 m elevation), plants were maintained between 60°F/15.5°C and 86°F (90°F)/30°C (32.2°C), well within the minimum temperature range, but possibly exceeding the maximum temperature found in habitat. During the months of November through March (approximately), vegetative growth either slowed in varying degrees or in some cases appeared to stop. Of the species with reduced growth rate, some continued to flower and others not at all, but with each species flowering (or not) in accordance with its known schedule in habitat. The reduced rate of growth is possibly due to the reduced light intensity and shortened day length at this latitude.

Growth patterns for *Xanthosoma* were diagrammed schematically by Engler (1877) and Ray (1988). There is no information available pertaining to shoot growth in *Chlorospatha*. Ray did not consider *Chlorospatha* in his survey of shoot organization (1988) or treatment of diversity of shoot organization (1987b), nor did Grayum (1990) in his later review of shoot growth. However, Ray made observations regarding *X. violaceum* Schott, in *Xanthosoma* sect. *Xanthosoma*, which would probably apply to *Chlorospatha*, the vegetative aspects of *Xanthosoma* sect. *Xanthosoma* and *Chlorospatha* being the same in most respects. A brief summary of their observations is provided here, and the reader is referred to Grayum (1990) and Ray (1987a, 1987b, 1988) for more detailed accounts. The terminology used here is that of Ray (1987a). Growth of the main axis is monopodial in all Araceae, at least until the time of first actual or aborted flowering, after which the mature stem of *Xanthosoma* has polyphyllous sympodial growth, wherein the stem articles bear a variable number of leaves, whether foliage leaves or cataphylls, before terminating in a sympodial leaf subtending an inflorescence bud which may or may not develop and mature to anthesis. A stem article is a section of the stem produced from a single meristem, from its inception to its termination in a developed or aborted inflorescence (Grayum, 1990). The main axis of the stem consists of a series of such articles, with flowering morphologically terminal, although it appears to be axillary. Although the stem appears to be unbranched, it actually produces a new branch following each sympodial leaf. In *X. violaceum*, growth of the new branch is sylleptic, meaning that the vegetative bud does not rest relative to the

parent shoot. The first leaf of the new growth (of an article) is a sylleptic prophyll. In *Xanthosoma* sect. *Xanthosoma* and presumably *Chlorospatha*, the sylleptic prophyll is a cataphyll.

The growth habit of *Chlorospatha* is terrestrial or occasionally hemiepiphytic or emergent aquatic. Most taxa are consistently terrestrial. Only two species have been reported as exclusively epiphytic, *C. risaraldensis* and *C. yatacuensis*. Both collections of *C. risaraldensis* were reported as “climbers.” *Chlorospatha yatacuensis* is known only from the type and is reported as “epiphytic on tree stump.” It is likely that both species are usually terrestrial. Eleven taxa are reported as both terrestrial and epiphytic: *C. antioquiensis*, *C. cogolloi*, *C. dodsonii*, *C. croatian* var. *enneaphylla*, *C. giraldoi*, *C. grayumii*, *C. ilensis*, *C. longiloba*, *C. longipoda*, *C. nicolsonii*, and *C. planadensis*. One or more collections of each of these taxa were reported as either “epiphytic” or “epiphytic or terrestrial,” with two collections of *C. longiloba* reported respectively as a “liana” or “hemiepiphyte.” The report of *C. longiloba* occurring as a liana can be excluded, lianas being woody-stemmed vines of the forest canopy, whereas the stem of *Chlorospatha* is always somewhat fleshy. The type of *C. dodsonii* was collected as an “epiphyte on tree trunk.” Labels of herbarium collections that report the habit as “epiphytic” are often suspect, when in fact, the collections were probably rooted in the soil and therefore, were technically hemiepiphytic. This was the condition observed (by the authors) in *Chlorospatha*; therefore, these collections would be secondary hemiepiphytes (Putz & Holbrook, 1986), having the stems growing and rooted in or on the soil. The condition occurs in species of *Chlorospatha* that grow erect and in those with the stem decumbent and erect at the apex, although it is reported in only three species that can be erect-growing: *C. dodsonii*, *C. grayumii*, and *C. ilensis*. All erect-growing species frequently produce adventitious roots on the exposed portion of the stem and should the roots come in contact with a tree or possibly a rock, it is likely that these would attach themselves, particularly in the presence of mosses. The fact that the condition occurs in both erect-growing and decumbent species combined with field observations (by the authors) of different populations of two species, *C. longiloba* and *C. longipoda*, suggest that the condition is probably adventitious rather than innate. *Chlorospatha longipoda* was found almost exclusively as a decumbent-growing terrestrial, but when the growing stem encountered an obstacle such as a tree trunk, it would occasionally become appressed to the trunk, with the appressed portion no more than 10 cm long.

On several occasions, *C. longiloba*, also with a decumbent habit, was observed with the appressed portion as much as 1–4 m long, with the stem still retaining its attachment to the ground. In two instances, the elongate stems were loosely held within thick mats of moss among the long thorns of palms and not attached to the trunks. Plants were also found attached to moss-covered tree trunks. There was no apparent difference between the roots observed in the soil and those attached to the trees, and those attached to the trees did not grow downward toward the soil surface. The plants were easily removed, the roots being thin and fragile, as is typical of *Chlorospatha*, and their attachment tenuous, thus differing significantly from the roots of true hemiepiphytes in Araceae. However, it would not be surprising to find other species, perhaps many, at least occasionally assuming this habit, provided that the roots received the moisture necessary to sustain them. Since *Chlorospatha* is known only from consistently mesic habitats, this would not be unlikely, especially considering that almost 20% of known taxa have been reported as at least occasionally hemiepiphytic. Although collections are occasionally made in bright light in disturbed areas, this situation is unnatural, *Chlorospatha* being a plant of the dark forest understory, not requiring the brighter light of an exposed position to achieve maturity and flowering. An elevated position, as a hemiepiphyte, would therefore, provide no apparent advantage but rather the disadvantage of an increasingly drier situation, relative to the height attained. There is no significant shortening or widening of the internodes as a plant climbs or any evidence of leaf or root dimorphism. The normal complement of leaves observed at the apex of the stem in the terrestrial state is retained in the hemiepiphytic state, in plants of the same species. Possibly significant is the fact that the longest internodes in the genus are found in some of these occasional hemiepiphytes. However, no difference in the internode lengths of the appressed and epigaeous portions has been observed. There are otherwise no notable differences in that the vegetative or floral structures of species that are reported as strictly terrestrial and those reported as strictly or occasionally hemiepiphytic.

Stems of taxa with a terrestrial habit can be erect, decumbent, or both (in some species), usually with some portion of the stem subterranean. Of the 42 taxa for which the habit is known, the majority have decumbent stems, with the following 13 having erect stems: *Chlorospatha atropurpurea*, *C. castula*, *C. croatian* subsp. *croatiana*, *C. cutucuensis*, *C. dodsonii*, *C. gentryi*, *C. grayumii*, *C. hammeliana*,

C. ilensis, *C. kolbii*, *C. maculata*, *C. mirabilis*, and *C. morae*. Of these, only the habit of *C. croatianana* subsp. *croatiana*, *C. dodsonii*, and *C. grayumii* is reported as both erect and decumbent. It is interesting to note that taxa with pedate leaf blades are well represented here, eight of the 13 erect-growing species having such blades. Five of these were observed in cultivation (by the authors) for several years and all eventually developed a somewhat decumbent habit while maintaining the more arborescent character of these species. The largest plants in the genus are found in this group, some species attaining heights of 1.5–2 m, with the stems frequently 3–4 cm in diameter and the internodes rarely more than 2 cm long. *Chlorospatha croatianana* subsp. *croatiana* is the giant of the genus, reportedly reaching 2 m in height, although usually less, with the stem portion to 1 m tall. *Chlorospatha dodsonii*, *C. ilensis*, and *C. mirabilis* can be 1.5 m tall. Unfortunately, the habit of collections is too often not recorded. Such is the case with *C. caldasensis*, which is reported as 2 m tall and is probably an erect-growing species. However, the same could not be said for *C. giraldoi*, which can be either terrestrial or hemiepiphytic and was reported as 2 m tall, but has only moderately long petioles and long internodes (2–3.5 cm long), which would accord with a decumbent-growing species in a hemiepiphytic state. The habits of *C. cedralensis* and *C. narinoensis*, both terrestrial species, are not known, but both can be as much as 1.5 m tall. Among the far more numerous decumbent-growing species, only four are known to grow to 1.5 m tall, *C. bogneri*, *C. carchiensis*, *C. litensis*, and *C. sagittata*. Most taxa of *Chlorospatha*, whether the stem is erect or decumbent, are 1 m tall or less, with only 12 species exceeding this height.

In *Chlorospatha*, decumbent stems are epigaeous, occasionally in part rhizomatous, and usually erect for 10–20 cm at the apex. The epigaeous portion has been reported as (10–)25–80 cm long and as much as 1.5 m long in two species, *C. bullata* and *C. succumbensis*. This portion is not known to retain living leaves and is usually inconspicuous, buried for most of its length beneath the litter on the forest floor. The stems of decumbent-growing species are usually 1–2 cm in diameter, with the internodes usually 1–1.5 cm long, occasionally 4–6(–8) cm long in some species.

Stems of *Chlorospatha* are caulescent, elongated, more or less fleshy and composed mainly of parenchymatous tissue lacking starch (French & Tomlinson, 1981; Madison, 1981). One collection of *C. macphersonii* was reported as having a “somewhat woody stem,” but this would presumably accord with

the typical stem of *Chlorospatha*, as defined here. Stems of erect-growing species become slightly less succulent with age, which would presumably accord with their frequently larger size, as compared to those with a decumbent habit, which remain consistently fleshy regardless of age. The sap of *Chlorospatha* is usually somewhat milky, occasionally transparent or nearly so, and rarely pink. Sap color is known in only 24 taxa. Of these, 18 species have milky sap; four species have transparent sap; and one collection of *C. cogolloi* (Cogollo *et al.* 3160) has pink sap. *Chlorospatha croatianana* var. *enneaphylla* is reported as having either milky or transparent sap, while that of *C. croatianana* subsp. *croatiana* is consistently milky. The sap of *C. oblongifolia* is transparent and becomes gelatinous when the stem is cut.

Internodes are usually short in *Chlorospatha*, approximately 1–2 cm long. Those of the erect-growing species rarely exceed this length and are frequently less than 1 cm long. Although usually 1–2 cm long, longer internodes are found in the decumbent and hemiepiphytic species, frequently more than 2 cm long in strictly decumbent-growing species and occasionally 4.5–8 cm long in those that are occasionally hemiepiphytic, but otherwise decumbent-growing, these having the longest observed in the genus. Internode width is greatest in erect-growing species, usually 3–4 cm in mature specimens but in decumbent and hemiepiphytic species, the diameter of the stem is 2 cm or less in all but 24 species. Of these species, 20 species can have stems 2–3 cm, some of which are the largest in the genus. Only *C. planadensis* consistently has long internodes (3.5–8 cm long). In decumbent and hemiepiphytic species, the diameter of the stem is 2 cm or less in all but 24 species. Of these species, 20 species can have stems 2–3 cm in diameter and only four can have stems 3–3.5 cm in diameter, *C. bayae*, *C. besseae*, *C. boosii* and *C. litensis*, relatively few species compared to the erect-growing species, which frequently have stems 3–4 cm in diameter. In all taxa, internodes are frequently longer in the initial growth made from seeds or bulbils (see discussion below) than in the mature stem. Internodes of juvenile plants of *C. longipoda* can be 4–6 cm long. The possibility of juvenile growth must be considered when delimiting species, the internode length and width being good characters only in adult specimens.

The stem is not stoloniferous and is typically unbranched in *Chlorospatha*, but can be branched through injury. When the apical meristem is severed or severely damaged, a plant can initiate growth from dormant buds or bulbils along the stem, or both. Budding can occur simultaneously at one or several

points along the stem. With the meristem intact, the dormant buds appear as small elevations within a separation of the epidermis and are evident on the stems of all taxa, whether or not they possess bulbils. When bulbils are also present, growth can begin from one or several bulbils as well as from buds. Usually, only one growth near the apex will predominate and growth will cease elsewhere. When bulbils are present, the ultimate dominant growth will be from one of these and not from a bud. These observations were made of 10 species in cultivation: *C. atropurpurea*, *C. boosii*, *C. croatianae* subsp. *croatiana*, *C. dodsonii*, *C. hannoniae*, *C. ilensis*, *C. kolbii*, *C. longipoda*, *C. plowmanii*, and *C. pubescens*. Bulbils are known to occur in only 13 species: those listed above as well as *C. castula*, *C. portillae*, and *C. sagittata*, species not cultivated by the authors. Madison (1981) included bulbils in his descriptions of *C. atropurpurea* and *C. castula*, but their presence was not noted on the herbarium labels of the collections cited. He cultivated both species at Marie Selby Botanical Garden and probably later observed bulbils in the cultivated specimens. Bulbils were not reported on the label of any herbarium specimen made from a wild collection examined by the authors and only one dried specimen examined possessed bulbils (one), *Luteyn 3155* (DUKE), *C. croatianae* subsp. *croatiana*. The implication that bulbils usually occur only in cultivation is improbable. An additional explanation for the apparent rarity of observation of bulbils lies in the nature of their attachment, which is tenuous, as in *Xanthosoma* (Madison, 1981), being narrow at the point of attachment, 1–2 mm or less in diameter. The bulbils could be easily lost during the collecting, transporting, drying, and mounting of plants.

Unlike those of *Xanthosoma* (Madison, 1981), the bulbils of *Chlorospatha* are not produced in association with or opposite the axillary bud. The bulbils and dormant buds occur randomly along the stem and are not produced in conjunction with injury but are an integral part of the mature plant. Their tenuous attachment might, to some extent, explain the colonial habit of some species, although bulbils were not observed in all colonial species under cultivation (not in *C. besseae*). Five colonial species in cultivation produced bulbils, *C. boosii*, *C. hannoniae*, *C. longipoda*, *C. plowmanii*, and *C. pubescens*. All had a decumbent habit and developed some growth from bulbils on the erect portion of the stem that was immediately below the soil surface with the bulbils elongating to 2–3 cm in length, in the absence of damage to the meristem and eventually abscising after initiating roots. Other growths occurred from

bulbils that had been dislodged from the parent plant both in cultivation and in the wild, and this appears to be the primary mechanism for growth from bulbils in the erect-growing species that were cultivated but does not explain why these species are not colonial in wild population. It is possible that a colonial habit occurs in these species but has not been reported and could not be determined with certainty in cultivation. In *C. ilensis* and *C. kolbii*, the bulbils below the soil surface exhibited considerable elongation, to as much as 10 cm in the first species and 5 cm in the latter species, without producing leaves or roots. However, when plants were disturbed and the elongated bulbils dislodged, the bulbils would occasionally then develop roots and leaves. This would seem to indicate the possibility of a colonial habit, but in these species, it is also possible that bulbils simply provide a means of survival if the main body of the plant dies. It is noteworthy that when a plant dies and the stem collapses, the bulbils remain viable and attached to the dead epidermis, suggesting that they are perhaps of epidermal origin, as in *Xanthosoma* (Madison, 1981).

Bulbils occur in taxa that are erect-growing (*Chlorospatha atropurpurea*, *C. castula*, *C. croatianae* subsp. *croatiana*, *C. dodsonii*, *C. ilensis*, *C. kolbii*) or decumbent-growing and colonial or not (*C. boosii*, *C. hannoniae*, *C. longipoda*, *C. plowmanii*, *C. portillae*, *C. pubescens*, *C. sagittata*). *Chlorospatha dodsonii* and *C. longipoda* are the only occasionally hemiepiphytic species that are known to possess bulbils. Bulbils occur only in the basal one third of the stem of *C. dodsonii* and *C. ilensis*, but along the entire length in all other taxa. Another cultivated, mature collection of *C. dodsonii* possessed no bulbils. Bulbils are either exclusively or usually solitary in all taxa discussed here except *C. boosii*, which consistently has bulbils of nearly equal size, in rosette clusters of (one)two to six. In the other taxa, there are occasionally much smaller, collateral bulbils associated with the dominant bulbil, usually only one or two, and these remain small.

The shape of bulbils (on the exposed portion of the stem) can be cylindrical and elongated (*Chlorospatha croatianae* subsp. *croatiana*, *C. dodsonii*), subglobose (*C. boosii*, *C. plowmanii*, *C. pubescens*, *C. sagittata*), conical (*C. atropurpurea*) or ovoid (*C. hannoniae*, *C. ilensis*, *C. kolbii*, *C. longipoda*, *C. portillae*). When mature, the bulbils can be more or less pointed at the apex or rounded and briefly attenuated, with short internodes approximately 0.5–1.5 mm long. Bulbils are green when emerging, with the outer portions comprised of triangular, scalelike leaves that become sparsely fibrous at the nodes when mature, with the

fibers pale to medium brown, thus resembling miniature stems, which in turn have dormant buds on their surfaces. The largest bulbils were observed in *C. atropurpurea* and *C. croatianana* subsp. *croatiana*, which were as much as 2 cm long and 1.5 cm diameter in the first species and 2.2 cm long and 1.2 cm diameter in the latter. Bulbils are usually 5–10 mm long and 3–10 mm diameter in the other species.

Most *Chlorospatha* have more or less green, featureless internodes that are glabrous, lack scales, and are not costate, wrinkled, speckled, lineate, or striate. One collection of *C. croatianana* subsp. *croatiana* (Croat 83606) reportedly had the epidermis peeling and curling back on internodes at the base of the stem, and those of *C. engleri* and *C. sagittata* were reported as occasionally having closely spaced longitudinal grooves near the nodes. It is possible that these and other features exist in collections of additional taxa and have not been reported. However, the fresh coloration, texture, and degree of glossiness provide useful characters, having proven to be consistent within an acceptable range of variation in both wild and cultivated collections. The surface texture and color of living internodes are known for 42 taxa, 32 of which have matte to more or less glossy, green internodes. In 23 of these, the internodes are consistently entirely green, regardless of age, and can be from pale to dark green, yellow-green, olive-green, brownish green, or grayish green, depending on the species. Four of the 32 species, *C. besseae*, *C. bogneri*, *C. longipoda*, and *C. planadensis*, have internodes that are green and occasionally or usually purplish or purple-tinged. Two species, *C. atropurpurea* and *C. queremalensis*, have green internodes that become brown with age, and *C. bayae* has green internodes that become gray with age. Two species, *C. boosii* and *C. hannoniae*, have green internodes that become pale, greenish tan, and weakly scurfy with age, mainly at and around the nodes. *Chlorospatha yaupiensis* is unique in the genus in having red internodes. The nine remaining species have brown internodes and represent eight of the 13 species that are known to be erect-growing: *C. corrugata*, *C. croatianana* subsp. *croatiana*, *C. cutuensis*, *C. dodsonii*, *C. hammeliana*, *C. ilensis*, *C. maculata*, *C. mirabilis*, and *C. morae*. The habit of *C. corrugata* is not known, but is probably erect, since entirely brown internodes are known to occur only in erect-growing species. The color and texture of the internodes are not known in *C. castula* and *C. gentryi*, both erect-growing species. The only erect-growing species known to have consistently green internodes is *C. kolbii*, and these can occasionally be partially somewhat scurfy and brownish and possibly become

brown with age, as is the case in *C. atropurpurea*. *Chlorospatha queremalensis*, with weakly glossy, green or brown internodes, probably has a decumbent habit, having green internodes 2–4 cm long, which become brown with age. In seven of the erect-growing species, the brown internodes are also reported as somewhat scurfy in texture, meaning that the epidermis is visibly dull and rough, with numerous, minute fissures: *C. croatianana* subsp. *croatiana*, *C. dodsonii*, *C. hammeliana*, *C. ilensis*, *C. maculata*, *C. mirabilis*, and *C. morae*.

Nodes are always visibly distinct in *Chlorospatha*, but usually otherwise poor in useful features. The internodes between the cataphylls subtending a leaf and the leaf itself are so short that these appear as a single node. A node can be a narrow band ca. 0.5–2 mm wide, which can be slightly raised or not, and slightly minute-fissured, or narrowly, sunken or raised on plants with nodes otherwise in narrow bands. This is possibly explained by the fact that cataphylls are not always produced with foliage leaves in some species, which would presumably result in narrower nodes. The nodes can be green, tan, brown, or brownish in those taxa with green internodes and only brown in those taxa with brown internodes. Younger but mature nodes are green, with the older nodes comparatively more prominently raised, scurfy, and tan to brown or brownish green in three species, *C. boosii*, *C. hannoniae*, and *C. kolbii*.

Roots. According to French (1987), the cortex of the roots of *Chlorospatha* is comprised entirely of thin-walled, unligified parenchyma cells and lacks resin canals. The roots of *Chlorospatha* are adventitious and can occur at any point along the stem, most frequently immediately above or below the nodes. Roots were frequently seen emerging from within the bases of a petiole sheath in decumbent-growing species.

The number of roots produced is greatest in the portion of the stem in contact with the soil. A substantial subterranean system of mostly fine, fragile, many-branched roots was produced in the species observed in the wild and in cultivation. Branching of the main roots typically does not occur until these make contact with the soil, or in the case of hemiepiphytes, with another substrate, which, in some cases, can be as insubstantial as an accumulation of moss (*Chlorospatha longiloba*). Only moderate lateral branching has been observed on the main roots, with intense ramification proceeding from these branches and all segments accompanied by numerous, fine, short root hairs. Occasionally, the main roots do not branch, but are accompanied by short root hairs. On the erect, exposed portion of the

stem, the unbranched roots are most numerous near the base in both decumbent and erect-growing species, but more numerous in those species with a decumbent habit. The latter also produce more roots than the erect-growing species, on the exposed portion of the stem above the soil surface, these roots being few in the erect-growing species. In erect-growing species, the roots near the base of the exposed stem frequently reach the soil surface and develop normally, with the unbranched, basal portion of the root exposed and becoming brownish with age, whereas the roots higher on the stem reach various lengths, from about 1 cm to occasionally as much as 6 cm, at which point growth ceases. There would appear to be some limiting factor in the length of these exposed roots, none above the basal 6 cm having been observed continuing growth to the soil surface. In cultivation, after growth of exposed roots had ceased, the epidermis of the exposed portion would usually harden somewhat and become brownish. As noted previously, if exposed roots come in contact with a moss-covered tree trunk or suitable substrate, they can develop as they would in the soil.

Little variation in coloration of the fresh, growing roots has been observed, these being almost invariably white to greenish or yellowish cream-colored, occasionally somewhat pinkish.

Cataphylls. The three most taxonomically important character states of cataphylls are whether the cataphylls are deciduous or persistent, if persistent, in what condition they persist, and, in an apparently limited number of species, the consistency with which these are produced in association with foliage leaves. In 63 taxa, these three character states have been determined with some degree of certainty from label notes and observations of living or dried material.

The vegetative cataphylls in *Chlorospatha* are rich in characters, some of which can be difficult or even impossible to determine in dried material because the cataphylls become somewhat fragile on drying, frequently losing the apices during the drying process and having some features obscured. Cataphylls are narrowly triangular to narrowly lanceolate and attached around the circumference of the stem. Typically, fresh cataphylls are thin but firm and occasionally thicker and somewhat fleshy in the larger, erect-growing species. There are no notable differences in the number or features of cataphylls subtending foliage or sympodial leaves. All *Chlorospatha* have marcescent cataphylls that wither more or less intact or partially weakly fibrous on the newest growth and are then either deciduous or to some degree persistent below the apex of the stem.

Cataphylls that are deciduous before withering are not known in *Chlorospatha*. An unusual condition has been reported for *C. bayae*, wherein the cataphylls quickly collapse before drying and are then persistent and more or less fibrous. This possibly occurs in other taxa. Usually two to three cataphylls are produced in association with each foliage and sympodial leaf, occasionally only one and this usually only on juvenile growth. As many as four cataphylls have been observed in *C. croatianae* subsp. *croatiana* and *C. pubescens*. In most taxa, the cataphylls subtending a given leaf exhibit only moderate disparity in length, with the proximal cataphyll being the shortest and all successive cataphylls progressively slightly to moderately longer. In a few species, the disparity in length is more pronounced, as is the case in *C. croatianae* subsp. *croatiana*, in which the proximal cataphyll is only a few centimeters long and the uppermost cataphyll (the third or fourth) is as much as 25 cm long. A similar situation was observed in *C. atropurpurea*, *C. kolbii*, and *C. mirabilis*. Interestingly, all four are erect-growing species. In all *Chlorospatha* with cataphylls subtending foliage and sympodial leaves, the ultimate cataphyll subtending either leaf will be slightly to moderately shorter or longer than the characteristic length of the petiole sheath of the sympodial leaf. The petiole sheath of the foliage leaf is notably shorter than the sheath of the sympodial leaf in most taxa, but the length of the ultimate and longest cataphyll will accord only with the length of the sheath of a sympodial leaf (of similar size) and therefore can be notably longer than the petiole sheath of the foliage leaf. The size of successive leaves and, therefore, the lengths of the petioles and usually the sheathing increase from the time of first flowering until a plant attains its fully mature aspect. This difference can be pronounced in some taxa; therefore, it is best to express the length of the petiole sheath of the sympodial leaf as the ratio of its length to the total length of the petiole, this ratio having proved reliably consistent within an acceptable range in most taxa, regardless of the size of the plant and, therefore, the degree of maturity of the adult petiole. Only the length of the ultimate cataphyll is usually included in descriptions, the lengths of the others having no known significance. The maximum lengths given (in descriptions) do not necessarily correspond to the maximum lengths given for the petiole sheaths because cataphylls are frequently missing or incomplete on herbarium specimens.

Cataphylls are glabrous in all *Chlorospatha* except *C. pubescens*, in which the outer surface of the cataphylls can be either densely crispy-puberulent or

granular-puberulent, in minutely spaced longitudinal rows or densely to sparsely so only along the abaxial rib (or ribs) and major veins, or occasionally not at all (terminology defined below; see Petiole Surfaces). The color and surface texture of cataphylls are rarely reported on herbarium labels and are known in only 23 taxa. In these, cataphylls can be matte or weakly glossy to semiglossy, and in 15 species, usually entirely pale to medium green, rarely dark green (*C. bogneri*, *C. litensis*). Of these 15 species, *C. boosii* can occasionally have cataphylls that are weakly darker green-mottled in narrow transverse bands and those of *C. longipoda* can rarely be similarly purple-mottled. Four species have cataphylls that can be entirely purple or purple-tinged green, *C. atropurpurea*, *C. croatica* subsp. *croatica*, *C. ilensis*, and *C. mirabilis*, but which can also be, except in the case of *C. mirabilis*, green with purple mottling in narrow transverse bands. Those of the other three species are consistently green with bands of either darker green mottling (*C. hannoniae*), darker purple mottling (*C. maculata*), or, in the case of *C. kolbii*, either pinkish or green with dark brown, purplish, or black mottling. The cataphylls of *C. sizemoreae* are pink and narrowly transversely purplish lineate, but are green-tinged in the basal one fourth. All taxa with mottled cataphylls also have mottled petioles.

Cataphylls can be 1- or 2-ribbed throughout, 1-ribbed only in the apical one fourth to one half, or not at all ribbed. This character could be determined in only 24 species, and the possibility of error must be considered when only dried material was examined. Ribbing in cataphylls is variable in both shape and number in some species and consistent in others, and therefore would appear to be a weak character on the species level.

The apex of the cataphyll is known in 46 species, although with limited certainty in species known only from dried material, and is consistent on the species level, with a few exceptions that could be attributed to misinterpretation of the dried material. The apex is obtuse with an acumen or apical or subapical apiculum in 31 species, with the acumen or apiculum between 1 mm and 1.5 cm long. There is a tendency toward asymmetry in such cataphylls, with one side usually broader, most prominently so in those species from the eastern slopes of the Andes in Ecuador, in which the widest side is also frequently somewhat auriculate at its apex (*Chlorospatha boosii*, *C. hannoniae*, *C. longipoda*, *C. plowmanii*, *C. pubescens*). A subapical apiculum was observed in *C. litensis*, *C. longipoda*, *C. planadensis*, and *C. pubescens*. In all cases, the apiculum appears to be a continuation of the abaxial rib. In *C. atropurpurea*,

C. croatica subsp. *croatica*, *C. kolbii*, and *C. mirabilis*, usually the apex of only the ultimate cataphyll was obtuse with an acumen, the others being more or less acuminate or cuspidate (*C. kolbii*) or even acute at the apex in the case of the short, proximal cataphyll. These four species, as noted above, are among the few that exhibit pronounced disparity in the lengths of the cataphylls subtending individual leaves. The remaining species, which exhibit less disparity, also exhibit little or no disparity in the apical features. Ten species have cataphylls acuminate at the apex: *C. amalfiensis*, *C. betancurii*, *C. engleri*, *C. giraldoi*, *C. huilensis*, *C. jaramilloi*, *C. lehmannii*, *C. macphersonii*, *C. mansellii*, and *C. portillae*. In *C. giraldoi*, the apex can also be cuspidate. Five species can have cataphylls that are cuspidate at the apex: Species 4, *C. grayumii*, *C. pubescens*, *C. ricautensis*, and *C. timbiquensis*.

Most *Chlorospatha* produce cataphylls with every foliage and sympodial leaf and all taxa produce cataphylls when initiating growth from bulbils, dormant buds, or seeds. Six species deviate from the norm in one of two ways, either by producing cataphylls inconsistently with foliage leaves or by producing cataphylls only with sympodial growth: *C. besseae*, *C. boosii*, *C. dodsonii*, *C. engleri*, *C. hannoniae*, and *C. mansellii*. Of these, only *C. besseae* has persistent cataphylls, these persisting only at the upper nodes and being ultimately deciduous. All six species usually retain remnants of the old leaf bases as a few short fibers or fragments of epidermis, usually only at the upper nodes. Five of the six species mentioned have been observed in cultivation over a period of five to seven years, except *C. engleri*. *Chlorospatha besseae*, *C. dodsonii*, and *C. mansellii* produce cataphylls consistently with sympodial leaves and inconsistently with what are presumably foliage leaves. It is possible that the cataphylls produced with what are apparently foliage leaves are actually associated with sympodial growth in which the inflorescence bud does not develop; however, the lack of cataphylls with some vegetative growth is unusual. During vegetative growth, the new leaves emerge from the apex of the petiole sheath, usually without an attendant cataphyll. In all three species, the sides of the petiole sheath are more or less convolute, easily supporting and protecting the developing foliage leaf in the absence of a cataphyll. When the plant is flowering, the newest leaf is held within a cataphyll and emerges from the base of the previous growth in which the petiole sheath is occupied by the sympodium. These species are sympatric and apparently closely related, having

many characters in common, and *C. mansellii* is possibly a naturally occurring hybrid between the other two species (see *C. mansellii*). This pattern of cataphyll production would be expected to occur in other taxa but is difficult to determine in dried material. *Chlorospatha bogneri*, which appears to be related to these three species, possibly follows the pattern of *C. dodsonii*. No cataphylls were observed on the foliage leaves of the dried material; however, it is possible that these were produced but were either deciduous or lost in the drying process.

Chlorospatha boosii and *C. hannoniae* flower vigorously between May and September, with cataphylls accompanying each sympodial leaf. During the vegetative growth cycle, between October and April, numerous foliage leaves are produced but no cataphylls. In these two species, the arrangement of the cataphylls subtending the sympodial leaf differs from that observed in any other taxon, cataphylls typically being more or less appressed to the developing and mature leaves in *Chlorospatha*. In these two species, the flowering cycle begins with the development of a leaf subtended by one to three cataphylls. The first cataphyll produced may or may not be appressed to the developing leaf, but, as the leaf develops, the cataphylls become loosely arranged, assuming an erect-spreading position in which none is appressed to the leaf. As this growth matures, a sympodium usually develops at the axil of the already mature growth immediately below, rarely at the axil of the growth associated with the cataphylls. A sympodium will develop in association with this first growth of the flowering season only after subsequent growth has begun or has matured.

Most *Chlorospatha* have persistent cataphylls that remain attached to the stem after withering. Of the 63 taxa in which persistence is known, 12 species have deciduous cataphylls: Species 3, *C. bogneri*, *C. boosii*, *C. dodsonii*, *C. engleri*, *C. hannoniae*, *C. maculata*, *C. limonensis*, *C. mansellii*, *C. nambiensis*, *C. sagittata*, and *C. stellarraeae*. All but three of these 12 species retain remnants of old leaf bases as a few short fibers or fragments of epidermis. Species 3, *C. bogneri*, and *C. sagittata* are not known to retain any portion of the cataphylls or leaf bases. Of the 50 remaining taxa, 22 species have cataphylls that persist more or less intact at most nodes: Species 1, *C. antioquiensis*, *C. bullata*, *C. congensis*, *C. maculata*, *C. giraldoi*, *C. grayumii*, *C. jaramilloi*, *C. kolbii*, *C. lehmannii*, *C. longiloba*, *C. longipoda*, *C. munchiquensis*, *C. narinoensis*, *C. oblongifolia*, *C. planadensis*, *C. portillae*, *C. pubescens*, *C. ricaurtensis*, *C. sucumbensis*, *C. timbiquensis*, and *C. tokioensis*. Eight of these species also retain some remnants of the leaf bases: *C. antioquiensis*, *C.*

giraldoi, *C. jaramilloi*, *C. longiloba*, *C. longipoda*, *C. oblongifolia*, *C. ricaurtensis*, and *C. tokioensis*. The more or less intact remnants of the cataphylls can include some exposed fibers or semi-intact remnants. *Chlorospatha munchiquensis* is distinctive in having prominent remnants of the cataphylls that completely obscure the stem, whereas in *C. sucumbensis*, the remnants are intact but short (2–3 mm long), as if broken or possibly cut by the collector. In *C. oblongifolia*, the intact remnants ultimately become fibrous at the lowermost nodes. Fourteen species have cataphylls that persist more or less intact only at a few upper nodes: *C. amalfiensis*, *C. atropurpurea*, *C. bayae*, *C. besseae*, *C. caliensis*, *C. carchiensis*, *C. cutucuensis*, *C. huilensis*, *C. ilensis*, *C. litensis*, *C. mirabilis*, *C. nicolsonii*, *C. queremalensis*, and *C. sizemoreae*. The nodes below can be devoid of remnants or, in the case of *C. bayae*, *C. ilensis*, *C. litensis*, and *C. queremalensis*, retain fibrous remnants. In *C. bayae*, the fibrous remnants on the lower nodes are prominent, obscuring the stem. *Chlorospatha besseae*, *C. carchiensis*, and *C. nicolsonii* also retain some remnants of old leaf bases at the upper nodes. The cataphylls are retained most of the length in a semi-intact, more or less fibrous condition, with the fibers linear, in eight species: Species 4, *C. callejasii*, *C. cogolloi*, *C. gentryi*, *C. hammeliana*, *C. maculata*, *C. macphersonii*, and *C. morae*. In five taxa, the cataphylls are retained only as more or less numerous long, linear fibers at most nodes: *C. caldasensis*, *C. croatica* subsp. *croatica*, *C. croatica* var. *enneaphylla*, *C. kressii*, and *C. yaupiensis*. In *C. caldasensis* and *C. yaupiensis*, these are rather sparse and in *C. kressii* persist only at the upper nodes. The fibers are prominent and usually cover the stem in both varieties of *C. croatica*. Only a few short, linear fibers are retained along the lengths of the stems of *C. betancurii* and *C. plowmanii*. In *Chlorospatha*, the fibers retained are always more or less linear and usually pale and straw-colored to occasionally medium brown or reddish brown.

Leaves. The youngest part of the stem bears the leaves in all taxa of *Chlorospatha*. The older part of the stem can be devoid of all remnants of leaves and cataphylls or to some degree covered in the intact, semi-intact, or fibrous remnants of both or either the cataphylls or leaves, along most or all of its length or only at the uppermost nodes below the leaf-bearing portion of the stem. Vernation, as defined by Cullen (1978), is supervolute in *Chlorospatha*. Leaves undergo heteroblastic development, a gradual change in morphology from juvenile to adult forms (Grayum, 1990), which is less pronounced in *Chlorospatha* than in other genera of Araceae. In most *Chlorospatha*, the shape of juvenile blades is usually similar to that of

adult blades, with the change in morphology more pronounced in those taxa with mature blades that are pedatisect, pedatifid, trisect, or trifid. Even in species with limited heteroblastic development, some changes are worth noting, particularly considering the fact that numerous species can flower early in their development, before the sympodial leaf has attained the shape associated with the fully mature plant, a situation that could result in confusion when making determinations. Therefore, the term "mature," as applied here (in descriptions of taxa), refers only to the ultimate aspect of the leaf of a taxon, to the extent that this is known. The leaf subtending an inflorescence sympodium must be considered "adult" as opposed to "juvenile," but is not necessarily fully mature in its shape. For example, the fully mature leaves of *C. hastata* and *C. litensis* are conspicuously hastate, with long, well-developed posterior lobes that are more or less acute at the apex, but both species can flower with the subhastate and the posterior lobes short (relative to the length of the anterior lobe) and rounded at the apex. These two species also exhibit another commonly observed aspect of heteroblasty in *Chlorospatha*, wherein the pronounced constriction at the base of the anterior and posterior lobes of fully mature blades is weakly expressed or absent in juvenile and less than fully mature blades. Species with sagittate, subhastate, or hastate blades typically exhibit the conditions described above, with some also having juvenile blades ovate and cordate, subcordate, or cordulate at the base, with the posterior lobes much reduced. The latter condition is commonly observed in species from the eastern slopes of the Andes in Ecuador, but has also been observed in *C. dodsonii*, a species from the western slopes in Ecuador, which has markedly hastate mature blades with posterior lobes almost as long as the anterior lobe.

Heteroblasty is most pronounced in taxa with blades that are pedatifid or trifid. The juvenile blades of *Chlorospatha mirabilis*, a trifid species that occasionally has nearly trisect mature blades, can be entire and ovate to elliptical or hastate to subtrifid, with the lateral lobes reduced in length. The lateral segments of juvenile blades, when present, are moderately to conspicuously shorter than the medial lobe in all trifid and trisect species, with little or no change in the width of the confluent portion between segments. Mature blades of *C. kolbii*, a pedatifid species, have 11 to 14(15) segments, but will flower with blades having (seven to) nine segments, whereas the juvenile blades have five to seven segments that can be weakly broader, relative to their length, than those of adult blades. *Chlorospatha croatianae* subsp.

croatiana, typically a 5-lobed species, is somewhat problematic. Most of its mature characters are highly variable, and it is, in fact, the most variable species of *Chlorospatha*. The blades exhibit considerable variation at every stage of development, some of which may or may not be attributable to heteroblasty. Juvenile blades of *C. croatianae* subsp. *croatiana* are 3- to 5-pedatifid, with the segments usually narrow (3 to 4 times longer than wide) and narrowly confluent with adjacent segments, but the segments can occasionally be broad (about 2 times longer than wide), either broadly or narrowly confluent between segments, and, when 3-lobed, have the outer segments auriculate. Specimens with 5-lobed mature blades frequently have less than fully mature blades that are 3-lobed and auriculate on the same plant, indicating that the auricle is a precursor to the 5-lobed form. However, in other large and presumably mature flowering specimens, all blades are 3-lobed and prominently auriculate, suggesting the possibility that the 3-lobed form is also a mature form. Most 5-lobed blades of this species are more or less auriculate and it is possible that these plants could eventually produce 7-lobed blades, but these have never been observed. The juvenile and less than fully mature leaves of the few pedatisect and trisect species are usually respectively deeply pedatifid or trifid, with smaller and fewer segments than mature blades, which are free to the base or have the confluent portion markedly narrow between segments.

Petiole sheathing is usually proportionally shorter in juvenile leaves than in mature leaves, and the characters of the free portion are not usually as clearly articulated. In species in which the entire length of the free portion of the mature petiole is sharply D-shaped and prominently sulcate with the margins acute, these characters will usually be subdued, lacking, or will occur only in some percentage of the apical portion of the juvenile petiole.

No change in surface texture of petioles or blades has been observed in the development from juvenile to mature form.

In terms of adult blade shape, *Chlorospatha* is exceedingly diverse. Leaves are clustered in the apical portion of the stem, usually erect to erect-spreading, and in only a few species are more than five present at one time. The number of leaves and their habit are consistent characters. Sixty taxa have no more than five erect to erect-spreading leaves at one time, nine of which are known only from herbarium specimens with solitary leaves, a condition that is probably coincidental rather than innate. Eight

species can have as many as six to eight leaves, although they can have fewer, such as *C. bogneri*, *C. dodsonii*, *C. engleri*, *C. gentryi*, *C. litensis*, *C. mansellii*, *C. pubescens*, and *C. stellararreae*. Three species can have as many as 10 to 14 leaves, *C. boosii*, *C. hannoniae*, and *C. plowmanii*, although they can have fewer. *Chlorospatha boosii*, *C. hannoniae*, *C. plowmanii*, and *C. pubescens*, from the eastern slopes of the Andes in Ecuador, are noteworthy in consistently having leaves that are erect, erect-spreading, spreading, and reflexed-spreading on individual plants. All are small, decumbent-growing species that retain leaves along most or all of the length of the erect portion of the stem, thus giving them a somewhat bushy appearance, unusual in *Chlorospatha*.

All leaves of *Chlorospatha* are either fully expanded foliage leaves or cataphylls. Fully expanded leaves can be either foliage leaves or sympodial leaves.

Petioles. Petioles of *Chlorospatha* are usually erect or erect-spreading from the stem, with the developing blades initially extending in the same plane. *Chlorospatha boosii*, *C. hannoniae*, *C. plowmanii*, and *C. pubescens*, small, decumbent-growing species from the eastern slopes of the Andes in Ecuador, are noteworthy in having the petioles erect, erect-spreading, spreading, and reflexed-spreading on the same plant. Petioles of *Chlorospatha* lack a geniculum and are typically soft or spongy to moderately firm. Only the type of *C. maculata* is reported as having a "brittle" petiole. Petioles are usually long relative to blade length, with a long sheath. Thirty-eight species have petioles 1.4 to 2 times longer than the blades. Five species have petioles 2.5 times longer than the blades: *C. callejasii*, *C. ilensis*, *C. luteynii*, *C. mirabilis*, and *C. planadensis*. *Chlorospatha cedralensis* has petioles 3.1 times longer than the blades, the largest ratio in the genus. *Chlorospatha grayumii* and *C. portillae* are the only species in which the blades can occasionally be slightly longer than the petioles. It is noteworthy that all of the larger, erect-growing species have petioles 2 to 2.5 times longer than the blades. Seventeen species have short petioles, only 1 to 1.3 times longer than the blades. Petioles range in length from 10 cm in *C. stellararreae* to 125 cm in *C. mirabilis*. Forty-seven taxa have mature petioles between 30 and 79 cm long; 10 species have petioles less than 30 cm long; and 11 species have petioles more than 79 cm long. Five of the last species can have petioles 1 m long or more: *C. cedralensis*, *C. croatianae* subsp. *croatiana*, *C. ilensis*, *C. mirabilis*,

and *C. sagittata*. Only *C. stellararreae* has mature petioles less than 20 cm long.

Free portion and cross-section. The free portion of the petiole, that portion above the apex of the sheath, is 7 mm in diameter or less in all but seven species and is usually less than 5 mm in diameter. In Species 1, *Chlorospatha atropurpurea*, *C. corrugata*, *C. croatianae* subsp. *croatiana*, *C. dodsonii*, *C. grayumii*, *C. ilensis*, *C. mirabilis*, and *C. sagittata*, this portion can be as much as 1 cm in diameter, but is frequently less. Many taxa are known only from dried material, and measurements of these were estimated based on the known drying characteristics of similar, living taxa.

The variation of the cross-sectional shape in the free portion of the petiole of mature specimens is taxonomically important. Unfortunately, this diagnostic character is frequently omitted from label notes and nothing is known of this character in 27 species. In 29 taxa, the petiole is entirely terete or subterete, or subterete only toward the apex and otherwise terete. Of these taxa, only *Chlorospatha longipoda* can also have the free portion sharply C-shaped. For definitions of petiole cross-sectional shapes, refer to figure 1 on p. 217 in Croat (1983) with the margins more or less acute. In nine of these taxa, the free portion can also be sulcate either the entire length or only near or toward the apex: Species 1, *C. atropurpurea*, *C. besseae*, *C. bogneri*, *C. engleri*, *C. hastata*, *C. limonensis*, *C. longipoda*, and *C. macphersonii*. The entire free portion can be narrowly to acutely sulcate in Species 1, *C. besseae*, *C. hastata*, *C. limonensis*, and *C. longipoda*. The free portion can also be obscurely sulcate or bluntly V-sulcate in *C. longipoda* in which this character is more variable than in most taxa. In *C. besseae* and *C. bogneri*, the free portion can also be sharply V-sulcate, though only toward the apex in *C. besseae*. Obtuse sulcation occurs at the apex in *C. engleri* and *C. macphersonii*. In three species, *C. croatianae* subsp. *croatiana*, *C. dodsonii*, and *C. plowmanii*, the free portion can be obtusely D-shaped or terete, and in *C. dodsonii* and *C. plowmanii*, also obtusely sulcate at the apex.

The free portion is usually or frequently sharply D-shaped in five species, *Chlorospatha grayumii*, *C. litensis*, *C. mansellii*, *C. oblongifolia*, and *C. pubescens*, also sharply U-shaped and thicker than broad in *C. grayumii*. That of *C. oblongifolia* can also be sharply C-shaped, and that of *C. pubescens*, obtusely D-shaped. The free portion of *C. litensis* is also obtusely sulcate at the apex and unusual in having the margins of the free portion acutely raised. In *C. mansellii*, the free portion is broadly obtusely

sulcate. Sulcation observed in one collection of *C. pubescens* (L. P. Hannon et al. 97-365) is apparently unique in the genus, being narrowly triangular-sulcate, with flared margins that are concave near the apex of the petiole. Of the remaining six species in which this character is known, the free portion is consistently entirely obtusely D-shaped, usually with the margins becoming more or less acute near the apex in five species (*C. boosii*, *C. hannoniae*, *C. mirabilis*, *C. narinoensis*, and *C. ricourtensis*) and obtusely D-shaped only in the apical one fourth in *C. sizemoreae*. The free portion in *C. hannoniae* is usually U-shaped, with the margins becoming bluntly acute toward the apex, whereas the margins can be acute or acutely raised in *C. mirabilis*. In *C. boosii* and *C. pubescens*, the free portion is narrowly to acutely sulcate or, in the latter species, occasionally obtusely sulcate its entire length.

An obtuse medial rib has been observed in seven species, *Chlorospatha croatianana* subsp. *croatiana*, *C. grayumii*, *C. ilensis*, *C. kolbii*, *C. litensis*, *C. mirabilis*, and *C. oblongifolia*. *Chlorospatha kolbii* can also have lateral ribs that become acute or alate near the apex and are contiguous with a similarly shaped medial rib on the posterior rib. The occurrence of a medial rib is not associated with any particular cross-sectional shape and is found in species with terete, subterete, and obtusely or sharply D-shaped petioles.

Petiole sheath. The length of the petiole sheath, relative to the total length of the petiole, is taxonomically significant, the variability (or not) of the ratio being consistent within a narrow range at the species level in all taxa, with the greatest range occurring in *Chlorospatha mirabilis* in which the petiole sheath is one third to two thirds as long as the petiole, a range of one third of the total length. In the remaining taxa, the range between minimum and maximum lengths of sheathing is less than one fourth of the total length or not at all variable, except in *C. croatianana* subsp. *croatiana* with a range of one fourth to one half of the total length. It is important to note that this applies only to petiole sheathing of sympodial leaves, the sheaths of foliage leaves frequently being significantly shorter and more variable in relative length in most taxa. Only the ratio pertaining to the sympodial leaf is provided in most descriptions and, when possible, the ratio pertaining to foliage leaves. However, the latter character is frequently difficult to determine when only dried material is available. In 50 taxa, the ratio for sympodial leaves falls somewhere between one third and two thirds of total length, with the ratio consistently one third in 13 species, one third to one half in six species, consistently one half in 17

species, one half to two thirds in 10 taxa and consistently two thirds in four species. In *C. atropurpurea*, the ratio is usually one half to two thirds, but can rarely be three fourths. In nine species, the petiole is sheathed three fourths or more of its length, occasionally almost the entire length in some: *C. bogneri*, *C. cedralensis*, *C. cogolloi*, *C. litensis*, *C. macphersonii*, *C. sagittata*, *C. stellaris*, and *C. timbiquensis*. In two species, the petiole is sheathed one fourth to one third of its length, *C. gentryi* and *C. oblongifolia*. The petiole is usually sheathed one fourth of its length or less in four species, with that of *C. plowmanii* usually sheathed one fourth, *C. hammeliana* one sixth to one fourth, *C. pubescens* one tenth to one fourth, and rarely to one third in all three species or to one half in different populations of *C. plowmanii* and *C. pubescens*. The petiole of *C. sizemoreae* is sheathed ca. one tenth on both foliage and sympodial leaves.

The sides of the sheath are presumably convolute in most taxa, this condition having been observed in all living species that have the inflorescence held within the sheath and emerging at or near its apex, as is usually the case in *Chlorospatha* and necessary for the containment of the slender and usually relatively long peduncles associated with these taxa. This character usually cannot be determined in dried material, but can be deduced with reasonable certainty from relevant factors. The sheath margins are smooth in most taxa, but are frequently prominently undulate in *C. dodsonii* and rarely so in *C. ilensis* and *C. litensis*. Sheaths with sides that do not overlap is a condition apparently confined to seven species from the eastern slopes of the Andes in Ecuador, which have comparatively short peduncles and the floral sympodium subtended by a sympodial cataphyll that emerges at or toward the base of the petiole sheath of the subtending foliage leaf (see Cataphylls below): *C. boosii*, *C. engleri*, *C. hannoniae*, *C. longipoda*, *C. plowmanii*, *C. portillae*, and *C. pubescens*. In *C. boosii* and *C. hannoniae*, the sides of the sheath are wide and broadly spreading (to 90° midway), appearing winged (Fig. 22B). In the remaining five species, the sides are erect or erect-spreading, occasionally in-rolled along the margins, and occasionally convolute at the apex. It should be noted that sympodial cataphylls are not confined to species from the eastern slopes of the Andes or those that have the sides of the sheath more or less erect. *Chlorospatha longiloba* and *C. yatacuensis*, from the western slopes, have sympodial cataphylls, but the sides of the petiole sheath are convolute.

The apex of the sheath is decurrent onto the petiole in most taxa, free-ending in 18 species and can be

either decurrent or free-ending in eight species. In most species with free-ending sheaths, the condition occurs only in association with sympodial leaves, with the sheath decurrent on foliage leaves. Sheaths are consistently free-ending on both foliage and sympodial leaves in a few species, e.g., *Chlorospatha bogneri*. An unusual condition was observed in living plants of some species from the eastern slopes of the Andes in Ecuador, which possibly occurs in other taxa but is difficult to determine in dried material. In *C. engleri*, *C. longipoda*, *C. plowmanii*, and *C. pubescens*, one side of the sheath can be conspicuously broader than the opposite side, free-ending at the apex and weakly auriculate, with the opposite side decurrent onto the petiole or narrowly confluent with the more free-ending side, which is also true of the vegetative cataphylls in these species. This is consistently the case in *C. engleri*, frequently the case in *C. longipoda* and *C. pubescens*, and rarely so in *C. plowmanii* in which the apex is usually decurrent on both sides. The eight species in which the apex can be either decurrent or free-ending are *C. bullata*, *C. dodsonii*, *C. engleri*, *C. grayumii*, *C. longipoda*, *C. mirabilis*, *C. plowmanii*, and *C. pubescens*.

Petiole surfaces. Petioles in *Chlorospatha* are usually glabrous and matte to semiglossy. Although there are few reports regarding surface texture, most petioles are matte or weakly glossy, with only six of the 27 taxa in which the character is known having semiglossy petioles: Species 1, *C. croatianae* subsp. *croatiana*, *C. longiloba*, *C. maculata*, *C. munchiquensis*, and *C. portillae*. In *C. croatianae* subsp. *croatiana* and *C. longiloba*, the petioles can also be weakly glossy or matte. Only *C. sizemoreae* is known to have a glossy petiole. In nine species, the entire petiole or only the free portion is minutely many-ribbed: *C. bogneri*, *C. cogolloi*, *C. engleri*, *C. kolbii*, *C. litensis*, *C. morae*, *C. pubescens*, *C. sagittata*, and *C. timbiquensis*. Seven species have petioles that are entirely or partially other than glabrous: *C. bogneri*, *C. castula*, *C. corrugata*, *C. engleri*, *C. gentryi*, *C. pubescens*, and *C. yaupiensis*. These species have petioles that are usually to some degree granulose, granular-puberulent, minutely puberulent, crispy-puberulent or scurfy-pubescent, with the puberulence or pubescence usually occurring in longitudinal rows, frequently in association with minute ribs. When the surface is granulose, it appears to be covered with small, angular grains, much like grains of sand. The granular-puberulent indumentum is comprised of minute, acutely angular scales that are more elongated than the elements of the granulose indumentum. The minutely puberulent indumentum is similar but with the scales more elongated and

hairlike. The following terminology is attributed to Grayum (1986), who describes the scurfy-pubescent indumentum as having “more or less flattened, branched, multicellular hairs.” “Crispy-puberulent” is the same condition more weakly expressed, the hairs being shorter, with fewer or no branches. The various indumentums described do not appear to be distinct conditions but rather the same condition expressed in varying degrees of prominence, with the most prominent expression occurring at or toward the apex of the petiole. Invariably, more than one and occasionally all five forms of indumentum occur on individual petioles and typically extend onto the posterior rib. The petioles of *C. gentryi* and *C. pubescens* can be entirely crispy-puberulent or only so in the free portion, or crispy-puberulent with the free portion entirely scurfy-pubescent or only so toward the apex. Scurfy pubescence is known only in these two species. The petioles of the remaining species mentioned can be entirely granulose and granular-puberulent or crispy-puberulent, or partially so only in the free portion or toward the apex, and occasionally not at all. Granular puberulence is weakest in *C. castula*, occurring only briefly near the apex, with the remaining free portion granulose. Some sparse, random granular puberulence has been observed on petioles of some specimens of *C. longipoda*, but the condition was not consistent within single populations or between different populations.

Coloration. Petioles are usually entirely or partially green, with the 46 taxa in which coloration is known almost evenly divided between those with entirely green petioles (lacking mottling) and those that have some or all collections with the petioles green and either purple-tinged or mottled with purple or darker green in narrow transverse bands, with few exceptions. Mottling in narrow transverse bands consists of minute spots and closely spaced, short lineations, creating a reptilian pattern reminiscent of that found in the petioles of *Dracontium* L. and other genera of Araceae. Interestingly, the indigenous Awá people in northern Ecuador call *Chlorospatha hastata* “papa de la culebra,” “culebra” meaning “snake” in the Spanish language (Fig. 23B). The mottling is prominently reptilian in this species. Mottling is typically progressively darker toward the base of the petiole and muted or lacking toward the apex. Twenty-two species usually have consistently entirely pale to very dark green petioles, with those of *C. litensis* rarely being purplish brown toward the base and those of *C. longipoda* rarely being weakly purple-mottled.

Twelve species have petioles more or less green and consistently darker purple- or green-mottled: Species 1, Species 2, *Chlorospatha castula*, *C. engleri*, *C. hammeliana*, *C. hannoniae*, *C. hastata*, *C. huilensis*, *C. kolbii*, *C. kressii*, *C. sagittata*, and *C. sizemoreae*. The color of mottling is not known in Species 2, *C. huilensis*, or *C. kressii*. The label notes for these species indicate only "darker-mottled," possibly meaning "darker green-mottled." Dried material of *C. sucumbensis* has similarly mottled petioles, but nothing is known about the color of the petiole or mottling. Coloration of mottling is variable and unusual in *C. kolbii* and can be brown, purplish, or black, with the mottling more pervasive than in most taxa observed, frequently with the transverse bands barely distinguishable. The five species that can have entirely purple petioles also have the most variable petiole coloration known in the genus: *C. atropurpurea*, *C. croatian* subsp. *croatiana*, *C. dodsonii*, *C. ilensis*, and *C. mirabilis*. *Chlorospatha atropurpurea* and *C. croatian* subsp. *croatiana* can also have green petioles that are purple-mottled in transverse bands, with the latter species having petioles that can also be entirely green, purple-tinged green, purplish brown, or green with gray mottling. The petioles of *C. ilensis* and *C. dodsonii* can also be entirely green, with the sides of the sheath dark maroon on sympodial leaves of one collection of *C. ilensis*, a condition observed in only one other species, *C. nambiensis*. All species known to have mottled cataphylls also have mottled petioles, but it is not known that all species with mottled petioles also have mottled cataphylls. The petiole in *C. croatian* subsp. *croatiana*, *C. dodsonii*, and *C. mirabilis* can also be either entirely purple-tinged green for most of the length or with the apex green. Five species have petioles consistently only purple-tinged green: Species 4, *C. bullata*, *C. chocoensis*, *C. limonensis*, and *C. ricaurtensis*. In *C. limonensis*, the petiole is also dark purple-violet-striate-lineate toward the apex. Unusual coloration has been reported in *C. caldasensis* with brown petioles, one collection of *C. croatian* subsp. *croatiana* with gray-mottled petioles, *C. huilensis* with pink-tinged green petioles, *C. munchiquensis* with brownish green petioles, and *C. yaupiensis* with reddish pink petioles. The petioles of *C. mansellii* and *C. mirabilis* can have a glaucous bloom toward the base.

Dried petioles can provide additional useful characters. The petioles of 53 taxa dry dark brown to reddish brown or entirely or partially blackish brown, and matte to weakly glossy in 37, weakly glossy to semiglossy in 11, and matte in five. Of these, the petioles of only two species always dry

semiglossy, *Chlorospatha nicolsonii* and *C. queremalensis*. The petiole of *C. kolbii* can also dry brownish gray, that of *C. atropurpurea* purplish, and that of *C. limonensis* purplish only at the apex. An additional nine species have petioles that usually or occasionally dry green or greenish: *C. boosii*, *C. corrugata*, *C. engleri*, *C. hannoniae*, *C. longipoda*, *C. maculata*, *C. mansellii*, *C. plowmanii*, and *C. pubescens*. This drying color is possibly the result of different drying conditions; however, all but three of these species are representative of a distinct group from the eastern slopes of the Amazon in Ecuador (see Infrageneric Relationships) and the tendency to dry green or greenish brown is maintained in these species, even when different driers have been used. The three species not representative of this group are *C. corrugata*, *C. maculata*, and *C. mansellii*, which only occasionally have petioles that dry greenish brown. An unusual condition observed in only eight species appears to be a good character, with all collections of any given species mentioned exhibiting this character. In Species 1, *C. antioquiensis*, *C. betancurii*, *C. hammeliana*, *C. longiloba*, *C. luteynii*, *C. sizemoreae*, and *C. yatacuensis*, the epidermis of the petiole dries entirely or partially separated more or less intact from the main body, semi-transparent, and semiglossy to glossy. The portion that is not separated, if any, is matte to weakly glossy. The petioles of *C. antioquiensis*, *C. luteynii*, and *C. yatacuensis* dry almost black, whereas those of the other species mentioned dry dark brown or reddish brown.

Blades. The blades of *Chlorospatha* emerge in the same plane as the petiole and, at maturity, can be erect, erect-spreading, spreading, or drooping. Most blades are held horizontally (spreading) or drooping at maturity.

Blade texture. The texture of blades in *Chlorospatha* can be thin, thinly coriaceous, subcoriaceous or coriaceous, with the blades of one species reported as "fleshy," *C. macphersonii*. These terms apply only to the variation observed within the genus, the blades of *Chlorospatha* being comparatively thin for Araceae. Of the 47 taxa in which this character is known, 38 have blades that are thin, thinly coriaceous, or both, with *C. croatian* subsp. *croatiana* and *C. dodsonii* occasionally having subcoriaceous blades. Six species have blades that are usually subcoriaceous: *C. hammeliana*, *C. limonensis*, *C. mirabilis*, *C. munchiquensis*, *C. queremalensis*, and *C. sizemoreae*. The texture of the living blades is not known in *C. congensis*, but the blades dry subcoriaceous and it can be reasonably assumed that the texture of the living blades is either coriaceous or subcoriaceous.

Only two taxa are known to have coriaceous blades, *C. lehmannii* and *C. maculata*, with those of the latter species occasionally being thinly coriaceous, as well as those of *C. mirabilis*, which can be thinly coriaceous but are usually subcoriaceous. Almost all taxa of *Chlorospatha* have blades that dry thin to thinly coriaceous.

Blade surfaces. Laminae tissue is always glabrous on both surfaces in *Chlorospatha*. Engler and Krause (1920) describe the upper surface of the blade of *C. kolbii* as “scabra” and “subholosericea.” The upper surface of *Hort. Bull s.n.* (K), presumably a specimen from the original Wallis collection of this species, was examined and no “hairs” were observed. The upper surface is minutely alveolate in the dried material, which could explain their use of the term “scabra,” meaning “rough to the touch.” In all modern collections of this species, the upper surface is more or less velvety, with subhemispherical elevations seen under low magnification (10X), in both living and dried material. The term “velvety” is somewhat misleading and, as applied in this treatment, refers to a perceived effect rather than to a structural condition implying the presence of “hairs.” Eighteen of the 47 taxa in which surface texture is known have the upper surface velvety or matte-subvelvety. The upper surface is matte in 10 species, semiglossy in six species, glossy or occasionally semiglossy in six species, and weakly glossy in six species. The character is consistent in most taxa, with slight variation exhibited in some, such as in those species with matte blades that can occasionally be weakly glossy. Considerable variation has been observed in only a few taxa, the same species that exhibit variation in other characters. In *C. croatianae* subsp. *croatiana*, *C. dodsonii*, and *C. longipoda* (Fig. 32A), the surface can be velvety, subvelvety, matte, weakly glossy, or semiglossy.

In *Chlorospatha*, the upper surface is medium to very dark green, yellow-green or olive-green, with few exceptions. The upper blade surface of *C. caldasensis* is brown, that of *C. atropurpurea* has been occasionally reported as “purplish” medially, and that of *C. sizemoreae* is an unusual grayish green. The dried blades of *C. caliensis* are discolorous and pinkish tan along the major venation on both surfaces, suggesting the possibility of unusual coloration in the living blade. The blades of nine taxa in *Chlorospatha* sect. *Chlorospatha* can be maculate, although this character does not appear to be consistent in those taxa represented by multiple collections: *C. caldasensis*, *C. chocoensis*, *C. cogolloi*, *C. croatianae* subsp. *croatiana*, *C. croatianae* var. *enneaphylla*, *C. kolbii* (Fig. 28A), *C. luteynii*, *C. maculata*, and *C. mirabilis*.

Subepidermal cellular inclusions have been observed in the dried blades of three species. In *C. congensis* and *C. lehmannii*, these are regularly rounded, dark purple-brown speckles that also occur on the lower surface along the veins in the latter species. Cream-colored, linear cellular inclusions were observed only on the lower surface of a developing blade of *C. yaupiensis*. Diffuse, minute green speckles were also observed on the lower surface in *C. congensis*, the nature of which is not known. In *C. cedralensis*, *C. nambiensis*, *C. narinoensis*, and *C. tokioensis*, pale, punctiform, and short, linear raphid cells were observed on the upper surface of dried blades. Diffuse, blotchlike punctuations were observed on the lower surface of the dried blades of the type of *C. grayumii* (30X).

The lower surface of the blades is less frequently reported and thus less well known, but is usually weakly to conspicuously paler than the upper surface and matte to semiglossy, a glossy lower surface having been reported in only four species: Species 3, *Chlorospatha ilensis*, *C. portillae*, and *C. sizemoreae*. Several interesting diagnostic characters have been observed on the lower surface. The lower surface in *C. atropurpurea*, *C. bullata*, *C. castula*, *C. chocoensis*, *C. cogolloi*, *C. hastata* (Fig. 23B), and *C. mirabilis*, is purple, purplish, purple-mottled, or narrowly to broadly marginally discolored (purple) along the midrib and major veins, depending on the species. Of these, only *C. bullata* can also have the surface entirely green. No species from the eastern slopes of the Andes is known to have the lower surface purplish.

In 18 species, the lower surface is consistently conspicuously reticulate, with all orders of venation visibly distinct and usually raised or prominulous in both living and dried material: *Chlorospatha besseae*, *C. bogneri*, *C. boosii*, *C. bullata* (Fig. 8C), *C. corrugata*, *C. dodsonii*, *C. engleri* (Fig. 19D), *C. hannoniae*, *C. limonensis*, *C. longipoda*, *C. macphersonii*, *C. mansellii*, *C. morae*, *C. plowmanii*, *C. pubescens*, *C. sucumbensis*, *C. timbiquensis*, and *C. yaupiensis*. This character is represented in species from both slopes of the Andes in Colombia and Ecuador. Nine of these species exhibit another interesting character, wherein the laminae surface is narrowly colliculate along all veins: *C. besseae*, *C. boosii*, *C. engleri*, *C. hannoniae*, *C. limonensis*, *C. longipoda*, *C. mansellii*, *C. plowmanii*, and *C. pubescens*. In *C. sucumbensis*, the lower surface is also reticulate, but the colliculate border occurs only partially along the tertiary veins and not at all along the reticulate veins. “Colliculate” refers to the densely arranged, minute, rounded elevations comprising this border. In these species, the lower

surface is frequently reported as “matte” when, in fact, usually only the colliculate border is matte and the central portion within the border is usually semiglossy. This is most obvious in the dried material. This character is predominant in the species from the eastern slopes of the Andes in Ecuador, with nine of the 12 species from that region exhibiting this character. In *C. sizemoreae*, the condition is uniquely expressed in that the lower surface of the blade is not reticulate. The tertiary and reticulate veins are neither raised nor prominulous but merely visible and bordered by the colliculate blade surface.

The upper surface of the blade is more or less broadly quilted in most *Chlorospatha*, with the midrib, primary lateral veins, and innermost collective vein moderately to deeply sunken, occasionally with the interprimary and some secondary veins less prominently sunken, and the intervening leaf tissue broadly raised. The interprimary and some secondary veins are also moderately sunken on the blades of *C. dodsonii*, creating a wrinkled-quilted effect (Fig. 18B). In some or all collections of eight species, the blade surface is more or less flat and not broadly quilted: Species 2, Species 3, *C. bayae* (Fig. 7A), *C. croatianae* subsp. *croatiana*, *C. hammeliana*, *C. limonensis*, *C. maculata* (Fig. 34B), and *C. mirabilis*. In these, the midrib, primary lateral veins, and innermost collective vein are narrowly or obscurely sunken, etched-sunken or etched, with the intervening blade surface more or less flat. However, the surface can be quilted in some collections of *C. croatianae* subsp. *croatiana*, *C. hammeliana*, and *C. mirabilis*. *Chlorospatha pubescens* typically has broadly quilted blades, but one collection from the northern limit of its range has flat blades. Blades that are quilted or not, as described above, are considered “smooth.” Ten species have other than smooth blades, seven of which have bullate or sub-bullate blades: *C. bullata*, *C. congensis*, *C. engleri* (Fig. 19B), *C. hannoniae*, *C. macphersonii*, *C. morae*, and *C. munchiquensis*, and possibly also *C. huilensis*, which is reported as having all orders of venation “markedly impressed” on the upper surface in some collections. The living blade of *C. congensis* is not known, but the surface of the dried blade is minutely bullate. The blades are rugose in one species, *C. bogneri*, and corrugate in two species, *C. corrugata* (Fig. 15A) and *C. liensis*, consistently so only in *C. corrugata*.

Blade shape. Blade shape is highly diverse in *Chlorospatha* and can be entire, simple and ovate, oblong, cordate, sagittate, subsagittate, hastate, subhastate, trifid, or pedatifid, or compound and trifid or pedatisect. Blades are not known to be pinnately lobed or pinnately compound in *Chlor-*

ospatha. In some cases, blade shape relates to sectional differences, with *Chlorospatha* sect. *Chlorospatha* including all but one of the taxa with blades that are trifid, trisect, pedatifid, or pedatisect. *Chlorospatha* sect. *Orietales* and *Chlorospatha* sect. *Occidentales* include the remaining species, with one species with trifid to trisect blades assigned to the latter section, *C. corrugata*. Most *Chlorospatha* have blades with weakly developed to well-developed posterior lobes, but most are known only from dried material. Therefore, for the sake of consistency, only the shape of dried blades will be considered in these discussions but with the living blade shape provided in taxonomic descriptions, when known. Blade shape appears to be consistent within an acceptable range of variation in most *Chlorospatha*; however, more variation than is typical occurs in three species with posterior lobes, represented by numerous collections from numerous populations in the Amazon drainage, all members of *Chlorospatha* sect. *Occidentales*: *C. longipoda*, *C. plowmanii*, and *C. pubescens*. These and five other species in the section share the same basic styler morphology and all could probably be easily confused in the juvenile state. The other five species, as well as the remaining species in this section, are known only from one or two collections and it is possible that greater than normal variation in blade shape occurs in these species as well; therefore, it is possible that wide variation in blade shape is normal in most species in section *Orietales* and delimitation of species should be based, for the most part, on floral and other vegetative characters.

Fourteen species with posterior lobes have blades that are more or less narrowly to broadly ovate and cordate, subcordate, cordulate, subsagittate, or occasionally subtruncate at the base. In 16 species with moderately developed to well-developed posterior lobes, the blades are consistently subhastate in seven species, subhastate to hastate in three species, and consistently hastate in six species. The blades are more or less sagittate in 20 species with well-developed posterior lobes, with the shape somewhat variable, as would be expected. These can be narrowly to broadly triangular or have the posterior lobes directed somewhat outward. Three species, *Chlorospatha grayumii* (Fig. 20D), *C. longiloba* (Fig. 31A), and *C. sizemoreae* (Fig. 47A), are unusual in having oblong-elliptic, sagittate blades with the anterior lobes usually conspicuously longer than the posterior lobes. Some collections of *C. longiloba* are subsagittate at the base, with the posterior lobes extremely short (Fig. 29C). The blades of *C. antioquiensis* and *C. bullata* are usually sagittate but can occasionally be ovate-sagittate. Only three

species, *C. oblongifolia* (Fig. 40A), *C. portillae*, and *C. stellasarreae* (Fig. 44D), have blades that are entire, lack posterior lobes, and are usually rounded or acute at the base, rarely weakly subcordate or cordulate. The blades of *C. oblongifolia* are usually oblong, but can be ovate-elliptic, as can those of *C. stellasarreae*, which are usually merely ovate. Those of *C. portillae* are narrowly ovate.

The apex is usually more or less acuminate in species with undivided blades, and can be briefly, weakly, gradually, abruptly, broadly, or narrowly acuminate, or weakly to prominently long-acuminate. In eight species, the apex can be acute and in eight additional species, apiculate, or also more or less acuminate in all of these. *Chlorospatha atropurpurea* and *C. timbiquensis* exhibit the broadest range of variation, the apex being acute, gradually acuminate, or long-acuminate. The apex is less variable in most species. Numerous species are known only from one or two collections; therefore, the consistency or variability of the character on the species level cannot be determined with certainty.

A useful taxonomic character in species with posterior lobes is the amount of constriction in the area of petiole attachment. Of the 50 species with posterior lobes, there is little or no constriction of the blades in 30 species with weakly to moderately developed posterior lobes, including most species with ovate or sagittate blades as well as numerous species with well-developed posterior lobes. Ten species with well-developed posterior lobes have the blades weakly to moderately constricted, but only on one side in one of these species, *Chlorospatha mansellii*. Blades constricted only on one side were observed in two additional species, *C. carchiensis* and *C. giraldoi*, in which the constriction was moderate or prominent and which occurred only occasionally in the latter species. Moderately to prominently constricted blades are found in *C. grayumii*, *C. hammeliana*, and *C. pubescens*, although the character is not consistent in *C. hammeliana* and *C. pubescens*. The blades of the latter species are usually only moderately constricted, rarely prominently so, and those of *C. hammeliana* can also be weakly or not at all constricted. Six species are quite distinctive, having hastate blades with both the anterior and posterior lobes prominently constricted at their bases or occasionally only moderately so: *C. dodsonii*, *C. hastata* (Fig. 23B), *C. ilensis* (Fig. 26D), *C. litensis*, *C. nambiensis*, and *C. narinoensis*.

Nineteen taxa from Costa Rica, Panama, and western Colombia and Ecuador, but not known from the eastern slopes of the Andes, can have divided and simple (i.e., with the lobes not divided to the base) or

compound leaf blades (i.e., with the segments totally free at the base): *Chlorospatha betancurii*, *C. caldasensis*, *C. callejasii*, *C. cedralensis*, *C. chocoensis*, *C. cogolloi*, *C. corrugata*, *C. croatian* subsp. *croatiana*, *C. croatian* var. *enneaphylla*, *C. gentryi*, *C. hammeliana*, *C. ilensis*, *C. kolbii*, *C. kressii*, *C. luteynii*, *C. maculata*, *C. mirabilis*, *C. morae*, and *C. risaraldensis*. Divided blades occur on all growth in all of these taxa except *C. hammeliana* and *C. ilensis*. Typical blades of *C. hammeliana* are more or less ovate-cordate, but one sterile specimen of what is presumably a collection of this species has a 3-lobed blade. Blades can be hastate or subhastate as well as 3-lobed in *C. ilensis*. Divided blades are usually about as wide as or wider than long and, in most taxa, trifid or pedatifid, deeply lobed, and narrowly to moderately confluent between segments, with the confluent portion usually 0.2–3(–4) cm wide. Nine species have 3-lobed blades, *C. betancurii*, *C. callejasii*, *C. chocoensis*, *C. corrugata*, *C. hammeliana*, *C. ilensis*, *C. maculata*, *C. mirabilis*, and *C. risaraldensis*. Among the pedatifid taxa, *C. caldasensis*, *C. croatian* subsp. *croatiana*, and *C. luteynii* are usually 5-lobed, with *C. croatian* subsp. *croatiana* occasionally having blades that are 3-lobed and prominently auriculate. The blades of *C. croatian* var. *enneaphylla* are 5- to 9-lobed, those of *C. kolbii*, (7- to)9- to 14(15)-lobed, and those of *C. kressii*, 11- to 13(14)-lobed. The blades of only three taxa are consistently compound, but several taxa can consistently or usually have blades that are nearly so and either alate or with the confluent portion less than 4 mm wide or as little as 0.5 mm wide in some species, in dried material: *C. callejasii*, *C. corrugata*, *C. croatian* var. *enneaphylla*, *C. kressii*, *C. maculata*, and *C. risaraldensis*. This portion is usually 5–10 mm wide in *C. mirabilis*, but the blade of one collection is trisect, at least in the dried material. *Chlorospatha corrugata* can also have trisect blades when mature. The blades of *C. cogolloi* are usually trisect, but can be trifid, with the confluent portion usually 1–3 mm wide. The consistently pedatisect species are *C. cedralensis* with five lobes, *C. gentryi* with five to seven lobes, and *C. morae* with five to nine lobes. The degree to which lobes are confluent is consistent within an acceptable range on the species level.

Segments in all taxa with divided blades are usually narrowly to broadly ovate or elliptical, occasionally obovate, but in *Chlorospatha kolbii* and *C. kressii*, these are narrowly oblong-elliptic, lanceolate, or oblanceolate. Segments are also usually more or less acuminate at the apex, occasionally acute, with the medial lobe more or less symmetrical and the lateral lobes weakly to prominently inequilateral, with

the inner sides progressively narrower and the segments progressively shorter toward the outermost lobes in those taxa with more than three lobes. In 3-lobed species, the lateral lobes are usually weakly to moderately shorter than and of approximately the same width as the medial lobe or somewhat narrower. In only a few species are the lateral lobes as long as or slightly longer than the medial lobe, and only in *C. corrugata* and *C. risaraldensis* are they also conspicuously wider than the medial lobe. The comparative lengths and widths of medial and lateral lobes are useful characters in delimiting species. In all taxa with divided blades except *C. chocoensis*, the posterior side of the outermost segment is decurrent onto the posterior rib, at the base. In *C. chocoensis*, this side is decurrent onto the petiole. The nature of attachment on the posterior side of the outermost segments can also be useful and, in some cases, diagnostic. Such is the case in *C. croatian* subsp. *croatiana* and variety *enneaphylla*, with this portion acute toward the base in the latter taxon, but more or less rounded or auriculate in variety *croatiana*. Both can have five lobes, but the nature of attachment of the segments is one of the characters that serves to differentiate the two. These taxa illustrate another useful character, that being the nature of attachment of the lobes at the base, which can be narrow or broad, relative to the width of the lobe. In *C. croatian* var. *enneaphylla*, the attachment is conspicuously narrow, whereas in variety *croatiana*, the attachment is comparatively broad. While lobed leaves in some Araceae, e.g., *Monstera* Adans., are due to necrotic processes in which growth stops and tissue rots away (Madison, 1977), the lobed leaves of *Chlorospatha* result from differential growth of leaf tissue.

Little is known of the blade margins in most taxa, beyond the fact that these are usually smooth, except as regards constrictions in the area of petiole attachment or at the bases of anterior and posterior lobes. Margins are rarely weakly sinuate, this character being obvious but inconsistent in some collections of *Chlorospatha croatian* subsp. *croatiana* and *C. mirabilis*, and so weakly expressed in a few additional taxa as to be insignificant. Several species are known to have blades with more or less undulate margins, these being crispate-undulate in *C. engleri*, *C. gentryi*, and *C. sagittata*, narrowly undulate in *C. kolbii*, *C. kressii*, and *C. plowmanii*, and broadly undulate in *C. longipoda*, *C. plowmanii*, and *C. pubescens*. One collection of the last species has crispate-undulate blades. The presence of undulate margins and the nature of their expression are consistent on the species level. Undulate margins

would be expected to occur in other species, given the thin to thinly coriaceous texture of blades usually observed in *Chlorospatha*.

Posterior lobes. The shape of posterior lobes varies greatly in *Chlorospatha*. In those species with the blades more or less ovate and cordate, sagittate or subsagittate at the base, the lobes are usually broadest at the base and approximately as long as wide, with the apex usually narrowly to broadly rounded or bluntly rounded, e.g., *C. besseae*, *C. limonensis*. The typical blade of *C. hammeliana* is more or less ovate-cordate, with the posterior lobes approximately as long as wide, but the blade shape of this species is one of the most variable in the genus and can also be sagittate or subhastate at the base, with the posterior lobes as much as 2.3 times longer than wide, or sub-3-lobed or 3-lobed. Weakly developed posterior lobes also occur in species with blades that are frequently cordulate at the base, e.g., *C. bogneri*. Species with ovate-cordate and ovate-sagittate blades, and most species with sagittate blades, usually have relatively short posterior lobes, with the anterior lobe about 2 to 3.5 times longer than the posterior lobes, occasionally more than 4 times longer in *C. bogneri*, *C. grayumii*, *C. limonensis*, *C. longiloba*, *C. longipoda*, and *C. macphersonii*. The anterior lobe can be more than 10 times longer than the posterior lobes in *C. longipoda* and as much as 5.4 times longer in *C. longiloba*.

The remaining species with posterior lobes are sagittate, sagittate-subhastate, subhastate, or hastate, with the posterior lobes usually narrowly to broadly triangular or oblong, and acute, bluntly acute, narrowly rounded, or bluntly rounded at the apex, but more or less acuminate at the apex in nine species. The posterior lobes are usually broadest at the base, but can be broadest slightly above the base or midway in some species with the base constricted. The posterior lobes of most species with sagittate or sagittate-subhastate blades are from 1.5 to 2.8 times longer than wide, but those of *Chlorospatha castula* and *C. grayumii* are unusually narrow, usually between 3.1 and 4.3 times longer than wide. Such narrow lobes are usually confined to species with subhastate or hastate blades. The blades of *C. longiloba* can be either sagittate or subsagittate at the base and are unusual in having posterior lobes that can be either short or moderately long, relative to the length of the anterior lobe, with the shorter posterior lobes slightly longer than wide and broadly rounded at the apex, and the longer lobes 2 to 3 times longer than wide and narrowly rounded at the apex.

Species with subhastate to hastate blades usually have narrow posterior lobes, 3 to 4 times longer than

wide, but these can be approximately 5 times longer than wide in *Chlorospatha giraldoi* and *C. narinonensis*. The posterior lobes can be broader in some of these species, less than 3 times longer than wide, notably in species from the eastern slopes of the Andes in Ecuador: *C. plowmanii*, *C. pubescens*, and *C. succumbens*. The posterior lobes in these species are also comparatively short for subhastate to hastate species, with the anterior lobe approximately 2 times longer than the posterior lobes, all other such species usually having the anterior lobe only 1.1 to 1.5 times longer than the posterior lobes, or equal in length in some collections of *C. nambiensis*. The posterior lobes of *C. dodsonii* and *C. ilensis* are also broad for hastate species, less than 3 times longer than wide, occasionally as little as 2 times longer than wide. *Chlorospatha planadensis*, a subhastate species, has a broadly triangular blade with conspicuously broad posterior lobes only 1.4 to 1.7 times longer than wide.

The sides of posterior lobes, as defined by the position of the posterior rib, are more or less symmetrical or weakly to moderately unequal in most species of *Chlorospatha*, regardless of blade shape, with the posterior side narrower and the anterior side no more than 2.3 times wider than the posterior side at the midpoint of the lobe, with few exceptions. In 12 species, the sides can be markedly inequilateral, with the outer side between 3 and 6 times wider than the inner side midway, depending on the species: *C. amalfiensis*, *C. besseae*, *C. bogneri*, *C. boosii*, *C. bullata*, *C. hannoniae*, *C. limonensis*, *C. longiloba*, *C. longipoda*, *C. queremalensis*, *C. timbi-quensis*, and Species 1, although the ratio can be less. Four species exhibit an unusual condition, wherein the anterior side is narrower than the posterior side, *C. dodsonii*, *C. hammeliana*, *C. ilensis*, and *C. litensis*, although the sides can be more or less symmetrical in some specimens of all four species. Typically, when the posterior lobe is inequilateral, the posterior side is narrower than the anterior side and only on the lateral lobes of divided leaf blades is the posterior side wider than the anterior side. The blades of these four species would, in this sense, appear to be intermediate between taxa with divided blades and those with posterior lobes. The blades of *C. dodsonii* and *C. litensis* are consistently prominently hastate, whereas those of *C. hammeliana* are typically ovate-cordate but can be sagittate, subhastate, sub-3-lobed or 3-lobed. The blades of *C. ilensis* can be subhastate, hastate, or 3-lobed. Interestingly, the morphology of the pistils in both *C. hammeliana* and *C. ilensis* is the same as that otherwise found only in taxa with consistently divided blades, but that of *C. dodsonii* and *C. litensis* is not.

Species with posterior lobes are almost evenly divided between those with the inner side of the lobes decurrent onto the posterior rib at the base and those with that side decurrent onto the petiole. The character is consistent in all but a few species that usually have the inner side decurrent onto the posterior rib, with the rib naked less than 5 mm, but occasionally have the inner side decurrent onto the petiole. Eight species are unusual in having the inner sides of the posterior lobes narrowly confluent at the base, thus obscuring the petiole apex: *Chlorospatha amalfiensis*, *C. antioquiensis*, *C. graymii*, *C. huilensis*, *C. jaramilloi*, *C. longiloba*, *C. macphersonii*, and Species 4. Although some of these species are known only from single collections, several are represented by multiple collections that would indicate consistency in this character. This condition is frequently difficult to determine in dried material and possibly occurs also in *C. bullata*, *C. giraldoi*, and Species 1, in which the base of the inner side appears to be either decurrent onto the petiole or terminated at the petiole apex.

Sinus shape. Species of *Chlorospatha* with posterior lobes exhibit significant variation in the shape of the sinus of the mature blades, both between and within species; therefore, the character does not appear to be particularly useful on the species level. The shape of the sinus can vary between juvenile blades and mature blades, among different mature blades, and between the living and dried blades of a given species. However, the most common sinus shapes associated with a given species are presented here. The description of the sinus, as presented in this work, is exclusively that of the dried mature blade unless otherwise stated. *Chlorospatha mansellii* has living blades that are subhastate, with the posterior lobes usually overlapping and the sinus rhombic, but which are usually hastate on drying, with the sinus arcuate. In approximately half of all species, the sinus is usually arcuate, narrowly or broadly V-shaped, or V-shaped and narrowly rounded at the apex. *Chlorospatha hammeliana* is a variable species in which the sinus can be narrowly V-shaped, triangular or completely closed, with the posterior lobes overlapping. In *C. pubescens*, the sinus is usually arcuate (for definitions of sinus shapes, see Croat & Bunting, 1979), but can occasionally be oblong. Of the remaining 20 species, the sinus is usually parabolic in seven species, e.g., *C. giraldoi*, lanceolate in five species, e.g., *C. castula*, oblong in four species, e.g., *C. queremalensis*, spatulate in two species, e.g., *C. bayae*, and rhombic in three species, e.g., *C. carchiensis*. The sinus shape can be variable in these species also, as in *C. huilensis*, in which the

sinus is usually parabolic but can be oblong when the sinus is more closed. In all cases, the shape of the sinus can vary according to the degree of maturity of the blades. There is no apparent difference in the shape of the sinus of foliage and sympodial leaves.

Blade size. Blades of *Chlorospatha* are highly diverse in size, but those of most taxa are 20–50 cm long, with most less than 40 cm long. Only six species have blades more than 50 cm long, *C. atropurpurea*, *C. cogolloi*, *C. croatica* subsp. *croatica*, *C. graymii*, *C. mirabilis*, and *C. sagittata*, and of these, only *C. graymii* has blades more than 60 cm long, the longest in the genus. Four species have blades less than 20 cm long, Species 1, *C. bogneri*, *C. stellararreae*, and *C. timbiquensis*, with *C. stellararreae* having the smallest in the genus, less than 10 cm long. Most of the largest blades occur in taxa with divided blades; however, the blades of *C. gentryi* and *C. kressii*, pedatisect and pedatifid, respectively, are comparatively small, less than 30 cm long, and approximately as wide as long, as is typical of taxa with divided blades. In some cases, blade size can be a reliable taxonomic character, but the ratio of the length of a blade to its width is more useful and appears to be correlated with the overall shape of the blade. All taxa with divided or hastate blades have blades approximately as wide as long, less than 1.3 times longer than wide, and in some cases, wider than long. More than half of species with subhastate blades would also fall into this category, *C. cutucuensis*, *C. giraldoi*, *C. noramurphyae*, *C. planadensis*, and *C. tokioensis*, although these species can also have blades to as much as 1.5 times longer than wide. *Chlorospatha yaupiensis* is the only species among those with ovate or sagittate blades that has blades approximately as wide as they are long. Twenty-four species have blades approximately 1.5 to 2 times longer than wide, representing all ovate (except *C. yaupiensis*), ovate-cordate (or cordulate), most sagittate, and three subhastate species, these last being *C. atropurpurea*, *C. lehmannii*, and *C. mansellii*. *Chlorospatha atropurpurea* can also have sagittate blades. There is occasional variation of the ratio in these subhastate species, and the blades can be as little as 1.3 times longer than wide or as much as 2.2 times longer than wide. Eight species have blades 2 to 3 times longer than wide, seven with sagittate blades (Species 2, Species 4, *C. caliensis*, *C. carchiensis*, *C. congensis*, *C. engleri*, and *C. huilensis*) and one with subhastate blades, *C. nicolsonii*. The remaining five species are distinctive, all having more or less oblong-elliptic blades. Of these, *C. graymii*, *C. longiloba*, and *C. sizemoreae* have blades that are sagittate or subsagittate at the base

and between 2.7 and 4.4 times longer than wide. *Chlorospatha oblongifolia* and *C. portillae* have blades that are rounded or acute at the base and 3.5 to 5.6 times longer than wide and (1.3 to)2.5 to 3.3 times longer than wide, respectively.

Venation of the midribs and major veins. The extent to which the midrib and major veins are sunken (or not) on the upper surface, raised (or not) on the lower surface, and their shape and coloration in both living and dried material are usually consistent within a narrow range in all but a few species, and therefore are taxonomically significant characters. Midribs and major veins on the upper surface of the blades of *Chlorospatha* are usually more or less flat and featureless, with the margins obscure, with three exceptions. The midrib of the living blade is bluntly angular in *C. limonensis* and weakly convex, with the major veins also weakly convex in *C. mansellii*. Only the dried blades of *C. yaupiensis* are known, but the midrib and major veins dry convex toward the base. In those taxa in which the character is known, the midrib is deeply sunken in 23 taxa, moderately sunken in 12 species, and narrowly sunken in five species, with the character consistent in all but a few species. In *C. engleri*, *C. hastata*, *C. litensis*, and *C. longiloba*, the midrib can occasionally be either narrowly or deeply sunken, and in *C. mirabilis*, the midrib can be obtusely or deeply sunken. In *C. croatica* subsp. *croatica*, the most variable species, the midrib is also variable and can be obtusely, moderately, or deeply sunken. This aspect of the midrib is consistently duplicated in the major veins in all but four species. In Species 1, Species 3, *C. limonensis*, and *C. longiloba*, the midribs are moderately to deeply sunken or narrowly sunken, whereas the major veins are etched, etched-sunken, narrowly sunken, or obtusely sunken and, in all cases, less prominently sunken than the midrib. This condition occurs also in the northernmost population of *C. pubescens*. Only in *C. pubescens* can the midrib and major veins be entirely sparsely crispy-puberulent on the upper surface or only toward the base, these being glabrous in all other *Chlorospatha*. The midrib and major veins on the upper surface are concolorous in most taxa but can consistently or occasionally be weakly to moderately paler in living material of nine species, *C. besseae*, *C. engleri*, *C. hammeliana*, *C. limonensis*, *C. maculata*, *C. mansellii*, *C. mirabilis*, *C. morae*, and *C. ricaurtensis*, and possibly also in *C. bullata* and *C. congensis* in which the midrib and major veins dry weakly to moderately paler than the surface. In *C. sizemoreae*, the midrib is paler than the upper surface and the major veins are moderately darker.

The midrib and major veins on the lower surface exhibit more variation and a number of useful characters that appear to be consistent on the species level, the cross-sectional shape being one of these. This character is not frequently reported on herbarium labels but can usually be ascertained in most cases, with an acceptable degree of certainty, unless the veins dry flattened. No taxon of *Chlorospatha* is known to have the living midrib or major veins flat on the lower surface. In 49 species, the midrib is consistently round-raised on the lower surface, with two exceptions. In *C. mirabilis*, the midrib can also be narrowly angular or acutely raised, and in *C. croatianae* subsp. *croatiana*, the midrib can be acutely raised or convex. "Round-raised" is the most extreme type of raised midrib and appears to be a cylinder attached tangentially to the surface of the leaf (Croat, 1997). The major veins are also round-raised in most species with round-raised midribs but are consistently convex in 15 species with round-raised midribs. In *C. besseae* and *C. bullata*, the major veins are also usually round-raised but can be narrowly raised in the first species and convex in the latter. A few species in this group exhibit interesting variation, with the midrib and major veins round-raised but also obtusely angular in *C. pubescens* and *C. boosii*, the midrib obtusely angular and the major veins acutely angular in the northern population of *C. pubescens*, and the midrib round-raised and the major veins convex and obtusely angular in *C. hannoniae*. The midrib of *C. kolbii* can also occasionally be acutely 1-ribbed medially. Both the midrib and major veins are consistently convex on the lower surface in 12 species, narrowly round-raised in four species, and narrowly raised in two species, with two exceptions. In *C. longipoda*, the midrib and major veins can be narrowly round-raised, round-raised, or convex. In *C. longiloba*, the midrib is usually narrowly round-raised but can occasionally be round-raised, with the major veins either convex or acutely raised.

In most taxa, the midrib and major veins lack ribs and are glabrous or weakly granulose on the lower surface. In nine species, the midrib and major veins are consistently minutely ribbed: *Chlorospatha bogneri*, *C. cogolloi*, *C. engleri*, *C. hastata*, *C. kolbii*, *C. litensis*, *C. morae*, *C. pubescens*, and *C. sagittata*. Eleven species have granulose, granular-puberulent, minutely puberulent, or crispy-puberulent midribs, and major veins: *C. bogneri*, *C. bullata*, *C. castula*, *C. congensis*, *C. corrugata*, *C. engleri*, *C. gentryi*, *C. kressii*, *C. pubescens*, *C. timbiquensis*, and *C. yaupiensis*. Terminology is defined above under section Petiole Surfaces. Interestingly, three of these species

also have minutely ribbed midribs and major veins, *C. bogneri*, *C. engleri*, and *C. pubescens*, with the puberulence occurring along the ribs. In all taxa, if the midrib and major veins are glabrous, ribbed, or puberulent, the given character(s) are usually to some degree duplicated on the posterior rib and petiole and are consistent on the species level.

The color of the midrib and major veins on the lower surface of the blades of living plants is known in 31 taxa and is green in all but five species, *Chlorospatha atropurpurea*, *C. castula*, *C. cogolloi*, *C. hastata*, and *C. mirabilis*, wherein these are more or less purple, as is the lower surface of the blade in most collections. It is likely that all species that have blades that are purplish on the lower surface also have purplish midribs and major veins. Accordingly, it is likely that the midrib and major veins of *C. caldasensis*, which has brown blades, are brown. In 24 of the 26 taxa with green midribs and major veins, these are consistently either concolorous, weakly paler or weakly darker than the lower blade surface, with slight variation in a few species, such as *C. longipoda*, in which these can be either concolorous or weakly darker than the surface. Those of *C. croatianae* subsp. *croatiana* exhibit the most variation, ranging from concolorous to moderately darker than the surface.

The drying color of the midrib and major veins on the lower surface can be a useful character, particularly in cases that deviate from the typical condition observed in 32 species of drying weakly or moderately darker than the surface. The drying color of the midrib and major veins is usually identical and usually varies within a narrow range in a given taxon, with the greatest variation exhibited in *Chlorospatha croatianae* subsp. *croatiana* and *Chlorospatha* var. *enneaphylla*, in which these can dry concolorous, weakly paler or weakly, moderately, or conspicuously darker than the surface. *Chlorospatha lehmannii* is unusual in having the midrib drying concolorous to weakly darker than the surface and the major veins drying moderately to conspicuously darker. The midrib and major veins dry more or less consistently conspicuously darker than the surface, frequently almost black, in 10 species, e.g., *C. luteynii*, purplish in two species, *C. atropurpurea* and *C. hastata*, more or less concolorous to weakly paler or weakly darker than the surface in 21 species, e.g., *C. bogneri*, and usually paler than the surface in five species, *C. bayae*, *C. munchiquensis*, *C. noramurphyae*, *C. sagittata*, and *C. sucumbensis*. The midrib, major veins, and some minor veins also dry more or less wrinkled only in *C. bayae* and *C. congensis*, possibly because the blades in both species dry subcoria-

ceous, unlike those of most taxa, which dry thin to thinly coriaceous.

Primary lateral veins. The primary lateral veins in *Chlorospatha*, previously referred to as “major veins” (see Venation of the Midribs and Major Veins above) and referred to by some authors as “secondary veins” are those that branch pinnately off the midrib and extend uninterrupted and usually unbranched, uniting in a submarginal collective vein. This use of primary lateral veins is consistent with that of Engler and Krause, who referred to these as “nervis primariis lateralibus.”

The primary lateral veins and midrib are typically similar on each surface of the blade, with the primary lateral veins always more or less raised on the lower surface, though frequently somewhat less raised than the midrib. In species with undivided blades, the number of primary lateral veins varies from as few as two to three pairs in *Chlorospatha amalfiensis* and Species 4, to as many as eight to 10 pairs in six species. Thirty-three species have between four and eight pairs of primary lateral veins, and 15 species usually have three to four pairs, including most species from the eastern slopes of the Andes in Ecuador. In taxa with divided blades, the number of pairs of primary lateral veins on the medial and lateral lobes can be the same or different, depending on the taxon, thus rendering the distinction taxonomically significant. The number of pairs are more or less the same on medial and lateral segments in 10 taxa and different in six species. Of the six species with the number of pairs different on the medial and lateral segments: *C. betancurii* has six pairs on the medial and seven to eight pairs on the lateral; *C. caldasensis* has five pairs on the medial and seven to eight pairs on the lateral; *C. callejasii* has five pairs on the medial and nine to 11 pairs on the lateral; *C. corrugata* has four to six pairs on the medial and eight to 10 pairs on the lateral; *C. maculata* has six to eight pairs on the medial and seven to 10 pairs on the lateral; *C. risaraldensis* has six to eight pairs on the medial and eight to 11 pairs on the lateral. *Chlorospatha luteynii* is unusual in occasionally having fewer pairs of primary lateral veins on the lateral lobes than on the medial lobe, the converse being the typical condition. The medial lobe is not entirely known in one species, *C. cedralensis*. *Chlorospatha croatianana* var. *enneaphylla*, *C. kolbii*, and *C. kressii* consistently have two to four pairs on all segments. Most species have four to six pairs on the medial segment, with only *C. mirabilis* having as few as three pairs; *C. croatianana* subsp. *croatiana* and *C. morae* as many as seven pairs; *C. maculata* as many as eight pairs; and *C. cogolloi* as many as 10 pairs, the most known. The number of pairs of primary lateral

veins is consistent within an acceptable range of variation and, therefore, is taxonomically significant.

The primary lateral veins arise from both sides of the midrib of the anterior lobe at between 30° and 65° in most species with undivided blades and on the medial lobes of most species with divided blades. In those species with undivided blades, some of the primary lateral veins can arise at an angle of as little as 15°–25° in 13 species, to as much as 75°–85° in six species, and as much as 90° in three species, these last being *Chlorospatha antioquiensis*, *C. bullata*, and *C. ilensis*. *Chlorospatha munchiquensis* has an asymmetrical anterior lobe and is unusual in having the veins arising at 50°–60° on the broad side and 35°–45° on the narrow side. Among taxa with divided blades, three taxa are unusual in having the veins on both the medial and lateral segments arising only at consistently more acute angles, 15°–30° in *C. croatianana* var. *enneaphylla* and 10°–30° in *C. kolbii* and *C. kressii*. The angle at which the veins arise on the lateral lobes can be the same as, but is usually moderately to markedly greater than, the maximum angle observed on the medial lobe. The lateral veins on the lateral lobes of 3-lobed blades are frequently aggregated toward the base on the posterior side, with some aggregated veins arising at as much as 90° in *C. chocoensis*, 110° in *C. maculata*, and 120° in *C. callejasii*. The angle is usually most acute toward the apex of all lobes or segments, in all taxa, regardless of blade shape. The veins usually ascend in a broad arc and are consistently weakly to moderately arcuate in most taxa, but can be markedly arcuate, straight, or occasionally irregularly ascending in some taxa, meaning that some veins are not evenly curved or straight.

Collective veins. The primary lateral veins ascend toward the margin of the blade and are loop-connected, forming a submarginal collective vein, the innermost of a series of collective veins that run more or less parallel to the margin, with the innermost raised on the lower surface and more or less sunken on the upper surface in a manner similar to but usually less pronounced than that of the primary lateral veins, in both living and dried blades. All but 17 taxa of *Chlorospatha* consistently have only three collective veins. Six species have two to three collective veins. Eleven taxa consistently have three to four collective veins, with three of these taxa, *C. pubescens*, *C. croatianana* subsp. *croatiana*, and variety *enneaphylla*, occasionally having only two. One species, *C. caliensis*, has no less than four collective veins.

The innermost vein is rarely precisely parallel to the margin, but is usually to some degree scalloped,

being indented at the points of union with the primary lateral veins and thus farther from the margin at these points. In 23 species, the collective vein is more or less parallel to the margin or occasionally slightly scalloped, with the indentation slight. Most of the remaining taxa have a weakly to moderately scalloped vein, with the indentation more pronounced. In 10 taxa, the collective vein is markedly scalloped, with the indentation conspicuous, and also markedly remote from the margin, relative to blade size. The collective vein is 3–10 mm from the margin in most taxa of *Chlorospatha*, occasionally 1–2 mm more, with the maximum measurement made from the margin to the union with the primary lateral vein. In those taxa with markedly scalloped collective veins, the maximum measurement can be 18–25 mm in some, to as much as 28 mm in *C. hammeliana*, with the minimum measurement similar to that observed in most taxa but the maximum measurement significantly greater. Several species with markedly scalloped collective veins, *C. kolbii*, *C. kressii*, and *C. limonensis*, have relatively small blades or lobes, and the maximum measurement falls between 8 and 10 mm but is, relative to blade size, markedly remote from the margin. *Chlorospatha gentryi* has a compound blade with relatively small segments and a collective vein that is both markedly scalloped and remote from the margin, as much as 15 mm from the margin. In only five species is the collective vein weakly to moderately scalloped and also markedly remote from the margin, relative to blade size: *C. bogneri*, *C. bullata*, *C. cogolloi*, *C. maculata*, and *C. pubescens*. The outer collective veins are typically aggregated against the margin, with those of *C. bullata* being a noteworthy exception, the vein adjacent to the innermost collective vein also being remote from the margin (on mature blades).

The collective vein typically arises from the base or from one of the lowermost lateral veins of the posterior or lateral lobe, in most taxa, but can arise either from the apex of the posterior rib or one of the lowermost lateral veins on the proximal side of the posterior lobe in six species (i.e., from the lowermost pair of veins on the posterior lobe). In four species, the vein usually arises only from the apex of the posterior rib, *Chlorospatha boosii*, *C. hannoniae*, *C. sizemoreae*, and *C. timbiquensis*. Typically, the collective vein is continuously loop-connected with all preceding lateral veins from its point of origin to the apex of the blade in mature plants. In one collection of *C. bullata* (Croat 50189), the collective vein on one side of the mature blade is continuous from the lowermost basal vein on the outer side (proximal side) of the posterior lobe to the apex of the

anterior lobe and does not intersect the three primary lateral veins on the anterior lobe. Each of the primary lateral veins forms a broad arc that terminates at the midrib apex, a condition occasionally observed in some juvenile blades in other species.

Basal veins. Primary lateral veins arising at the petiolar plexus, the junction of the blade, and apex of the petiole are herein referred to as “basal veins” (see Croat & Bunting, 1979). The first basal vein and occasionally the second usually extend upward into the anterior lobe, with the remaining veins extending into the posterior lobes. The veins extending into the posterior lobes are usually paired, with an equal number on either side of a prominent posterior rib almost as long as the posterior lobe and weakly coalesced into and branch from a posterior rib conspicuously shorter than the lobes. The number of pairs of basal veins ranges from one to nine, with 26 species having three to seven pairs, 13 species having one to three pairs, and only five species having as many as seven to nine pairs, but frequently as few as five or six pairs. Only four species, *Chlorospatha bogneri*, *C. boosii*, *C. hannoniae*, and *C. timbiquensis*, consistently have one to two pairs. Basal veins are lacking in the three species without posterior lobes, *C. oblongifolia*, *C. portillae*, and *C. stellararreae*.

Posterior ribs. The basal veins are usually to some extent coalesced near their union with the petiole, forming what is herein referred to as the “posterior rib” (see Croat & Bunting, 1979). The first basal vein is usually free to the base at the apex of the petiole and can be briefly fused very near the base with a second basal vein, with the remaining veins loosely coalesced for a short distance into a weak posterior rib or completely coalesced, forming a prominent posterior rib extending from the base almost to the apex of the posterior lobe. Both the number and nature of basal veins and the relative length of the posterior rib are useful taxonomic characters. Species with cordate blades and well-developed posterior lobes can have the posterior rib almost as long as the posterior lobe, e.g., *Chlorospatha besseae*, or conspicuously shorter, e.g., *C. macphersonii*. In *C. hammeliana*, the rib can be much shorter than the posterior lobe, with the basal veins loosely coalesced or almost as long as the posterior lobe, with the basal veins coalesced into a prominent posterior rib. Species with ovate-sagittate blades that are subsagittate or cordulate at the base, such as *C. bogneri* and some collections of *C. longipoda*, typically have relatively short posterior ribs that can be as little as 5 mm long in some

collections and notably shorter than the posterior lobes. The posterior rib is between 6 and 14.5 cm long in 37 species, eight of which can have ribs 14.5–17.5 cm long. In eight additional species, the rib can be as much as 18–24 cm long, with that of *C. sagittata* being as much as 25 cm long and that of *C. ilensis* as much as 28 cm long, the longest known in the genus, although in all cases, the rib can be shorter, depending on the length of the posterior lobe.

An important taxonomic character is the extent to which the posterior rib is naked (or not) along the sinus. Thirty-nine taxa have a naked posterior rib. All taxa with divided blades, except one, have the posterior rib conspicuously naked, to as much as 8 cm on each side in *Chlorospatha croatica* var. *enneaphylla*. In *C. chocoensis*, the margin of the lateral lobe is decurrent onto the petiole; therefore, the posterior rib is not naked. Most species with well-developed posterior lobes also have the posterior rib naked from a few millimeters to 1.5 cm on each side of the petiolar plexus, or between 2 and 3.5 cm in *C. atropurpurea*, *C. castula*, *C. hastata*, and *C. ilensis*. In *C. hammeliana*, *C. ilensis*, and *C. pubescens*, the posterior rib can be naked or the posterior lobe can occasionally be decurrent onto the petiole, at the base. A number of species with well-developed posterior lobes, the three species with entire blades that are rounded or acute at the base, and most species with ovate-sagittate blades and weakly developed posterior lobes have blades that are decurrent onto the petiole, a total of 22 species. An unusual condition has been observed in eight species in which the laminar tissue is narrowly confluent between the posterior lobes at the base, obscuring the petiole apex: Species 4, *C. amalfiensis*, *C. antioquiensis*, *C. grayumii*, *C. huilensis*, *C. jaramilloi*, *C. longiloba*, and *C. macphersonii*. The condition possibly occurs in three species in which the blades are herein described as decurrent onto the petiole or terminating at the petiole apex, Species 1, *C. bullata*, and *C. giraldoi*, all known only from dried material in which this condition is difficult to determine with certainty.

Lesser order veins. Venation in most *Chlorospatha* is “colocasioid,” with the lesser order venation branching at nearly right angles from the primary lateral veins, then arching strongly toward the margin and usually fusing to form a more or less distinct and usually sinuose interprimary collective vein that unites with the submarginal collective vein (Mayo et al., 1997). However, venation is reticulate in some species. Lesser order veins are herein referred to as “minor veins.” In *Chlorospatha*, the interprimary collective vein is frequently prominently sinuose but can be somewhat straight in some taxa. In a few

species of *Chlorospatha*, there are also intermediate primary lateral veins, herein referred to as “interprimary veins” that arise at the midrib and extend more or less parallel to the primary lateral veins, from the midrib to the submarginal collective vein, without major branching. These are similar to but less prominent than primary lateral veins but are too prominent to be classified as minor veins. There is usually no more than one between each pair of primary lateral veins, but occasionally two may be present. Minor veins arise along the margins of these veins as they do along the margins of primary lateral veins. Some interprimary veins have been observed in 22 species, but occur with some consistency in only eight species, and only in *C. bayae*, *C. corrugata*, *C. morae*, *C. risaraldensis*, and *C. stellasarreae* is their occurrence consistent. Even in these, the veins do not occur between all primary lateral veins.

The most prominent minor veins are the secondary lateral veins that arise from both the midrib and primary lateral veins. These are second order veins based on prominence and thickness (on the lower surface). Secondary veins are structurally indistinct and usually concolorous on the upper surface of the blade and, therefore, characterized only by the extent to which they are sunken or not on that surface. All or some secondary veins are weakly to moderately sunken in valleys in numerous taxa and etched, etched-sunken, or obscure in other taxa. Secondary veins are raised or occasionally in part prominulous on the lower blade surface in all taxa of *Chlorospatha*, usually weakly to moderately so, but prominently so in 11 species, most of which have a reticulate lower blade surface. Secondary veins also dry weakly, moderately, or prominently raised, or in part prominulous on the lower surface in almost all taxa, occasionally in part flattened in some taxa, rarely flat, e.g., in *C. lehmannii*, and usually weakly to moderately darker than the surface, although they can occasionally dry concolorous, weakly paler, or conspicuously darker than the surface in some taxa.

Tertiary veins, third order veins based on prominence and thickness on the lower blade surface, are more or less perpendicular to all of the more prominent veins, including the midrib, and are to some extent visible or otherwise distinct on the lower surface of the blade in most taxa. This character is not frequently reported but can be determined with reasonable certainty in dried material of most taxa. The tertiary veins are raised or prominulous on the lower surface of the blade in 42 taxa, prominently raised in eight species and visibly distinct but entirely flat or in part flat and otherwise prominulous in 20 species. Tertiary

veins are usually obscure on the upper surface, except in those species in which the upper blade surface is bullate, corrugate, rugose, or somewhat wrinkled, in which case they are more or less sunken in valleys. These can occasionally be obtusely sunken, e.g., *Chlorospatha besseae*, or etched or etched-sunken in a few species, e.g., some collections of *C. pubescens*. In no case have these been observed as distinct structures on the upper surface, and, therefore, they are characterized only by the extent to which they are sunken or not on that surface.

Reticulate veins, the smallest veins visible to the naked eye, are more or less perpendicular to all of the more prominent veins, including the midrib, and are to some extent visible or otherwise distinct on the lower surface in approximately half of all taxa. This character is not frequently reported but can be determined with reasonable certainty in most taxa. Reticulate veins dry raised or prominulous on the lower surface of the blade in 25 taxa, visibly distinct in 10 species, and obscure in the remaining species. Reticulate venation is most pronounced in the 18 species in which the lower blade surface is herein described as "reticulate," meaning that all orders of venation are raised, prominulous, or conspicuously distinct and visible, creating a fine, netlike pattern throughout the lower surface in both living and dried material (Fig. 19D). Reticulate veins are structurally indistinct and usually obscure on the upper surface, except in those species in which the surface is bullate, corrugate, rugose, or somewhat wrinkled, in which case they can be, but are not always entirely, or in part more or less sunken in valleys. The veins can occasionally be obtusely sunken, etched, or etched-sunken in a few species, e.g., *Chlorospatha hannoniae* and *C. pubescens*. Therefore, they are characterized only by the extent to which they are sunken or not on that surface.

In all taxa in which the character is known in both living and dried material, the minor veins are concolorous on the upper surface, with one exception. The secondary veins of *Chlorospatha sizemoreae* are slightly darker than the surface. Another possible exception is *C. bullata* in which all orders of venation dry paler than the upper surface in most collections; however, the living color is not known. All minor veins are usually green on the lower surface in living plants of a given species and can be concolorous, weakly paler, or weakly to moderately darker than the surface, occasionally with the tertiary veins prominently darker. The secondary and some or all of the tertiary and reticulate veins are known to be purple or purplish in *C. atropurpurea*, *C. hastata*,

and *C. mirabilis*, and are probably at least partially so in other species with the lower blade surface purple. Interestingly, in one collection of *C. mirabilis* (Croat 71002), the lower blade surface is entirely dark purple, but the secondary and tertiary veins are green and dry greenish and paler than the surface, which dries purplish. Of the 31 taxa in which the living color of the tertiary veins is known, the veins are darker than the surface in 19 and concolorous in 12. The color of dried tertiary veins is consistently darker than the surface in 34 taxa, either concolorous, concolorous to weakly darker, or concolorous to weakly paler than the surface in 23 taxa, paler than the surface in two species, and weakly darker to weakly paler than the surface in two species. The last two species, *C. bullata* and *C. kolbii*, are unusual in having tertiary veins moderately darker than the surface in living material but concolorous to paler than the surface in dried material. Typically, the color value of the living veins is not so different from that of the dried veins. The reticulate veins of living plants are either darker than the surface or concolorous in about equal numbers of taxa, in the 16 taxa in which the character is known. On drying, the reticulate veins are darker than the surface in 15 taxa, concolorous to weakly darker than the surface in 22 taxa, paler than the surface in three species, concolorous to weakly paler than the surface in one species, and, for the most part, not visible in the remaining species. The extent to which secondary, tertiary, and reticulate veins are sunken (or not) on the upper surface, raised (or not) on the lower surface, and their color in both living and dried blades are more or less consistent in all but a few taxa and, therefore, taxonomically significant characters.

Minor veins on the lower surface are glabrous in most *Chlorospatha*, but are consistently granulose, weakly to conspicuously granular-puberulent, or crispy-puberulent in eight of the 18 species in which the lower blade surface is reticulate, with few exceptions. If all or some of the minor veins are to some degree puberulent, the midrib and major veins of a given species will have a similar indumentum. Species in which some or all of the minor veins are more or less puberulent are: *C. bogneri*, *C. bullata*, *C. corrugata*, *C. engleri*, *C. gentryi*, *C. pubescens*, *C. timbiquensis*, and *C. yaupiensis*, with the character weakest in *C. timbiquensis*. The secondary, tertiary, and reticulate veins are entirely more or less puberulent in six of these species, with the reticulate veins glabrous, but prominent in *C. engleri* and *C. timbiquensis*.

MORPHOLOGY OF REPRODUCTIVE STRUCTURES

INFLORESCENCES

Flowering is morphologically terminal in *Chlorospatha*, although it appears to be axillary, with the stem apex terminating in an inflorescence sympodium or inflorescence bud that does not develop, subtended by a sympodial leaf. New growth is from a bud in the axil of the penultimate leaf below the spathe insertion (in polyphyllous sympodial growth) (Grayum, 1990). Ray (1988) described the inflorescence sympodium consisting of two or more inflorescences as a “gorgonoid monophyllous sympodium,” terminology that appears to accord with the sympodium of *Chlorospatha*. Ray speculated that the inflorescence sympodium was the most advanced state of floral morphology in allowing a plant to mature as many inflorescences with each vegetative article as its resources could support. He further concluded that this pattern possibly allows flowering to become highly seasonal, with a large number of inflorescences being produced with each sympodial leaf during the optimal season for reproduction. According to Ray (1987b: 1368), the (sympodial) “segment consists of an indefinite number of adnate internodes, each newer axis branching from the same side of the lower order axis in a neatly linear arrangement. All of the internodes are greatly reduced. The sympodial leaf subtends the lower end of the segment. The upper end of the segment incorporates the peduncle of the internode terminating the original axis, but also includes an indefinite number of bracteoles in a row, representing multiple axes.” Various terms have been used to describe the modified leaves associated with the inflorescence sympodium and individual inflorescences, resulting in some confusion regarding application of these terms. After discussions with the authors, Michael Grayum suggested a simple, descriptive terminology that eliminates any confusion regarding application of terms and will henceforth be used in this treatment. The “bracteoles” (of Ray) are herein referred to as “inflorescence cataphylls.” In all respects, the modified leaves associated with the sympodium and individual inflorescences are “cataphylls.” In *Chlorospatha*, the leaf subtending a sympodium, the sympodial leaf, is usually a fully expanded foliage leaf, but in some species, the sympodial leaf is a cataphyll, herein referred to as the “sympodial cataphyll.” Inflorescences are always more or less erect in *Chlorospatha*, with each subtended by an inflorescence cataphyll whether the sympodial leaf is a fully expanded foliage leaf or a cataphyll. Sympodial cataphylls and inflorescence cataphylls

are briefly acuminate, cuspidate, or obtuse with an acumen or apiculum at the apex, marcescent, and ultimately deciduous.

In *Chlorospatha*, the floral sympodium arises in association with one of the uppermost leaves, occasionally the uppermost. Flowering associated with the uppermost leaf occurs most frequently in erect-growing species as new vegetative growth is emerging at the base of the petiole sheath of the uppermost leaf. However, flowering can occasionally occur in association with the uppermost leaf in decumbent-growing species as well. In *Chlorospatha*, new vegetative growth typically emerges from the apex of the petiole sheath of the uppermost leaf, and a sympodium is produced in association with one of the leaves immediately below. Only one sympodium is in flower at a given time, but infructescences were frequently observed in association with the leaf or one of the leaves immediately below, occasionally more than one leaf (Figs. 4B, 19D).

In most *Chlorospatha*, the floral sympodium is held within the more or less elongated petiole sheath of a fully expanded sympodial leaf, with individual inflorescences emerging successively at or near the apex of the sheath (Figs. 13D, 26A). In most of these taxa, the length of the petiole sheath of the sympodial leaf will be moderately to conspicuously longer than the petiole sheath of a normal foliage leaf. The sides of the petiole sheath are invariably convolute in these taxa, thereby containing and thus supporting the usually relatively long, slender peduncles and protecting the developing inflorescences. The inflorescence cataphyll subtending each inflorescence is moderately shorter than the peduncle, acutely or obtusely 1- or 2-ribbed abaxially, extremely thin, glabrous, semi-transparent, whitish, or greenish white in color, and rarely observed, usually remaining completely contained within the petiole sheath.

In nine species, the sympodium is subtended by a sympodial cataphyll that emerges at or toward the base of the petiole sheath of the fully expanded foliage leaf subtending the sympodial cataphyll: *Chlorospatha boosii*, *C. engleri*, *C. hannoniae*, *C. longiloba*, *C. longipoda* (Fig. 4B), *C. portillae*, *C. ploumanii* (Fig. 41D), *C. pubescens*, and *C. yatacuensis*. An unusual condition was occasionally observed in *C. boosii* and *C. hannoniae*, wherein the first inflorescence in some sympodia did not appear to emerge from within the sympodial cataphyll. The sympodial cataphyll of a taxon is similar in appearance to a vegetative cataphyll in all respects, being obtusely or acutely 1- or 2-ribbed abaxially, matte to weakly glossy, pale to medium green, thin to thinly coriaceous, and glabrous in all

but one species. In *C. pubescens*, the sympodial cataphyll is frequently sparsely crispy-puberulent along the abaxial rib(s) and longitudinal veins, occasionally not at all, usually in accordance with the indumentum of the vegetative cataphyll of a given collection, although the vegetative cataphyll can be puberulent and the sympodial cataphyll glabrous (on the same plant). Only the sympodial cataphyll of *C. longipoda* is known to be occasionally purple-speckled. Inflorescence cataphylls produced in species with sympodial cataphylls are obtusely or acutely 1- or 2-ribbed throughout or only toward the apex, usually moderately thinner than the sympodial cataphyll, but more substantial than those produced in taxa lacking sympodial cataphylls. Inflorescence cataphylls are glabrous, usually weakly glossy, pale green, and moderately shorter or longer than their respective peduncles, frequently longer in those species with short peduncles (3.5–10 cm long). The number and shape of the abaxial ribs on sympodial and inflorescence cataphylls are not consistent on the species level and therefore not useful characters, which is also true of the vegetative cataphylls in these species. *Chlorospatha plowmanii* and *C. pubescens* usually have both short petiole sheaths and short peduncles; *C. boosii*, *C. hannoniae*, and *C. longipoda* have long petiole sheaths and short peduncles; and most of the remaining species have long petiole sheaths and comparatively long peduncles, *C. engleri*, *C. longiloba*, and *C. yatacuensis*. *Chlorospatha portillae* is unusual in having comparatively short petiole sheaths (to 12 cm long) and long peduncles (to 17.5 cm long). The presence of a sympodial cataphyll does not appear to be correlated with the relative length of the petiole sheath or the orientation of the sides of the sheath, and occurs in vegetatively and floristically diverse species from both slopes of the Andes in Colombia and Ecuador. In *C. boosii* and *C. hannoniae*, the sides of the petiole sheath are wide and broadly spreading (to 90° midway), thus appearing winged (Fig. 22B), and in *C. engleri*, *C. longipoda*, *C. plowmanii*, and *C. pubescens*, the sides of the sheath are more or less erect, occasionally in-rolled along the margins and occasionally convolute at the apex. The orientation of the sides is not known in *C. portillae*. The sides of the sheath are convolute in *C. longiloba* and presumably so in *C. yatacuensis* as well, yet the sympodium emerges at or toward the base of the sheath. *Chlorospatha yatacuensis* is included here with reservation, being represented by a single, incomplete herbarium specimen in which the sympodium has been removed from the petiole sheath and is accompanied by a cataphyll that could possibly be a vegetative cataphyll, since there are no

significant differences in the two structures. However, the inflorescences are small relative to plant size, a condition found most frequently in species with sympodial cataphylls. Therefore, this species is included here, with the hope that additional collections will provide pertinent information.

In both forms of sympodial development, the purpose would appear to be provision of support for the typically slender peduncles found in the genus, since the inflorescences of all taxa are held more or less erect. No comparative reproductive advantage is apparent in either form, but it seems likely that some differences in pollination biology or possibly fruit dispersal are involved.

The number of inflorescences per axil does not vary significantly in *Chlorospatha* and would not appear to be a useful character on the species level. Most *Chlorospatha* produce between three and six inflorescences per sympodium, with only two species producing as many as eight inflorescences (*C. croatianae* subsp. *croatiana* and *C. kolbii*), and only *C. portillae*, as many as 10, the maximum number observed in the genus, with the number of inflorescences varying slightly on individual plants and from plant to plant in all taxa. Mature specimens of species herein described as having fewer than three inflorescences in a sympodium probably produce more than one or two. All flower in typical fashion, with inflorescences appearing sequentially at the apex of the petiole sheath, but are known only from dried material with only one to two inflorescences visible or reported on labels. When flowering commences in these taxa, usually only one inflorescence is visible and a collector could mistakenly assume that no more than one inflorescence was present. Due to the nature of flowering in most *Chlorospatha*, the petiole sheath must be dissected in order to determine the full complement of inflorescences in a sympodium. Additionally, when less than sufficient resources are available to a plant or when prevailing climatic or other conditions are less than optimal, some inflorescences may be aborted. No mature specimen of any species observed in the living state (by the authors) produced less than three inflorescences per sympodium. However, most living taxa of *Chlorospatha* observed can flower when quite young and small, with the first flowering usually producing no more than one to two inflorescences. The ability to flower in a less-than-mature state has been observed in 16 species and is probably typical in *Chlorospatha*, but could not be verified in all taxa, many being known only from dried material of presumably mature specimens. In species with sympodial cataphylls, usually more than one and occasionally the entire

complement of inflorescences are visible when flowering commences in habitat. In cultivation, these species tend to grow and flower less vigorously than in the wild, and, consequently, the sympodium can be less obvious.

In species with sympodial cataphylls, inflorescences emerge in quick succession, with each reaching anthesis approximately one to three days after anthesis of the preceding inflorescence. A few relatively large, erect-growing species that lack sympodial cataphylls and flower in the typical manner, e.g., *Chlorospatha atropurpurea*, *C. croatica* subsp. *croatica*, and *C. ilensis*, are unusual and thus noteworthy in producing inflorescences in quick succession, frequently with three to four inflorescences visible at or near the apex of the petiole sheath prior to anthesis of the first inflorescence (Figs. 5B, 16D), at which point only one to several days pass between anthesis of one inflorescence and anthesis of the next. The inflorescences of most *Chlorospatha* that lack sympodial cataphylls emerged in slow progression, with several to many days (approx. five to 10 days) between anthesis of one inflorescence and emergence of the next inflorescence at the apex of the petiole sheath (Fig. 6B). The number of days in this cycle varies in individual plants and from plant to plant in cultivation, apparently in accordance with the health and vigor of the plant and prevailing conditions.

PEDUNCLES

The cross-sectional shape of the peduncle is known in 22 species and is terete, cylindroid (thicker than wide), or both, in most of these taxa and presumably most taxa in which shape is not known. The peduncle can also be obtusely flattened toward the apex, occasionally its entire length, or obtusely D- or U-shaped. An unusual condition was observed in *Chlorospatha kolbii* and *C. mansellii*, wherein the peduncle was broader than thick. In *C. boosii*, the peduncle is obtusely D-shaped in the apical half, with the margins acute toward the apex. The peduncles of *C. mirabilis*, *C. oblongifolia*, and *C. sizemoreae* are obtusely triangular, a condition also observed in the northernmost collection of *C. pubescens*, and in *C. oblongifolia*, also weakly sulcate. The character could not be determined in dried material and is known only from observations of living plants or label notes. With so few taxa represented here, the significance of the character can only be surmised.

Coloration of the peduncle is known in 32 taxa, most of which have peduncles that are pale to medium green, yellow-green, greenish cream, or

cream-colored. Of these, *Chlorospatha atropurpurea* can also have yellow peduncles and *C. pubescens* can also have white peduncles. The peduncles are consistently pale to medium green and entirely or partially weakly to moderately purple-tinged in *C. hannoniae* and *C. limonensis*, occasionally so in *C. longipoda* and *C. pubescens*, and prominently so in *C. portillae* and *C. sagittata*. In *C. bullata*, *C. huilensis*, *C. kolbii*, *C. sizemoreae*, and occasionally *C. ilensis*, the peduncle is green and darker green-mottled in narrow transverse bands, and it is similarly purple-mottled in *C. castula* and *C. hastata*. *Chlorospatha croatica* subsp. *croatica*, the most variable species in the genus, has peduncles that can be entirely purple, green, or yellow-green, or additionally, either darker green- or purple-mottled in transverse bands. In most of the 19 species in which the character is known, the peduncle is matte to weakly glossy, but it is semiglossy in *C. dodsonii* and *C. sizemoreae*, weakly glossy to semiglossy in *C. ilensis*, and glossy in *C. longiloba* and *C. mirabilis*. Peduncles are not ribbed in *Chlorospatha* and are glabrous in all but four species, *C. corrugata*, *C. gentryi*, *C. pubescens*, and *C. yaupiensis*, in which these are usually entirely or in part granular-puberulent, minutely puberulent, or crispy-puberulent (terms defined above under Petiole Surfaces).

In all but nine species of *Chlorospatha*, the peduncle is held within the petiole sheath from its inception through the fruiting cycle and can be slightly shorter or longer than the sheath, with one exception. In *C. hammeliana*, the petiole sheath is 6.5–15.5 cm long, approximately one third of the total length, but the peduncle is 20–40 cm long and only the basal portion is held within the sheath. In all taxa that have most of the peduncle held within the sheath, the lengths of the peduncle and petiole sheath are directly correlated; therefore, the diagnostic character of the ratio of the length of the sheath to total petiole length can also be applied to peduncle length. If the petiole of a sympodial leaf of a given taxon is sheathed one third of its length, the associated peduncles will be approximately one third as long as the petiole. Peduncle length varies slightly within a sympodium but can vary significantly between sympodia on a single plant or different plants of a given taxon, depending upon the maturity of the plant, as can the lengths of the petiole and sheath. Therefore, the ratio of the lengths of the peduncle and petiole is a more useful character, having proven to be consistent within an acceptable range of variation. In the nine species with sympodial cataphylls, the length of the peduncle is not

correlated with the length of the petiole sheath. In this group, species with relatively long sheaths can have long peduncles, e.g., *C. longiloba*, *C. yatacuensis*, or short peduncles, e.g., *C. boosii*, *C. hannoniae*, and species with short petiole sheaths can have long peduncles, e.g., *C. portillae*. However, most of the shortest peduncles in the genus occur in these species in which the longest peduncles are no more than 25 cm long (in *C. longiloba*).

The maximum length of the peduncle can be between 20 and 50 cm in 34 taxa and can exceed 50 cm in only eight species, seven of which have peduncles between 50 and 60 cm long, with *Chlorospatha sagittata* having the longest in the genus, 88 cm. Twenty-four species consistently have peduncles less than 20 cm long, 15 of which have peduncles between 12 and 17.5 cm long and nine that have peduncles 10 cm long or less, two of which have peduncles 3–6.5 cm long, *C. plowmanii* and *C. oblongifolia*, the shortest in the genus. The latter species is atypical in being a relatively small plant with a short peduncle that is also broad, 3–4 mm in diameter. Most *Chlorospatha* have peduncles 1–3 mm in diameter. Only 16 species can have peduncles as much as 4 mm in diameter, most of which are large, robust taxa with long peduncles, except *C. oblongifolia*, and, of these, only seven species can have peduncles as much as 5 mm in diameter, *C. besseae*, *C. boosii*, *C. croatian* subsp. *croatiana*, *C. hammeliana*, *C. mansellii*, *C. planadensis*, and *C. sagittata*. The peduncles of *C. besseae*, *C. boosii*, *C. mansellii*, and *C. sagittata* are more or less cylindroid and only the larger dimension is as much as 5 mm. In all *Chlorospatha*, the peduncle is slightly broadened distally, merging imperceptibly with the spathe tube, and usually narrowest at the base.

SPATHES

The spathe of *Chlorospatha* completely surrounds the spadix prior to anthesis and is invariably narrow, relative to its length, with little or no constriction between the blade and tube. It is more or less narrowly cylindrical, ellipsoid, or ovoid, frequently curved somewhat forward, acute to acuminate at the apex (pre-anthesis) or somewhat cucullate, and thin to thinly coriaceous with the margins slightly thinner and the sides convolute, usually more prominently so on the tube than on the blade. The pre-anthesis spathe is also frequently somewhat deeper (i.e., broadest dorsoventrally) than broad. Although the character is difficult to determine in dried material, the flattened spathe is lanceolate, narrowly ovate, or elliptical in most taxa, narrowly obovate in a few species from the eastern slopes of the Andes in

Ecuador, and weakly to moderately or not at all constricted between the tube and blade. The flattened spathes of *C. atropurpurea*, *C. ilensis*, and possibly others are unusual in having the tube approximately twice as wide as the blade and conspicuously narrower at its union with the blade, which can be weakly constricted at the base or not.

In most taxa, the maximum length of the mature spathe is between 5 and 10 cm, but exceeds 10 cm in 19 species, six of which can have spathes more than 13 cm long: *Chlorospatha bayae*, *C. boosii*, *C. dodsonii*, *C. macphersonii*, *C. mirabilis*, and Species 4. The spathe is no more than 15.5 cm long in five of these species, but can be 20 cm long in *C. dodsonii*, the longest in the genus. However, in all *Chlorospatha*, the length can be less than the maximum stated here. The length can vary significantly between young, developing inflorescences and mature inflorescences; therefore, only the lengths of mature inflorescences have been included in descriptions when possible, maturity occasionally being difficult to determine. In only 12 species is the spathe less than 5 cm long and of these, three species can have spathes less than 4 cm long, *C. engleri*, *C. oblongifolia*, and *C. portillae*, the last two species having mature spathes that can be as little as 3 cm long, the shortest in the genus. The spathe is always longer than the spadix in *Chlorospatha*, usually slightly to moderately so (1–2 cm or less), but prominently so in 11 species with spathes consistently as much as 3–4 cm longer or occasionally 6 cm longer in *C. boosii*.

In almost all taxa, the unopened spathe is 10 to 20 times longer than wide, as much as 25 times longer than wide in a few species, and less than 10 times longer than wide in seven species with relatively short spathes that are approximately 6 to 9 times longer than wide. The ratio is correlated with the typically narrow spathes in *Chlorospatha*, most being between 4 and 9 mm in diameter, with the diameters of the tube and blade more or less equal in all taxa. The spathe can be less than 4 mm in diameter in 11 species with relatively short spathes and more than 1 cm in diameter in nine taxa that represent most of the taxa with the largest spathes in the genus. Of these, *C. atropurpurea*, *C. croatian* subsp. *croatiana*, *C. croatian* var. *enneaphylla*, *C. dodsonii*, and *C. ilensis* can have spathes 1.2–1.5 cm in diameter, the maximum for the genus. Although numerous taxa are known only from dried material, the dimensions of those specimens were determined based on the drying characteristics of similar living spathes.

Of greater significance on the generic level is the ratio of the length and width of the spathe tube, this

being one of the characters that distinguishes *Chlorospatha* from *Xanthosoma* (see Intergeneric Relationships). A precise determination of the apical limit of the spathe tube would be particularly difficult in *Chlorospatha* at or prior to anthesis but can be approximated after staminal anthesis, when the apex is more or less constricted, at which time the tube can be said to terminate at the point of greatest constriction. In *Chlorospatha*, the tube is narrowly ovoid or ellipsoid, decurrent onto the peduncle at the base, and comprises the portion of the spathe that covers the pistillate portion of the spadix and all or most of the sterile staminate portion. The tube is usually 6 to 9 times longer than wide in the genus but can be 10 to 12 times longer than wide in eight species and less than 6 times longer than wide in 18 species, eight of which have tubes less than 4 times longer than wide (3 to 3.7 times longer than wide). Most of the species in which the ratio is small have small inflorescences, with *C. atropurpurea* and *C. ilensis* being exceptions, with ratios 3 times and 4.6 times longer than wide, respectively. Both species have comparatively large inflorescences of large diameter. The tube in *Xanthosoma* is less than 3 times longer than wide, usually 2 times longer than wide or less.

The spathe tube increases somewhat in thickness and persists intact through the fruiting cycle, with the margins convolute on the developing infructescence and more or less separated on the mature infructescence, and the apex directed downward, unless the infructescence is lying on the ground, which is occasionally the case in small, decumbent-growing species from the Amazon Basin. In the 26 taxa in which the infructescence is known, the tube is between 4 and 7.5 cm long in most, between 8 and 10 cm long in six species, and 11–12.5 cm long in *Chlorospatha macphersonii*, the longest in the genus. Three species with the pistillate portion of the spadix comparatively short have presumably mature infructescences less than 4 cm long, *C. corrugata*, *C. cutucuensis*, and *C. longipoda*. The spathe tube is 2 to 2.5 times longer in fruit than at anthesis in 15 species, 1.5 to 1.8 times longer in nine taxa, and less than 1.5 times longer in only two species, *C. corrugata* and *C. cutucuensis*. Infructescences that are less than 1.8 times longer are probably not mature.

The pistillate portion of the spadix in *Chlorospatha* is typically narrow, with few flowers across the axis (as viewed from above; see Spadix, discussion of female portion below) usually between three and five flowers. Consequently, the infructescence is also narrow, between 1 and 1.5 cm in diameter in 14 taxa

and between 5 and 9 mm in diameter in 12 species. The diameter of the tube in fruit is approximately 2–5 mm greater than that of the tube at anthesis, and is approximately 4 to 10 times longer than wide in all but three species: *C. corrugata*, *C. cutucuensis*, and *C. engleri*. The infructescences of *C. corrugata* and *C. engleri* were apparently mature and between 3.4 and 4.5 times longer than wide, whereas that of *C. cutucuensis* was probably immature and 3.1 times longer than wide. Only two species have infructescences more than 10 times longer than wide, *C. munchiquensis* (10.3 times longer than wide) and *C. macphersonii* (11 to 12 times longer than wide).

In most taxa, the spathe tube and blade are of approximately equal length or the blade is slightly longer than the tube, but the tube is longer than the blade in 15 species, usually 5–18 mm longer, but as much as 22 mm longer in *Chlorospatha macphersonii*. In some species, particularly those from the eastern slopes of the Andes in Ecuador, the blade can be conspicuously longer than the tube, usually 5–20 mm longer or occasionally to 3 cm longer, but as much as 6 cm longer in *C. boosii*, 5 cm longer in *C. plowmanii*, 4.5–5 cm longer in *C. dodsonii* and *C. litensis*, and 3.5 cm longer in *C. longipoda* and *C. pubescens*. In those species from the eastern slopes (*C. boosii*, *C. longipoda*, *C. plowmanii*, *C. pubescens*), the marked difference corresponds to a marked difference in the lengths of the pistillate and fertile male portions of the spadix, with the pistillate portion usually being considerably shorter than the fertile male portion, unlike the cited species from the western slopes (*C. dodsonii*, *C. litensis*).

The spathe blade is frequently either entirely obtusely 1-ribbed abaxially or only toward the apex, with the rib frequently acute toward the apex and the margins of the blade more or less in-rolled. The spathe is always glabrous on the inner surface in *Chlorospatha* and usually so on the outer surface, with four exceptions, *C. corrugata*, *C. gentryi*, *C. pubescens*, and *C. yaupiensis*. In *C. gentryi*, the tube is more or less crispy-puberulent on the outer surface, with the indumentum extending narrowly onto the medial portion of the blade. Only the tube is to some degree crispy-puberulent, granular-puberulent, or granulose in the other three species (terminology defined above; see Petiole Surfaces).

The shape of the spathe at anthesis is taxonomically significant but seldom described and, in most respects, difficult to determine in dried material. Certain characters can be determined with some degree of certainty, such as the apex, a reasonably consistent character on the species level, which is acute to weakly, gradually, or abruptly acuminate in

most taxa and cuspidate in 22 species. In *Chlorospatha dodsonii*, the apex can be cuspidate or obtuse with an acumen, and in *C. kolbii*, the apex can be obtuse with an acumen or acute. The blade is also more or less cucullate in 13 taxa, conspicuously so in eight of these: *C. atropurpurea*, *C. boosii*, *C. castula*, *C. croatiana* subsp. *croatiana* (Fig. 16C), *C. hammeliana*, *C. hannoniae*, *C. ilensis* (Fig. 26A), and *C. mirabilis*. The spathe of *C. boosii* can exhibit an extreme (in cultivation), wherein the apical half of the blade curves over the spadix (Fig. 9C) and is directed downward, as opposed to more or less outward as it is in other taxa. At other flowerings, the spathe was weakly cucullate in this species. In *Chlorospatha*, the blade is typically more or less erect at anthesis, with the apex oriented in such a way as to shield the open tube from rain, whether cucullate or not. The blade of *C. plowmanii* is usually held in the erect-spreading position at anthesis and does not shield the open tube.

In *Chlorospatha*, the blade is marcescent and typically withers around the fertile male portion of the spadix after staminal dehiscence, then abscises with that portion and, therefore, remains essentially erect, with few exceptions. In *C. corrugata*, *C. limonensis*, and *C. plowmanii*, the blade reflexes after female anthesis, but in *C. plowmanii* (Fig. 41D), the blade quickly withers or is occasionally somewhat caducous and is, in both cases, quickly deciduous, with abscission occurring prior to or coinciding with staminal dehiscence, an apparently unique behavior in the genus. Photographs of *C. corrugata* show the spadix after releasing pollen with the blade persisting in a withered state (Fig. 15B). *Chlorospatha limonensis* is known from a single pickled inflorescence with the blade reflexed but not withered. A fourth species, *C. pubescens*, is inconsistent, with the blade remaining erect after anthesis at most flowerings, or spreading, but not reflexed-spreading, at other flowerings on the same plant. However, it is not quickly deciduous, but persists in the typical manner, abscising with the fertile staminate portion of the spadix.

Most of the information pertaining to spathe shape at anthesis, as described herein, is based on 19 species observed in cultivation (by the authors), over a period of one to seven years, and six additional species known from photographs (*Chlorospatha bogneri*, *C. corrugata*, *C. gentryi*, *C. hammeliana*, *C. huilensis*) or published information (*C. castula*). The 25 species are floristically and vegetatively diverse, representing all known aspects of vegetative and floral morphology in *Chlorospatha* and the full geographical distribution of the genus, but not the

elevational distribution. Presumably most, if not all, pollination strategies are represented in these species. In *C. besseae*, *C. bogneri*, *C. corrugata*, *C. dodsonii*, *C. gentryi*, *C. huilensis*, *C. kolbii*, *C. mansellii*, *C. mirabilis*, *C. oblongifolia*, and *C. sizemoreae*, only the blade opens more or less broadly at anthesis, with the margins directed moderately to prominently outward or forward, depending on the species, and the opening rounded or narrowly to broadly elliptical, accompanied by some expansion of the apical portion, of the tube, thus exposing the fertile staminate portion of the spadix, some or all of the sterile portion, and occasionally as much as one third of the pistillate portion in some species, e.g., *C. besseae* (Fig. 6B). When fully expanded, the spathe is narrowly to broadly more or less funnel-shaped or tubular. In *C. atropurpurea*, *C. croatiana* subsp. *croatiana* (Fig. 16C), *C. hastata*, *C. ilensis*, *C. litensis*, and *C. mirabilis*, the entire spathe usually opens between two thirds and three fourths of its length, occasionally nearly to the base, with the margins directed forward or somewhat outward, thus exposing the fertile and sterile male portions of the spadix and part of the pistillate portion, occasionally almost the entire pistillate portion. The shape of the opening is narrowly elliptical, usually with the opening of the tube somewhat narrower than that of the blade. The apex of the tube is not constricted, and only a short portion toward the base remains convolute. The tube is somewhat more expanded at anthesis in all *Chlorospatha*, and in *C. croatiana* subsp. *croatiana* and *C. ilensis*, can approach 2 cm in diameter, with the spadix no more than 5–7 mm in diameter, which would suggest the possibility of larger pollinators than were previously considered. When plants are not growing vigorously, the spathe can open only one half of its length, occasionally with the sides of the tube directed inward and the margins touching. In the remaining seven species, the spathe opens narrowly most of its length, occasionally to within 1–2 mm of the base, with the sides directed forward, the margins directed slightly inward, and the opening narrowly elliptical: *C. boosii*, *C. engleri*, *C. hannoniae*, *C. longiloba*, *C. longipoda*, *C. plowmanii* (Fig. 41C), and *C. pubescens*. These are relatively small-growing species with small inflorescences, from the eastern slopes of the Andes in Ecuador, except *C. longiloba*, which is somewhat larger and occurs only on the western slopes.

Spathe color. Coloration of the mature spathe is generally taxonomically significant in *Chlorospatha* and usually varies in value and, in some cases, hue as the spathe develops, reaching ultimate intensity at anthesis. The colors of the spathe tube and blade are

to some degree different in all but 21 taxa, with the blade usually paler than the tube and the transition from one color to the next more or less gradual, never abrupt, though it may initially appear to be so. Although the character is known in fewer than 22 species, the inner and outer surfaces of the tube are usually concolorous or the inner surface is paler, except where otherwise noted, prominently so in a few species. Mature spathe tubes can be consistently or occasionally dark purple or to some degree purple-tinged on the outer surface in 16 species, but are more or less green when developing. The tube can be entirely dark purple outside or only narrowly so at the base, the apex, along the margins, or any combination of these. The color of the blade is not known in all of these species, but in six, the blades are white or cream-colored: *C. amalfiensis*, *C. bayae*, *C. callejasii*, *C. castula*, *C. jaramilloi*, and *C. sagittata*. In *C. longiloba*, *C. longipoda*, *C. plowmanii*, *C. pubescens*, and *C. ricautensis*, both the tube and blade can be purple-tinged, with the blade paler than the tube or not and either entirely purple-tinged or only at the base and along the margins, depending on the species. The spathes of *C. longipoda*, *C. plowmanii*, and *C. pubescens* can also be entirely green, with some collections of *C. longipoda* and *C. plowmanii* exhibiting an unusual condition, wherein the spathe blade is dark purple, with the tube purple-tinged green and paler than the blade. This is consistently the case in *C. hannoniae*, which has a dark maroon blade and maroon-tinged green tube, and *C. portillae* in which the tube and blade are purple-tinged green, but more so prominently on the blade, which is darker than the tube. Although the character is not known in all species with the outer surface of the tube more or less dark purple, the inner surface is also dark purple in *C. bayae*, *C. callejasii*, *C. longiloba*, *C. munchiquensis*, *C. ricautensis*, and *C. sagittata*. The inner surface is usually green in the remaining species, except *C. hannoniae*, in which it is slightly purple-tinged.

In 23 species, both surfaces of the tube are consistently pale to medium green, yellow-green, or greenish cream, and the blade is conspicuously paler and white, greenish white, yellow, cream, yellowish cream, or greenish cream, with four exceptions (see *Chlorospatha genryi*, *C. atropurpurea*, *C. macphersonii*, and *C. noramurphyae*). The coloration of the tube and blade is more or less the same on the outer surface in 21 species, although the spathe blade is frequently slightly paler than the tube and can occasionally be a different color in one species, *C. antioquiensis*. However, in most of these species, the spathe is entirely pale to dark green, yellow-green,

greenish cream, cream, white, yellow, or yellowish cream on both surfaces, with green being the most common color observed, but the entire spathe is red on the outer surface in *C. noramurphyae*. The inner surface of the tube is occasionally purple or purplish in two of these species, *C. croatianae* subsp. *croatiana* and *C. mirabilis*, and is dark violet three fourths of its length in *C. kressii*.

The biological significance of coloration is not known, but coloration would presumably have some role in pollination, considering the reasonable consistency of the character on the species level. Most inconsistencies can be attributed to the somewhat variable nature of species that are relatively wide-ranging and exhibit variation in numerous characters, within and between populations, such as *Chlorospatha croatianae* subsp. *croatiana* and *C. longipoda*. Similarly, the various surface textures of the inner and outer surfaces of the tube and blade would presumably have a role in pollination, but these are poorly known from living material and in the 20 species in which some or all aspects are known, apparently variable. All surfaces can be matte, weakly glossy to semiglossy, or glossy, with the texture of the tube and blade more or less the same on the outer surface in 12 species and occasionally glossy in only one of these, *C. mirabilis*. The outer surface of the tube is glossier than that of the blade in five species and that of the blade is glossier than the tube in four species. The inner surface of the tube is usually somewhat glossier than the outer surface and frequently semiglossy to glossy, but can be the same as the outer surface. Only that of *C. kolbii* is known to be matte on the inner surface. The inner and outer surfaces of the blade can similarly be the same or have one surface glossier than the other, but unlike those of the tube, there is no apparent tendency for the inner surface of the blade to be glossier than the outer surface and it can, in fact, be matte in 11 species.

SPADIX

Chlorospatha is monoecious, with a more or less cylindrical spadix with naked, unisexual flowers lacking a perigone and arranged in spirals. The spadix can be slightly to conspicuously shorter than the spathe and is, for the most part, contained within it at anthesis, although in some taxa the spadix can curve somewhat forward, e.g., *C. ilensis*, *C. longipoda*. The axis is typically more or less straight, but in some species, the pistillate portion is curved somewhat forward and the staminate portion is erect, e.g., *C. plowmanii*. The spadix in *C. congensis* is apparently unique in curving forward at the base, with the

remainder of the pistillate and staminate portions recurved midway, then back again, thus rendering the apex erect. The apex is consistently either bluntly acute or narrowly rounded in 44 taxa or can be either in five species. The spadix is sessile in most taxa, but is consistently prominently stipitate, with the stipe between (5–)7 and 18 mm long in four species (*C. atropurpurea*, *C. hastata*, *C. kolbii*, *C. kressii*), weakly (1–3 mm) and somewhat inconsistently so in five species, and either moderately stipitate or sessile in *C. croatianae* subsp. *croatiana*. The stipe and axis are green in *C. kolbii* and dark violet in *C. kressii*, with coloration serving as a diagnostic character in these quite similar species. The axis can be white or green in *C. dodsonii* and is dark maroon in *C. sagittata*, which is, interestingly, also the color of the ovaries in this species. An unusual condition was observed in *C. hastata* and *C. luteynii*, both of which are stipitate, wherein the stipe emerges from a sheathlike structure on the spathe, with the sides of the sheath approximately 1 mm wide.

The female flowers are borne on the basal portion of the spadix and the fertile male flowers on the apical portion, with the fertile portions usually separated by a sterile portion that bears distinctive flowers. Occasionally, a few synandrodia are present at the apex of the fertile staminate portion, which are morphologically similar to the synandria, but usually not as deeply lobed, if at all, and lack microsporangia. What appeared to be several free staminodes were observed near the apex in *Chlorospatha atropurpurea*, which had the typical purple coloration of the sterile flowers found in this species and were quite distinct from the cream-colored synandria. The spadix is consistently adnate to the spathe at the base for half or more of the length of the pistillate portion of the spadix in 52 species, in 19 of which it is fused the entire length of that portion and in eight also frequently all or part of the sterile staminate portion. In most of the remaining taxa, the pistillate portion is adnate for one fourth to one third or less of its length but is adnate one fourth to one half of its length in two species. Interestingly, in all prominently stipitate species, the spadix is adnate only along the stipe or occasionally also narrowly (1–2 mm) onto the pistillate portion at the base. The degree to which the spadix is fused to the spathe is taxonomically significant, being consistent in 52 taxa, with the amount of variation less than one fourth of the total length of the pistillate portion in all but six of the remaining species in which the ratio varies by one fourth of the total length. Of these six species, *C. croatianae* subsp. *croatiana*, the most variable species in all respects, is the only one in which the ratio

varies by more than one fourth of the length of the pistillate portion and is either not adnate to the spathe or is adnate for one fifth to three fifths or three fourths of its length. In all taxa, the measured length of the adnate portion can vary significantly between inflorescences on a plant or between plants of a given taxon, according to the maturity of an inflorescence or plant, with the ratio of the adnate portion to the total length of the pistillate portion remaining reasonably consistent and therefore serving as a better character.

The total length of the spadix, though somewhat variable depending on the maturity of plants, is a useful character on the species level when only maximum length of mature specimens is considered. Total length is known in 60 taxa and in 37 of these the maximum length of the spadix is between 5 and 9.5 cm. The spadix can exceed 10 cm in length in 10 species and can be as much as 12 cm long in *Chlorospatha bayae*, *C. macphersonii*, and *C. ricaurtensis*, and as much as 16.5 cm long in *C. dodsonii*, the longest in the genus. In 13 species, the spadix is consistently less than 5 cm long and can be as little as 2.2–2.3 cm long on mature inflorescences of *C. oblongifolia* and *C. portillae*. Regardless of length, the spadix is relatively narrow in all taxa, as would be expected in the typically narrow inflorescences of *Chlorospatha*, and is 4–6 mm in diameter (measured usually midway, but closer to the apex when spadix is clavate) in 40 taxa, 6.5–7 mm in *C. croatianae* subsp. *croatiana* and *C. sagittata*, and as much as 8 mm in *C. dodsonii*, the largest in the genus. In 22 species, the spadix is less than 4 mm in diameter and is only 1.5–2 mm in diameter in *C. stellatarreae*.

The comparative lengths of the three portions of the spadix have greater taxonomic significance than actual lengths in *Chlorospatha*. Admittedly, numerous species are known from only one or two collections; however, in the equally numerous taxa known from multiple collections representing more than one to many populations, this character is consistent on the species level and would appear to represent the typical rather than exceptional condition. The fertile male portion is invariably densely flowered in *Chlorospatha* and shorter than the pistillate portion in 19 species (to 2 cm shorter in *C. macphersonii*), approximately equal in length in 16 taxa, moderately longer (ca. 1 cm longer or less) in 17 species and conspicuously longer in four species in which it can be between 2 cm (*C. hannoniae*, *C. mansellii*) and 3 cm (*C. boosii*, *C. luteynii*) longer. The fertile male portion is more or less cylindrical in 24 taxa, cylindrical to somewhat tapering in four taxa, consistently tapering in 14, ellipsoid in seven species, and clavate in 11 species in which this

portion can also be tapering. Coloration of the fertile male portion is diverse in *Chlorospatha* and known in 48 taxa, with the character more or less consistent in all but a few. The fertile portion is consistently white, creamy white, or cream-colored in 17 taxa, somewhat variably white, cream, or weakly yellowish or greenish in 12 species, bright orange in five species, and reportedly brown in three species, this last color being somewhat questionable. The fertile male portion has been observed as weakly brownish after staminal anthesis; however, it abscises several days after staminal anthesis and the authors have not observed what would be considered a brown fertile portion at anthesis, although the first author reported this portion as "pale yellow-brown" in *C. bayae*. Yellow or creamy yellow fertile portions were reported in six species, or occasionally cream-colored in some of these, with *C. huilensis* having this portion either white or dark yellow. Unusual coloration was reported in some species, with the fertile portion pink in *C. noramuphyae*, green in *C. gentryi*, and dark purple-violet in *C. limonensis*. A dark purple fertile portion is known in only one collection of one other species, *C. croatica* subsp. *croatica*, in which this portion can also be white, cream, greenish cream, or yellowish, with this species and *C. antioquiensis* exhibiting the most variation in the genus, with the latter species having the fertile portion red, yellow, or green.

Coloration of the sterile portion is seldom reported and it cannot be assumed that it is usually the same as that of the fertile portion, although this is apparently frequently the case in taxa in which the fertile portion is white or cream-colored. Even in some of these (e.g., *Chlorospatha hannoniae*, *C. plowmanii*, *C. pubescens*), the sterile portion can be either purplish or white to cream-colored, with the fertile portion white or cream-colored. In *C. besseae*, *C. dodsonii*, and *C. mansellii*, the fertile portion is bright orange and the sterile portion a combination of cream and yellow to yellow-orange. More striking differences were observed in other species: the fertile portion more or less cream-colored and the sterile portion dark purple to maroon in *C. atropurpurea*, *C. castula*, and *C. hastata*; the fertile portion somewhat cream-colored and the sterile portion pink or bright orange in *C. longiloba*; and the fertile portion yellowish cream and the sterile portion pink in *C. sagittata*, which is also true of one collection of *C. croatica* subsp. *croatica*. The sterile portion is green in *C. mirabilis* and yellow in *C. corrugata*. Although the coloration of the two portions can intensify somewhat as the spadix develops toward anthesis, there is no notable change in that of either

portion at anthesis. The drying color of the sterile portion is usually weakly to conspicuously different from that of the fertile portion and can be darker or paler, depending on the taxon. The colors themselves and their juxtaposition to the different colors of the other portions would presumably have some role in pollination, as would the different surface textures observed, although the latter character is poorly known. The fertile and sterile portions can be matte, weakly glossy, semiglossy, or glossy. In *C. boosii* and *C. hannoniae*, which are similar, sympatric species, the fertile and sterile portions are usually similarly colored, but those of the latter species are glossy and those of the first, matte.

The sterile portion of the spadix and the arrangement of the sterile flowers exhibit considerable diversity in *Chlorospatha*, providing a number of useful and reliable characters on the species level. The characters cited here are reasonably consistent in all taxa, with considerable variation occurring in all characters only in *C. croatica* subsp. *croatica*, including the length of the sterile portion, which can be short, long, or absent (3–17 mm long), relative to the length of the other two portions in this species. The length of the sterile portion ranges between zero and 1–2 mm or to as much as 2.7 cm (*C. hastata*) in *Chlorospatha*, exceeding 1.6 cm in only 10 taxa, but is significant only relative to the lengths of the other two portions. In most *Chlorospatha*, the sterile portion is moderately to conspicuously shorter than the pistillate and fertile male portions and can be only one to a few millimeters long in approximately 10 species with either long or short spadices. The sterile portion is only a few millimeters long in *C. dodsonii*, which has the longest spadix in the genus, and in *C. stellarreae*, which has one of the shortest. The sterile portion is also absent in some collections of *C. croatica* subsp. *croatica* and *C. dodsonii* and some spadices of *C. tokioensis*. In a few species, each portion of the spadix occupies approximately one third of the total length: *C. atropurpurea*, *C. castula*, *C. chocoensis*, *C. hastata*, and *C. mirabilis*. Although the sterile portion is shorter than the pistillate portion in all but one species of *Chlorospatha* (some collections of *C. atropurpurea*), it can be almost as long in the aforementioned species. In *C. hammeliana*, the fertile and sterile male portions are almost equal in length, as in the above species, but the pistillate portion is notably longer. The sterile portion is frequently longer than the fertile male portion and rarely longer than the pistillate portion in *C. atropurpurea*, apparently unique conditions in the genus.

The shape of the sterile portion is slightly variable on the species level, but is more or less cylindrical in most taxa and can be weakly broadest at either the base or apex in some species, occasionally either on different inflorescences in other species. The sterile flowers are either densely arranged or weakly coherent in most taxa, laxly arranged in 15 species, and can, in either case, but more frequently in the latter, have 1–2 mm or as much as half of the axis naked at the base of the sterile portion or with a few scattered flowers present in some taxa. In some species (e.g., *Chlorospatha grayumii*, *C. longiloba*, *C. sagittata*), the flowers can be densely arranged in one or more apical whorls and laxly arranged in the basal whorls, which is more frequently the case in species with more than one type of sterile flower on the same spadix. In *C. croatica* subsp. *croatica*, the flowers can be either laxly or densely arranged in one to six whorls or none may be present, depending on the collection, thus exhibiting the most variation in the genus. Flowers are arranged in five to as many as nine whorls in most *Chlorospatha* and in two to four whorls in 14 species, usually with a variation of one to two whorls or occasionally three whorls. The number of whorls is not correlated with the density of arrangement. *Chlorospatha stellarreae* and *C. tokioensis* have flowers laxly and densely arranged respectively, in one to two whorls. Only three species can have flowers in more than nine whorls, *C. giraldoi* (eight to 10), *C. mirabilis* (seven to nine, or 11), and *C. noramurphyae* (12). In *Chlorospatha*, one or more sterile flowers frequently occur in the upper whorl of pistillate flowers, occasionally in one or two whorls immediately below the upper whorl.

The female portion of the spadix is narrow and usually cylindrical or ellipsoid, with the width equal to or slightly greater than that of the sterile portion. Even when the entire female portion is adnate to the spathe, it is subcylindrical, with most of the axis distinguishable and the flowers arranged around the exposed circumference, with one exception. In some collections of *Chlorospatha dodsonii*, the axis is obscure and appears to be imbedded in the spathe, with the flowers appearing to emerge directly from its inner surface and arranged in rows, thus rendering the pistillate portion much broader than thick. An intermediate condition was observed in some specimens of *C. besseae*, wherein the axis was weakly distinct from the spathe. The female portion is between 2 and 6 cm long in 41 taxa, as much as 6.7 cm long in *C. macphersonii*, 9 cm long in *C. dodsonii*, and can be less than 2 cm long in the remaining 22 species, consistently less in 12 of these, including *C. hannoniae*, *C. oblongifolia*, and *C. pubescens*, in

which this portion can be 7–8 mm long, the shortest in the genus. In all taxa, the diameter is usually more or less equal to that of the fertile male portion, but can be 2 mm greater in 10 species and 2–3 mm less in six species. In most *Chlorospatha*, the female portion is relatively densely flowered but never to the degree attributable to *Xanthosoma*, except in one collection of *C. mirabilis* (Croat & Mora 83686). In this collection, pistils in the central three fourths of the pistillate portion of the spadix are prismatic (viewed from above), and most of the length of each ovary is coherent with that of adjacent ovaries. In all other *Chlorospatha*, “densely arranged” pistils are better described as “weakly coherent,” meaning that some, but not all, portions of each ovary contact some portions of most or all adjacent ovaries. Excluding the aforementioned collection of *C. mirabilis*, the female portion is most densely flowered in *C. callejasii*, *C. cutucensis*, *C. portillae*, and *C. sizemoreae*, but, as described above, the pistils are easily distinguishable as separate structures (with the naked eye) and not at all prismatic in appearance, which could not be said of members of *Xanthosoma*. In 16 species, the female flowers are more or less laxly arranged, with only a few or no ovaries weakly coherent, depending on the species, and the axis visible between most or all flowers in most species (see Female Flowers below). *Chlorospatha stellarreae* is the most laxly flowered taxon, having only one to two pistils per whorl, with the whorls conspicuously remote from each other. The density of arrangement of the female flowers is consistent on the species level and taxonomically significant. In *Chlorospatha*, the female portion is typically more laxly flowered near and at the base, occasionally also in the apical one to two whorls in some species. The number of flowers across the axis, as described herein, refers to the number visible in face-view, essentially two-dimensionally, with the inflorescence intact, this number being applicable to all taxa, whether the spadix is fused to the spathe or not and, therefore, is more useful. This is described “as viewed from above” in this treatment. There are between three and five flowers across the axis in approximately half of all taxa, two to three flowers in 21 species, one to two flowers in one species (*C. stellarreae*), and four to six flowers in seven taxa that have relatively large, densely flowered spadices. All species with laxly flowered spadices have less than four flowers across the axis, except those with relatively large spadices, e.g., *C. dodsonii*, *C. sagittata*.

Coloration of the female portion of the spadix is diverse in *Chlorospatha* but usually consistent on the species level in the 32 species in which color is

known. The color of the styler region is frequently distinct from that of the sterile and fertile staminate portions. Although inflorescences of only a few species were examined, coloration of the pistillate portion apparently intensifies to some degree as the inflorescence develops toward anthesis, more conspicuously so than that of the fertile and sterile male portions. The female portion is white, cream-colored, or greenish to yellowish white or cream in nine taxa, but in two of these taxa it can also be pale yellow (*C. cutucuiensis*) and pale yellow-green (*C. pubescens*). The female portion is pale to medium yellow, green, or yellow-green in nine species, more or less orange in three species, and purplish in two species. Other coloration is represented in single species: rose-colored in *C. besseae*, maroon in *C. sagittata*, red in *C. callejasii*, and pink in *C. hastata*. More variation was observed in three species, with the female portion white or yellow in *C. croatiana* subsp. *croatiana*, cream-colored, pale green, or yellow-green in *C. longiloba* and pink, pale yellow, or pale orange in *C. mirabilis*. Such diverse and more or less species-specific coloration of the female portion of the spadix would presumably serve some purpose in pollination.

Inflorescences of 19 species were examined at anthesis, 18 of which were pleasantly fragrant, with the fragrance fruity, sweet, spicy-sweet, spicy, mint-like, spicy-fruity, sweet-soapy, or like musty fruit that is beginning to rot, apparently reasonably consistent on the species level. Only one or several collections of each species were examined and the numbers of collections and examinations of each species were not sufficient to define the fragrance observed, but the fruity aspect appeared to be predominant. The perceptions of the various fragrances were subjective and, therefore, open to question, but certain general conclusions would appear to be useful, with the caveat that more careful research is needed. Fragrance began in early to mid-morning, as the spathe began to open, increased in intensity between noon and mid-afternoon, then decreased in late afternoon to early evening and was undetectable by nightfall of the first day of the flowering cycle. However, a weak fragrance of unknown origin was detected at the apex of the spathe on the second and third days in *Chlorospatha hannoniae*, *C. kolbii*, and *C. longipoda*. Madison (1978) maintained that the female flowers emitted the fragrance in *C. atropurpurea*, which does not appear to be the case. The spadices of *C. atropurpurea*, *C. croatiana* subsp. *croatiana*, *C. hannoniae*, *C. kolbii*, and *C. longipoda* were dissected into three portions, the fertile male, sterile male, and female portions, and the sterile male portion appeared to be the source of the fragrance.

The absence of fragrance in *C. plowmanii* cannot be explained. As in the other species observed, some of which are closely related, anthesis occurs during the day in this species, and the inflorescence was not fragrant during the night. It is possible that fragrance was present but not detectable by the observer. Since the species examined represent all known flowering strategies in the genus, it is likely that most *Chlorospatha* are fragrant and that fragrance serves an important function in pollination biology, coincidental with female anthesis.

Male flowers. The androecium of *Chlorospatha* consists of two to six stamens fused into a deeply or shallowly lobed synandrium, with the fused connectives thickened and the thecae extending almost to the base of the synandrium, opening by terminal pores or longitudinal slits (Madison, 1981; Mayo et al., 1997). In most taxa, the synandrium is more or less truncate at the apex, subprismatic, and more or less regularly polygonal (as viewed from above), although some elongation in the direction of the axis was observed in one to several whorls of the lowermost flowers in some taxa. In five species from the eastern slopes of the Andes in Ecuador, all synandria on the spadix were occasionally highly bilaterally symmetrical, usually moderately to prominently elongated in the direction of the axis and consistently broadly concave medially, with the margins of the lobes thickened, frequently accompanied by additional thickening around the individual pores, creating a more or less conspicuous tubelike effect: *C. boosii*, *C. hannoniae*, *C. longipoda*, *C. plowmanii*, and *C. pubescens*. In these species, the margins are prominently sinuate-undulate, interlocking with the margins of adjacent flowers, whereas those of typical synandria are only weakly to moderately sinuate and neither undulate nor interlocking.

Most synandria are 3- to 4-androus or 4-androus in more than 40 taxa and 3-androus in eight species. The number of stamens per flower is rarely constant on a single spadix, variation having been observed in all taxa except *Chlorospatha amalfiensis* with only three stamens and *C. munchiquensis* with only four stamens. Interestingly, on different spadices of *C. luteynii* and *C. mirabilis*, most synandria were either 3- or 4-androus, a condition not observed in other taxa. As many as five stamens were observed in 26 species, but frequently in only 11 of these species that usually had three to five stamens on a single spadix, with some synandria of *C. dodsonii* also having two stamens. Synandria with two to three stamens are found in only five species: *C. engleri*, *C. grayumii*, *C. oblongifolia*, *C. portillae*, and *C.*

sizemoreae, with those of *C. engleri* and *C. grayumii* occasionally having four stamens (on the same spadix). Otherwise, 2-androus synandria usually occur only occasionally near the base or apex of the fertile portion, occasionally also 1-androus synandria. Flowers with six stamens occur in only two species: *C. ricautensis* with (four)five to six, most of which have five; and *C. sagittata* with (three)four to six. The number of stamens in a synandrium is usually easily determined except in synandria that are not truncate at the apex, and occasional fusion of two adjacent synandria was observed in both forms of synandria, usually near the apex of the spadix. However, in some species, e.g., *C. engleri*, the synandria are so deeply lobed that individual stamens frequently appear to be separate, with the terminal pores relatively remote from each other, thus making the determination of the number of stamens more difficult. In most species, the synandrium is between 1 and 1.5 mm long, rarely less, and between 1 and 1.5 mm in diameter. Twenty-three taxa have synandria that can be 2–2.3 mm in diameter, with those of *C. ilensis* and *C. litensis* being as much as 2.5 mm in diameter and those of *C. dodsonii* as much as 3 mm in diameter, the largest known, commensurate with the large spadix of this species. Synandria can also be 2 mm long in *C. dodsonii*, *C. longiloba*, and *C. sagittata*. In some species, the synandria are somewhat elongated in the direction of the axis in the basal two to four whorls, and in *C. cutucuensis*, in all whorls in the basal half of the fertile portion. Elongation was most pronounced in *C. planadensis*, which has flowers 2 mm long and 1 mm wide (as viewed from above). Moderate to prominent elongation of all flowers on the spadix occurs in six species, *C. boosii*, *C. hannoniae*, *C. longipoda*, *C. plowmanii*, *C. pubescens*, and *C. ricautensis*, all members of *Chlorospatha* sect. *Orientalis* except *C. ricautensis*. In these six species, the synandrium, as viewed from above, is from 1.5 to 2.2 mm long, or to 2.5 mm long in *C. plowmanii*, and from 1 to 1.2 mm wide, or to as much as 1.5 mm wide in *C. pubescens*.

Sterile flowers. Sterile flowers in *Chlorospatha* are male flowers comprised of one or more staminodes that can be free or to some extent fused and branched, fungiform, or irregularly to evenly lobed. A “branched” flower consists of one to six staminodes that are fused only at or near the base and are otherwise free, with the individual branches clavate, ellipsoid or broadest at the apex and bluntly rounded, concave, truncate, or obtusely truncate, depending on the taxon. Red chromoplasts were observed in sterile flowers in some species, e.g., *C. croatianae* subsp. *croatiana*, *C. longipoda*. Although

the morphology of sterile flowers is remarkably diverse in *Chlorospatha*, it is reasonably consistent on the species level and taxonomically significant. Only evenly to irregularly lobed or subprismatic flowers occur in 42 taxa, occasionally as synandrodia in the apical whorl; eight taxa have some prismatic flowers in the apical one to three whorls. In *C. gentryi* and *C. yatacuensis*, the flowers are exclusively prismatic. All three types of flowers are more or less obpyramidal or somewhat anvil-shaped, and coherent the entire length of the sterile portion of the spadix in most taxa but are consistently laxly arranged the entire length in some species (e.g., *C. litensis*, *C. mirabilis*, *C. timbiquensis*), or only in the basal whorls (e.g., *C. grayumii*, *C. sagittata*). Synandrodia or irregularly lobed flowers also occur in the apical one to three whorls in most but not all remaining species in which most flowers are either branched or fungiform, or a combination of these. All or most of the sterile flowers are branched in eight species and in some collections of *C. kolbii*. In eight species, all or most of the sterile flowers are fungiform, with the flowers assuming one of three basic shapes, depending on the species. Two types of fungiform flowers resemble toadstools and are broadest at the apex and more or less abruptly narrowed below. In one of these two types, the broad apical portion is moderately to prominently convex, e.g., *C. kressii*, *C. longiloba*, *C. stellararreae*, and *C. tokioensis*, and in the other type, moderately to prominently concave, e.g., *C. chocoensis*. The flowers of both types are usually more or less rounded or subprismatic when viewed from above, but in some species, can have moderately to conspicuously sinuate margins, e.g., *C. chocoensis* and *C. lehmannii*, and bear no resemblance to synandrodia. The third type of fungiform flower is found exclusively in three species, *C. atropurpurea*, *C. castula*, and *C. hastata*, and is irregularly and deeply cup-shaped, usually sessile, rarely weakly stipitate, with the medial concavity frequently extending almost to the base and the margins sinuate-undulate.

The remaining taxa have two types of sterile flowers prominently represented on the same spadix, each occurring on one third to two thirds of the sterile portion: *Chlorospatha caliensis*, *C. lehmannii*, *C. nambiensis*, and occasionally *C. kolbii*, with the latter having three different types of sterile flowers on some spadices, these being branched and fungiform toward the base, with synandrodia near the apex. The other three species have only branched and fungiform flowers on the same spadix. Considerable variation between different collections was observed in only one species, *C. croatianae* subsp. *croatiana*, wherein

the flowers were subprismatic, evenly or irregularly lobed, fungiform (either convex or concave at the apex), or branched, and either densely or laxly arranged, with the branches either clavate or obtusely truncate.

Regardless of shape, sterile flowers in *Chlorospatha* can be coherent, weakly coherent, laxly arranged, or any combination of these, but with the laxly arranged state confined to the portion toward the base if more or less coherent flowers occur on the same spadix. The density of arrangement of flowers is reasonably consistent on the species level. In 54 taxa, the flowers are approximately 1 mm long or less, most being 0.5–0.8 mm long or occasionally somewhat less. Five species can have flowers 1.5 mm long; those of *C. croatiana* subsp. *croatiana* can be 1.8 mm long; and *C. kolbii* and *C. lehmannii* can have the longest observed, as much as 2 mm long. The average diameter of flowers that are weakly or not at all elongated in the direction of the axis is 1–1.5 mm, but in four species, the diameter can be 2–2.2 mm and in five species, as little as 0.6–0.8 mm. Flowers are usually more or less elongated in the direction of the axis in most taxa, as viewed from above, and can be as much as 2–2.2 mm long and 0.6–1.5 mm wide in 20 taxa and 2.5–3 mm long in 14 species.

POLLEN

Chlorospatha pollen is extruded in strands as permanent tetrads, with the individual grains spheroidal or subspheroidal, inaperturate, apolar, radiosymmetric, and their limits frequently barely discernible, as circumscribed by Grayum (1992). However, Bogner (1997) observed that although the tetrads are usually arranged tetrahedrally in *Chlorospatha*, the pollen of *C. plowmanii* (= *Caladium plowmanii*) is shed in both tetrahedral and linear tetrads, based on his examination of SEM micrographs. Grayum considered inaperturate, globose, apolar, and radiosymmetric pollen to be the most advanced, which would include that of *Chlorospatha*. Individual grains have a mean diameter of 26 μm , with a range of 24 μm (*C. hammeliana*) to 29 μm (*C. castula*), and tetrads, a mean diameter of 40.5 μm , with a range of 33–48 μm . The pollen is, on average, more than 50% smaller than that of *Xanthosoma*, starchless and binucleate, whereas that of *Xanthosoma* is starchy and usually trinucleate (Grayum, 1986). Starchiness in pollen would appear to be directly correlated with pollen size and, therefore, the body size of the pollen vector. Starchless pollen stores energy in the form of lipids (as opposed to starch) that require more energy to produce and break down but

which are more compact and typically correlate with smaller pollen (Grayum, pers. comm.).

Grayum (1992) described the exine sculpturing of *Chlorospatha* as psilate and obscurely punctate (*C. corrugata*) to obscurely verruculate or, in *C. croatiana*, foveolate-reticulate with psilate bands marking the boundaries between grains and the foveolae as in certain species of *Dieffenbachia* Schott. Pollen from species not considered by Grayum was submitted by the authors, at the request of Josef Bogner, to Michael Hesse and Heidi Halbritter at Institut für Botanik der Universität in Vienna, Austria. The resulting micrographs indicate additional forms of exine sculpturing in *Chlorospatha*: reticulate in *C. hannoniae*, *C. plowmanii* (Fig. 3G–L, Croat & L. P. Hannon 81475), and *C. pubescens*; smooth (lacking ornamentation) in *C. dodsonii* (Fig. 2A–F, Croat et al. 82836) and *C. oblongifolia* (Fig. 3A–F, Croat & J. Gaskin 80957); or with unusual ornamentation circumscribed by Halbritter as “variable-perforated” in *C. kolbii* (Fig. 2G–L, Croat & Mora 83727). Additionally, Bogner observed the pollen of *C. kolbii* (Bogner s.n.) as irregularly reticulate to foveolate. Halbritter reported that the pollen of *C. atropurpurea* was peculiar in having holes in the walls (two collections examined).

FEMALE FLOWERS

Chlorospatha exhibits a variety of gynoecial characters that are taxonomically significant on the generic level, clearly distinguishing it from *Xanthosoma*, with each character exhibiting a range of diversity that is remarkable in some cases and usually consistent on the species level, thus providing an abundance of taxonomically useful and frequently diagnostic information. The female flowers are naked and unipistillate, lack staminodia, and can be either relatively densely or laxly arranged on the spadix (see Spadix, above). Pistils are 1.3–2 mm long in 31 taxa and 1.5–2 mm diameter in these and most remaining taxa, with the stylar region surrounding a central pollen tube canal and moderately to extremely short or elongated and more or less attenuated. In *C. jaramilloi*, *C. lehmannii*, and *C. noramurphyae*, pistils can be 2.5 mm long, and in *C. caliensis* and *C. dodsonii* as much as 3 mm and 3.2 mm long, respectively, the longest in the genus, with the stylar region comprising as much as two thirds of the total pistil length. *Chlorospatha dodsonii* is also one of eight species with pistils 2–2.5 mm in diameter, exceeded only by those of *C. noramurphyae* and *C. sagittata*, which are 2.5–3 mm in diameter. Fourteen species have pistils approximately 1 mm long or slightly less, with some pistils 0.6 mm long in *C.*

hannoniae and 0.5 mm long in *C. risaraldensis*, the shortest in the genus. The diameter of the pistil accords with the maximum diameter of the ovary in all but a few species in which the stylar region is conspicuously wider than the ovary (see Style and Stigma Morphology below).

Ovaries are more or less terete in cross-section, subglobose, or occasionally obtusely conical or ovoid, and weakly to deeply 2- to 4(5)-furrowed in the majority of taxa. Exclusively obtusely conical ovaries were observed only in *Chlorospatha dodsonii*, *C. jaramilloi*, *C. kressii*, and *C. sagittata*. It should be noted that numerous taxa are known only from dried material, which, owing to the delicate nature and small size of the female flowers, could possibly result in some misinterpretation of shape; however, we have applied knowledge of similar drying characteristics of flowers known from living material of other taxa in our interpretations of dried material. The shapes of mature ovaries on a spadix or different spadices of a given taxon are usually slightly variable in most taxa, depending on position on the spadix and density of arrangement or both, with proximal flowers usually less densely arranged and somewhat smaller than average, but more pronounced variation does occur. Subglobose and cylindrical or ovoid ovaries were observed on single spadices of *C. kolbii*, *C. macphersonii*, and *C. yatacuensis*. In the last two species, the cylindrical ovaries were approximately as long as wide or slightly wider than long, which is the typical condition in *Chlorospatha*, regardless of ovary shape. However, in *C. kolbii*, the ovaries (on some spadices) were more or less cylindrical to ovoid and longer than wide in the apical half of the pistillate portion of the spadix and subglobose in the basal half. Cylindrical to ellipsoid or ovoid ovaries are fairly common in *Chlorospatha* and usually representative of sectional differences (see Infrageneric Relationships). Cylindrical, ellipsoid, or ovoid ovaries that are longer than wide are found only in *Chlorospatha* sect. *Chlorospatha*, with two exceptions, *C. cutucuensis* and *C. portillae*, members of section *Orientalis*. The pistils in most taxa in section *Chlorospatha* are relatively densely arranged, with those of *C. mirabilis* being the most densely arranged and described by Masters (1874) as subcuboidal, reflecting the obtuse angularity commensurate with this arrangement. The cylindrical ovaries found in other species are usually dimensionally typical except in eight of the 10 species assigned to *Chlorospatha* sect. *Orientalis*, in which ovaries are approximately 1 mm long or less, frequently 1.5 to 2 times wider than long, and frequently more or less broadly concave at the apex, whereas typical ovaries are more or less rounded or

obtusely truncate at the apex and about as wide as long. Obtusely obconical ovaries frequently occur exclusively or in conjunction with cylindrical ovaries on the same spadix in these eight species in section *Orientalis*. Only in these species and one collection of *C. mirabilis* (Croat & Mora 83686) is the ovary as broad as or broader at or near the apex than at the base, the ovary in *Chlorospatha* typically being weakly to prominently narrower at the apex, regardless of shape.

The coloration of ovaries is presumably the same or similar to that of the axis and is white, cream, or somewhat greenish in most taxa. In *Chlorospatha sagittata*, the axis is dark maroon and the ovaries so densely dark maroon-speckled that these also appear to be entirely dark maroon. The axis in *C. kressii* is dark violet, but the coloration of the ovaries is not known. Atypical coloration was observed in two collections. In Croat 74799 (*C. croatiana* subsp. *croatiana*), the axis is white and the ovaries are lavender-tinged white, with dark purple streaks toward and at the base. Similar coloration was observed in Hort. Veitch s.n. (*C. mirabilis*).

The internal morphology of the ovary and most or all of its attendant parts are known in 23 floristically diverse species in which most or possibly all morphological conditions in the genus are probably represented. There are (one) two to four (five to six) locules in ovaries of *Chlorospatha*, with the locules usually ovoid or somewhat spherical, or subspherical and slightly wider than long, and the septa exceedingly thin and translucent or almost as thick as the ovary walls, depending on the species. Locules in all taxa examined extended most of the length of the ovary and contained no fluid. The number of locules present in ovaries on a given spadix varies within a reasonably consistent range on the species level, with the ovaries usually or consistently 2-locular in nine species, consistently 2- to 3-locular in seven species, usually or consistently 3- to 4-locular in five species, and consistently 3-locular in three species. Species that usually or consistently have 2-locular ovaries are known from both slopes of the Andes in Ecuador, with five of the six species from the eastern slopes being the only species of *Chlorospatha* known usually to have some 1-locular ovaries: *C. boosii*, *C. hannoniae*, *C. limonensis*, *C. plowmanii*, and *C. pubescens*. In *C. boosii*, *C. hannoniae*, *C. limonensis*, *C. pubescens*, and most collections of *C. plowmanii*, 1-locular ovaries were observed almost exclusively in the basal whorls, rarely immediately above the basal whorls in the basal half of the pistillate portion of the spadix. The condition is clearly pseudomonomerous, the ovaries

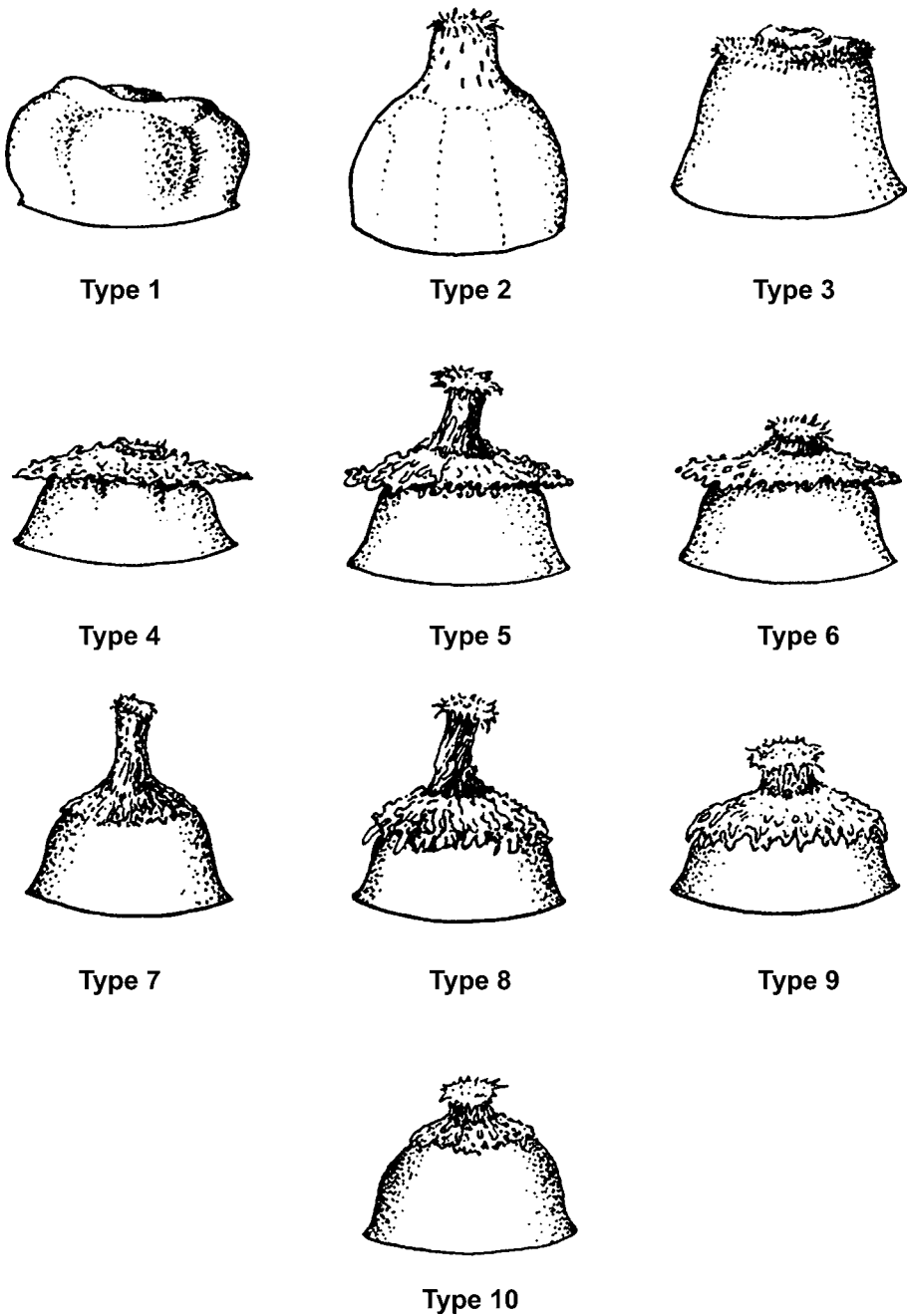


Figure 1. *Chlorospatha* style types 1–10. [Style types were created from a collective set of specimens from species that encompass an entire styler group, no one singular species.]—Type 1. Styles not or obscurely attenuate, less than 1/4 the pistil length, and lacks a mantle, as seen in eight species of *Chlorospatha* Engl. sect. *Orientalis* Croat & L. P. Hannon (e.g., *C. boosii* Croat & L. P. Hannon). Style Type 1 ranges from 1 to 2 mm diam.—Type 2. Styles shortly attenuate, 1/4 to 1/3 the pistil length, and lacks a mantle, as in three species of *Chlorospatha* sect. *Orientalis* (e.g., *C. cutucensis* Madison). Style Type 2 ranges from 0.8 to 1 mm diam.—Type 3. Styles only obscurely attenuate, to 1/4 or less the pistil length, expanded in a disklike mantle as wide as the ovary apex, as seen in *Chlorospatha* sect. *Chlorospatha* as seen in 18 taxa (e.g., *C. betancurii* Croat & L. P. Hannon). Style Type 3 ranges from 0.75 to 2 mm diam.—Type 4. Styles obscurely or not attenuate, significantly less than 1/4 of the pistil length, with an obvious mantle much wider than the ovary apex, as in four species in *Chlorospatha* sect. *Occidentales* Croat & L. P. Hannon (e.g., *C. Castula* (Madison) Madison). Style Type 4 ranges from 1 to 3 mm diam.—Type 5. Styles long attenuate and ca. half the pistil length, the style broadly expanded into a mantle much wider at the base than the ovary apex, found in six species in *Chlorospatha* sect. *Occidentales* (e.g., *C. grayumii* Croat & L. P. Hannon). Style Type 5 ranges from 1.2 to 2.6 mm diam.

being multicarpellate in all cases, with multiple furrows and frequently the vestiges of one to two septa present. In *C. boosii* and *C. hannoniae*, which flower seasonally, more 1-locular ovaries were observed (in cultivation), with the ovules depauperate, toward the end of the flowering season, when the plants were flowering less vigorously. The type of *C. plowmanii* (Plowman et al. 3979) is the exception, having most or possibly all ovaries unilocular. All ovaries of this collection were not dissected, but several were examined at different positions along the length of the pistillate portion and found to be unilocular. In an apparently aberrant collection tentatively assigned to *C. longipoda* (Croat et al. 86607), most ovaries were 2-locular, but many, at various positions on the spadix, were 1-locular with markedly depauperate ovules and vestigial septa present in some ovaries (at first flowering in cultivation). However, the spathe blade remains erect after anthesis in this collection, unlike that in all collections of *C. plowmanii*, which reflexes after anthesis. Placentation was basal in the 1-locular ovaries in this collection, a condition found only in the type of *C. plowmanii* (and in *C. castula*). Madison (1978) reported a semi-unilocular condition in *C. atropurpurea* and *C. castula*, describing the ovaries of *C. atropurpurea* as 3- to 4-locular near the base, with the parietal placentae axially connate and deeply intrusive, with axile placentation becoming unilocular near the apex. Earlier, Madison (1976) described the ovary of this species as 2- to 3-locular with axile placentation, but with the septa weakly united in the center and frequently separating, thus appearing as two to three deeply intrusive parietal placentae ("as in *Caladium*"). The ovaries of three living collections of *C. atropurpurea* were examined by the authors and found to be 2- to 4-locular, with the septa connate the entire length and placentation axile, with no indication of a unilocular condition near the apex. However, all of the collections examined were from Esmeraldas Province, Ecuador, and the type is from Los Ríos Province, farther to the south. It is likely that this is the collection Madison examined, and perhaps the geography involved can

entirely, or in part, explain this discrepancy, since this condition is possibly variable. Madison (1981) described the ovary of *C. castula* as tricarpellate and semi-unilocular, with the unilocular condition occurring at the apex. Neither fresh nor pickled material of this species was available for examination.

The Hort. Veitch s.n. collection of *Chlorospatha mirabilis* is the only collection of *Chlorospatha* reported to have more than 4-locular ovaries, with a handwritten note on the label reporting the presence of three to six locules. However, a maximum number of four locules was observed (by the authors) in ovaries of a living collection of this species and Masters (1874) described the ovaries as 4-locular; therefore, 4- or 6-locular ovaries would be unique in the genus. Mayo et al. (1997) describe the berries of *Chlorospatha* as 3- to 5-furrowed, indicating the presence of as many as five carpels; however, the authors have observed no more than 4-furrowed ovaries or berries. Only one living collection of *C. mirabilis* could be examined, and it is hoped that the examination of additional collections will clarify this issue.

Ovules. The 23 species in which the number of ovules per locule (in plurilocular ovaries) was determined or estimated (*Chlorospatha lehmannii*) usually had between six and 10 ovules in each locule, with species occasionally having three or four, and six species consistently having more numerous ovules. Two species consistently had relatively few ovules, *C. atropurpurea* with three to seven per locule and *C. hastata* with four to eight per locule. Locules of *C. ilensis* and *C. longipoda* frequently have 12 ovules and those of *C. dodsonii*, *C. engleri*, *C. longiloba*, and *C. sizemoreae*, 14 ovules. The few unilocular ovaries in species that otherwise have plurilocular ovaries usually have 10 to 16 ovules, with those of *C. boosii* having only eight and those of *C. hannoniae* and *C. plowmanii* as many as 20. Ovules are usually approximately 0.15–0.22 mm in length, with the funicles as long as the ovules in three species, longer than the ovules in six species, and shorter than the ovules in 13 species,

—Type 6. Styles briefly attenuate and ca. 1/3 of the pistil length, the style broadly expanded into a mantle wider than the ovary apex, as seen in two species in *Chlorospatha* sect. *Occidentales* (e.g., *C. antioquiensis* Croat & L. P. Hannon). Style Type 6 ranges from 0.6 to 2 mm diam. —Type 7. Styles long attenuate and 1/2 to 2/3 of the pistil length, the style expanded into a spreading mantle approximate to or narrower at the base than the ovary apex, observed in three species in *Chlorospatha* sect. *Occidentales* (e.g., *C. caliensis* Croat & L. P. Hannon). Style Type 7 ranges from 0.3 to 1.5 mm diam. —Type 8. Styles long attenuate and 1/2 to 2/3 of the pistil length, the styler mantles not or weakly coherent, and confined to seven species in *Chlorospatha* sect. *Occidentales* (e.g., *C. amalfiensis* Croat & L. P. Hannon). Style Type 8 ranges from 0.7 to 2 mm diam. —Type 9. Styles briefly attenuate and ca. 1/3 of the pistil length, the styler margins coherent or weakly coherent (nine species) or not coherent (*C. bayae* Croat & L. P. Hannon), and seen in *Chlorospatha* sect. *Occidentales* (e.g., *C. bayae*). Style Type 9 ranges from 0.8 to 2 mm diam. —Type 10. Styles briefly attenuate, usually 1/4(to 1/3) of the pistil length, the styler margins not coherent, and restricted to four species in *Chlorospatha* sect. *Occidentales* (e.g., *C. congensis* Croat & L. P. Hannon). Style Type 10 ranges from 0.7 to 5 mm diam.

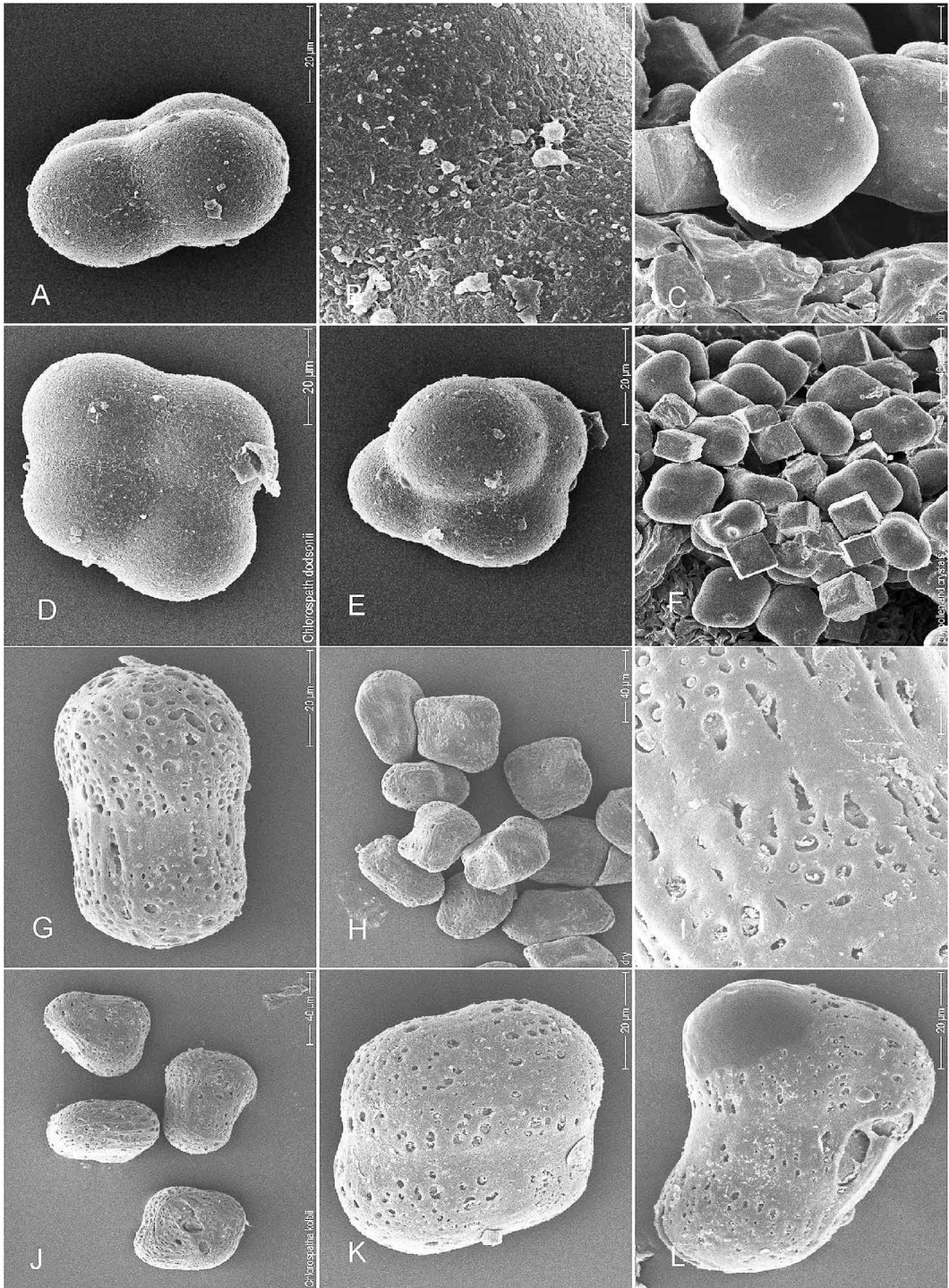


Figure 2. A–F. *Chlorospatha dodsonii* (G. S. Bunting) Madison, Croat *et al.* 82836 (MO). —A. Pollen tetrad, side view. —B. Close-up of tetrad surface. —C. Close-up of tetrad (center). —D. Tetrad, top view. —E. Tetrad, oblique view. —F. Tetrads interspersed with crystals. G–L. *Chlorospatha kolbii* Engl., Croat & Mora 83727 (COL, MO). —G. Tetrad, side view. —H. Group of pollen tetrads. —I. Close-up of tetrad surface. —J. Tetrads, top view. —K. Tetrad, top view. —L. Tetrad, oblique view.

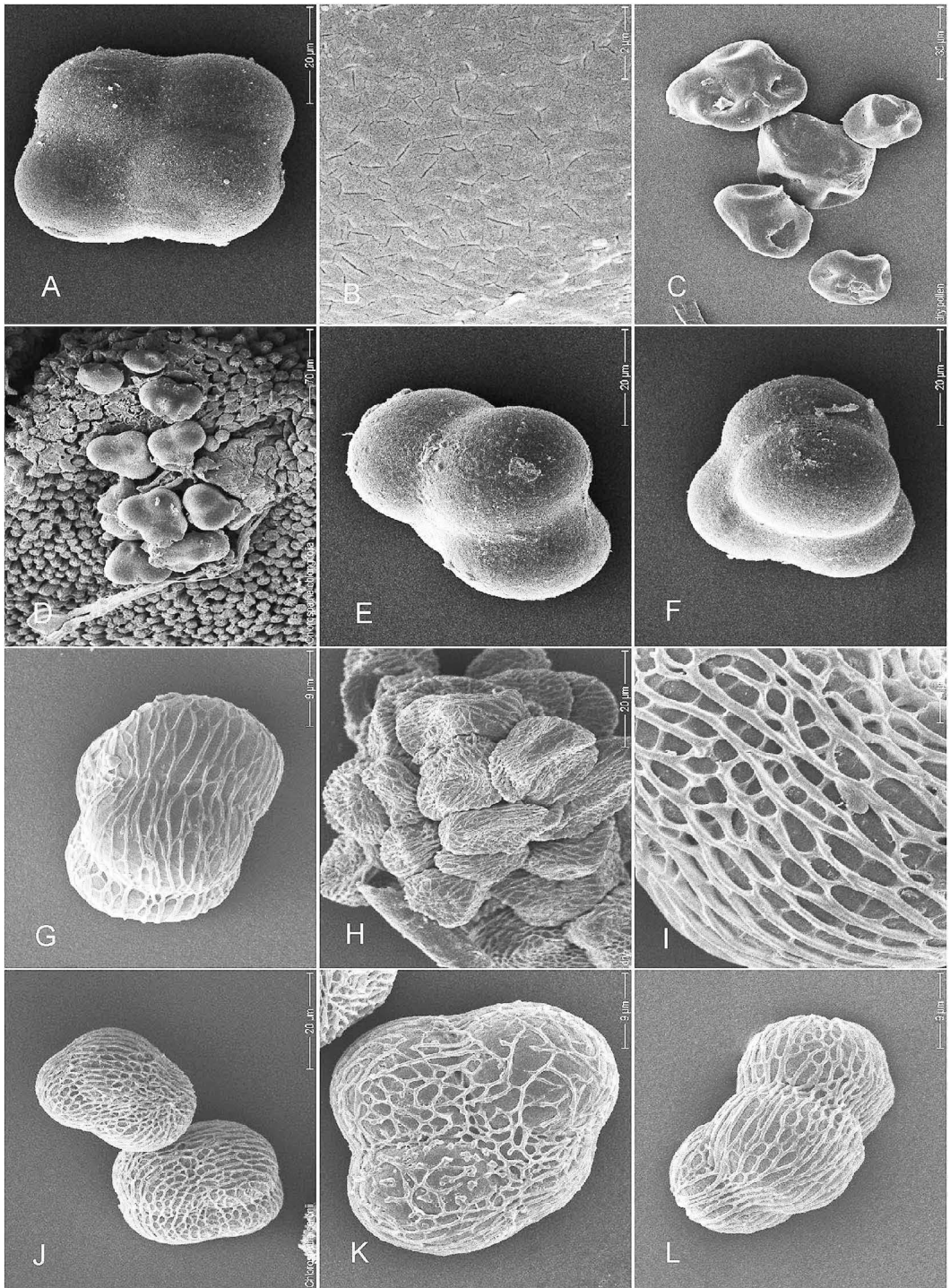


Figure 3. A–F. *Chlorospatha oblongifolia* Croat & L. P. Hannon, *Croat & Gaskin 80957* (MO). —A. Pollen tetrad, top view. —B. Close-up of tetrad surface. —C. Group of tetrads. —D. Group of tetrads emerging from anther. —E. Tetrad, side view. —F. Tetrad, oblique view. G–L. *Chlorospatha ploumanii* (Madison) Croat & L. P. Hannon, *Croat & L. P. Hannon 81475* (MO). —G. Tetrad, side view. —H. Group of tetrads. —I. Close-up of tetrad surface. —J. Tetrad, oblique view. —K. Tetrad, top view. —L. Tetrad, side view.

except in *C. croatiana* subsp. *croatiana*, in which these can also be longer. All eight species from the eastern slopes of the Andes for which funicle length is known have funicles shorter than the ovules.

Ovules are anatropous or hemianatropous in *Chlorospatha*. Of the 23 species from both slopes of the Andes for which ovule orientation was determined, 17 had hemianatropous ovules. Anatropous ovules were observed in *C. hastata*, *C. kolbii*, and *C. oblongifolia* from the western slopes and *C. cutucuensis*, *C. longipoda*, and *C. sizemoreae* from the eastern slopes. Most ovules are more or less subhemispherical in longitudinal section, but the ovules were dorsiventrally compressed and comparatively narrow in one collection of *C. corrugata* (*E. Spear s.n.*), two collections of *C. croatiana* subsp. *croatiana* (Croat & Grayum 60208, Croat 74799), and one collection of *C. longipoda* (Croat 59100). Other collections of *C. longipoda* had what are presumably typically shaped ovules. Ovule orientation in *C. corrugata* and *C. mirabilis* was determined from illustrations in Mayo et al. (1997) and Masters (1874), respectively.

The embryology of *Chlorospatha* has, to our knowledge, not been examined. However, according to Grayum's (1991b) treatment of embryology, the ovules would presumably be bitegmic in *Chlorospatha*, with the inner integument forming the micropyle, this being the typical condition in Araceae, unitegmic ovules having been reported only in *Montrichardia* Creg.

Placentation. Placentation is pseudoaxile, axile, subaxile, or rarely sub-basal or basal in *Chlorospatha*. Pseudoaxile placentation, as defined by Mayo et al. (1997), is "a form of parietal placentation in which the placentae are borne on very deeply intrusive partial septa which may be partially fused (e.g., basally or apically)." Pseudoaxile placentation was observed in eight species. Superficially, the placentae appear to be a single axis, with placentation effectively axile or subaxile, with ovules occurring the entire length and placentation axile in *C. atropurpurea*, *C. lehmannii*, *C. plowmanii*, and *C. sagittata*; occurring only on the basal two thirds and placentation subaxile in *C. cutucuensis* and *C. kolbii*; or occurring the entire length and axile or on the basal one half to two thirds and subaxile in *C. longipoda*. Madison's descriptions of the ovaries of *C. castula* (1981) and *C. atropurpurea* (1976, 1978) clearly indicate a pseudoaxile condition. However, three collections of *C. atropurpurea* examined by the authors had true axile placentation, with the septa connate the entire length. In *C. castula*, placentation is effectively basal, according to Madison's descrip-

tion, a rare condition observed only in the type collection of *C. plowmanii* and some ovaries of an aberrant collection of *C. longipoda* (Croat 86607). Excluding the aforementioned species, true axile and subaxile placentation were the most common states observed in *Chlorospatha*, with placentation axile in 10 species, subaxile in four species, and either axile or subaxile in one species, *C. boosii*, one of the six species examined that usually have 2-locular and occasionally some 1-locular ovaries, the others being *C. hannoniae*, *C. limonensis*, *C. longipoda*, *C. plowmanii*, and *C. pubescens*. In the species not previously discussed, 1-locular ovaries (when present) have an interrupted axis in *C. hannoniae*, *C. limonensis*, and *C. pubescens*, whereas those of *C. boosii* have a complete, but extremely thin, fragile axis, and all but *C. hannoniae* have subaxile placentation. Unilocular ovaries of *C. hannoniae* have a sub-basal placental ring with depauperate ovaries arranged in a single row along the margin.

Arrangement of the ovules was consistently biseriate in 16 of the 23 species in which the condition could be determined. Placentae were 1- to 2-seriate in *Chlorospatha croatiana* subsp. *croatiana*, *C. longipoda*, and possibly other taxa. It is possible that what would appear to be uniseriate placentae in *Chlorospatha* are actually biseriate, with the funicles attached alternately along the placental ridge, a condition that Mayo (1989) maintained might occur in apparently uniseriate placentae in *Philodendron*. This could not be determined in *Chlorospatha*, the arrangement of ovules in uniseriate placentae being somewhat disorganized in most cases. In *C. hannoniae*, *C. limonensis*, and *C. oblongifolia*, placentae were usually biseriate, but occasionally also 3-seriate. Engler (1920) described the ovules of *C. lehmannii* as biseriate, but his illustration of the ovary in this species indicates a 3- to 4-seriate condition.

Style and stigma morphology. **Style Type 1** (Fig. 1) lacks a mantle and is weakly thickened, comprising significantly less than one fourth of the length of the pistil, as broad as or somewhat narrower than the ovary apex, more or less truncate at the apex, and occasionally broadly concave medially. Though usually not attenuated, it can rarely be obscurely so. Style Type 1 is restricted to eight species in *Chlorospatha* sect. *Orietales*, from the eastern slopes of the Andes in Ecuador, and is the predominant style type in the region: *C. boosii*, *C. engleri*, *C. hannoniae*, *C. limonensis*, *C. longipoda*, *C. plowmanii*, *C. pubescens*, and *C. yaupiensis*.

Style Type 2 (Fig. 1) lacks a mantle and is similar to Style Type 1, but differs in being briefly to

moderately attenuated, thus comprising one fourth to one third of the length of the pistil. Style Type 2 is restricted to three species from the eastern slopes of the Andes in Ecuador, *Chlorospatha cutucuensis*, *C. portillae*, and *C. sizemoreae*, members of *Chlorospatha* sect. *Orientalis*. In a pickled inflorescence of *C. cutucuensis*, the style appeared to be somewhat elastic, being prominently and variably wrinkled on some pistils, particularly at the apex, frequently forming a “collar” around the stigma, with only the apex of the stigma visible above the apex of the style. Fresh material of this species was not examined. This condition does not appear to occur in *C. portillae* or *C. sizemoreae*.

Style Type 3 (Fig. 1) is expanded into a disklike mantle that is approximately as wide as the ovary apex and surrounds the stigma, thus obscuring its point of attachment. The style is not typically attenuated, but can rarely be obscurely so, and comprises one fourth or less of the length of the pistil. Style Type 3 is confined to taxa in *Chlorospatha* sect. *Chlorospatha*, which is comprised of all taxa (18) that consistently or occasionally have divided leaf blades, with one exception, *C. corrugata*, a species with divided blades and Style Type 4 (Fig. 1). All taxa with Type 3 styles occur in Central America or northern Colombia, except *C. ilensis*, which is from Ecuador.

Style Type 4 (Fig. 1) is expanded into a broadly spreading mantle much wider than the ovary apex, obscuring the point of attachment of the stigma, and is obscurely or not at all attenuated. Style Type 4 comprises ca. one fourth or less of the length of the pistil and is confined to four species in *Chlorospatha* sect. *Occidentales*. *Chlorospatha corrugata* occurs only in northern Colombia. The other three species, all from the western slopes of the Andes in Ecuador, exhibit some noteworthy variation. In *C. castula* and *C. hastata*, the mantle is extremely thin, composed of tuberculate cells and is as much as 3 times wider than the ovary apex, with the margins more or less coherent with those of adjacent mantles. The mantle of *C. corrugata* is similar to that of these two species. The mantle in *C. sagittata* is not as broadly spreading and is slightly thicker, composed of subhemispherical cells, and the margins usually are not coherent with those of adjacent mantles.

Style Type 5 (Fig. 1) is expanded into a broadly spreading mantle that is conspicuously wider at the base than the ovary apex and not appressed to the ovary. The long-attenuated style comprises approximately one half of the length of the pistil, with the margins of the mantles more or less coherent or weakly coherent with those of adjacent mantles. Style

Type 5 is restricted to six species in *Chlorospatha* sect. *Occidentales*: *C. grayumii*, *C. huilensis*, *C. jaramilloi*, *C. longiloba*, *C. narinoensis*, and *C. planadensis*. Five of these species occur only on the western slopes of the Andes in Colombia and Ecuador. Some collections of the sixth species, *C. huilensis*, were made in the Magdalena River drainage on the western slopes of the Cordillera Oriental in Colombia; however, one or possibly two collections were made in the Amazon drainage, at the southern terminus of the mountain range. This species and *C. sucumbensis* (Style Type 9, Fig. 1) from northern Ecuador are the only species occurring in the Amazon drainage that have styles expanded into mantles. Some dried material of this style type could possibly be confused with Style Type 8 (Fig. 1H), regarding whether the mantle is appressed to the ovary; however, the distinction is clear in living or pickled material.

Style Type 6 (Fig. 1) is expanded into a broadly spreading mantle that is conspicuously wider at the base than the ovary apex and not appressed to the ovary. The briefly attenuated style comprises approximately one third of the length of the pistil, with the margins of all mantles more or less coherent or weakly coherent. Style Type 6 is restricted to two species in *Chlorospatha* sect. *Occidentales*: *C. antioquiensis* from the Magdalena River drainage in Colombia and *C. litensis* from northern Ecuador. Some dried material of this style type could possibly be confused with Style Type 9 (Fig. 1), regarding whether the mantle is appressed to the ovary; however, the distinction is clear in living or pickled material.

Style Type 7 (Fig. 1) is expanded into a spreading mantle approximately as wide as or slightly wider or narrower at the base than the ovary apex. The long-attenuated style comprises one half to two thirds of the length of the pistil, with the margins of the mantles not at all coherent in two species and weakly coherent in one species (*Chlorospatha caliensis*). Style Type 7 is restricted to three species known only from dried material, in *Chlorospatha* sect. *Occidentales*: *C. caliensis*, *C. lehmannii*, and *C. stellararreae*, from the western slopes of the Andes in Colombia.

Style Type 8 (Fig. 1) is expanded into a spreading mantle that is appressed to the ovary and slightly wider at the base than the ovary apex. The style is long-attenuated and comprises one half to two thirds of the length of the pistil, depending on the species. The margins of the mantles are not at all coherent in five species and somewhat weakly coherent in two species. Some dried material of this style type could possibly be confused with Style Type 5 (Fig. 1), but

style type is easily determined in living or pickled material. Style Type 8 is confined to seven species from the western slopes of the Andes in Colombia and Ecuador and the Magdalena River drainage in Colombia, all members of *Chlorospatha* sect. *Occidentales*: *C. amalfiensis*, *C. atropurpurea*, *C. dodsonii*, *C. giraldoi*, *C. nambiensis*, *C. noramurphyae*, and *C. tokioensis*.

Style Type 9 (Fig. 1) is expanded into a spreading mantle that is appressed to the ovary and weakly wider at the base than the ovary apex. The style is briefly attenuated and comprises approximately one third of the length of the pistil. The margins of mantles are coherent or weakly coherent in nine species and not at all coherent in one species (*Chlorospatha bayae*). Some dried material of this style type could possibly be confused with Style Type 6 (Fig. 1), but style type is easily determined in living or pickled material. This style type is confined to 10 species from the western slopes of the Andes in Colombia and Ecuador, all members of *Chlorospatha* sect. *Occidentales*: *C. bayae*, *C. besseae*, *C. bogneri*, *C. bullata*, *C. carchiensis*, *C. mansellii*, *C. ricaurtensis*, *C. sucumbensis*, *C. timbiquensis*, and *C. yatacuensis*.

Style Type 10 (Fig. 1) is expanded into a spreading mantle that is approximately as wide as or weakly wider or narrower at the base than the ovary apex. The style is briefly attenuated and comprises approximately one fourth to one third (usually one fourth) of the length of the pistil, with the margins of the mantles not at all coherent. Style Type 10 is restricted to four species from the eastern and western slopes of the Cordillera Occidental in Colombia, all members of *Chlorospatha* sect. *Occidentales*: *C. congensis*, *C. macphersonii*, *C. nicolsonii*, and *C. oblongifolia*.

The styler region in *Chlorospatha* is herein defined as that portion of the gynoeceum between the ovary locules and stigmatic epidermis, with the terminology attributed to Mayo et al. (1997), who rightly note that the "style" can be as broad as the ovary and not elongated or attenuated in some Araceae, which is clearly the case in approximately 40% of taxa of *Chlorospatha*. However, for the sake of simplicity and in consideration of the fact that a distinct styler region exists in all *Chlorospatha*, the term "style" will henceforth be used in descriptions and discussions. Fresh or dried styles exhibit considerable diversity of form, even when viewed with a hand lens (10 \times). The various forms are frequently critical in delimitation of species and easily distinguishable in fresh material, although some morphological details are visible only microscopically, after dissection. In all taxa, the main body of the style is distinguished from the ovary,

externally, by a visible (30 \times) rimlike margin at the base of the style, although this margin can be somewhat obscure in some species (see Style Types 1 and 2, Fig. 1). Mantles, when present, must be removed in order to expose this margin. The diameter at the base of the main body of the style is the same as or somewhat narrower than that of the ovary apex.

Stylar morphology in *Chlorospatha* falls into two general but distinct categories herein designated, to facilitate reference in this discussion, as Category A, represented by 60 taxa with the style expanded into a mantle that is apparently, for the most part, not fused to the main body of the style (Style Types 3–10), and Category B, represented by 11 species in which the mantle is lacking (Style Types 1 and 2). Style Types are illustrated in Figure 1. Taxa with styles in Category A are further divided into two groups that reflect sectional differences: *Chlorospatha* sect. *Chlorospatha* and *Chlorospatha* sect. *Occidentales* (see Infrageneric Relationships above). In *Chlorospatha* sect. *Chlorospatha*, the style is obscurely or not at all attenuated or elongated and the mantle is more or less disklike, approximately as broad as or weakly narrower or broader than the ovary apex and usually less than 0.5 mm long, comprising a small fraction of the length of the pistil. The mantle surrounds the stigma, obscuring its point of attachment; therefore, the stigma appears to be sessile in all taxa in this section. The stigma is indeed sessile in *C. kolbii* (lacking any obvious style) and presumably so in other taxa in this section; however, dissection of the living pistils of some collections of *C. croatianae* subsp. *croatianae* and *C. ilensis* revealed an obscure attenuation of the style that could possibly occur in other taxa. The styles in all taxa belonging to *Chlorospatha* sect. *Chlorospatha* are Type 3 (Fig. 1), which occurs exclusively in this section.

In *Chlorospatha* sect. *Occidentales*, comprised of the second group of taxa in Category A, the style is typically more or less attenuated, comprising one fourth to two thirds of the length of the pistil, with the stigma elevated on the narrowed portion, rarely sessile or apparently so, and the mantle either spreading or appressed to the ovary and weakly to prominently broader than or as broad as the ovary apex. The mantle surrounds the entire length of the main body of the style subtending the stigma and terminates at its apex. Diversity of form is highest in this section, with seven of the 10 style types observed in *Chlorospatha* represented. Characters that separately or in combination delimit the style types in this section, in order of significance, are: the ratio of the length of the style to that of the pistil; whether the mantle is spreading or appressed to the ovary and, if

spreading, whether it is as wide as or slightly to moderately or distinctly wider than the ovary apex; and the degree to which the margins are coherent (or not) with those of adjacent styles. These characters and their various combinations are remarkably consistent on the species level, even in relatively wide-ranging taxa in which one might expect more variation. The style occupies one half or slightly more of the length of the pistil in 15 species, one third of the length in 12 species, one fourth to one third of the length in four species, and two thirds of the length in two species, and is atypical in four species in which the style occupies significantly less than one fourth of the length of the pistil: *C. castula*, *C. corrugata*, *C. hastata*, and *C. sagittata* (Style Type 4, Fig. 1). Madison (1978) maintained that the stigma of *C. castula* is sessile; however, it is possible that its stylar morphology accords with that of *C. hastata* and *C. sagittata* in which the style is obscurely attenuated, with the mantle obscuring the point of attachment of the stigma, thus rendering the stigma only apparently sessile (as observed in dissected living material). Therefore, the style of *C. corrugata* is possibly also obscurely attenuated.

The style is between 0.5 and 1.2 mm long in most species in *Chlorospatha* sect. *Occidentales*, but can be 2 mm long in *C. caliensis* and *C. dodsonii*, occupying two thirds of the total pistil length, and as little as 0.3–0.5 mm long in *C. oblongifolia*, *C. stellasarreae*, and *C. yatacuensis*, which have small pistils with styles occupying between one fourth and one half of the total pistil length, depending on the species. The ratio of the length of the style to the length of the pistil correlates with style type and, therefore, is a more taxonomically significant character than the actual length of the style, which varies considerably in *Chlorospatha*, according to the size of the flowers. The same principle would apply to the diameter. The diameter of the style is 1–1.3 mm in some species with relatively short pistils and styles either broader or narrower than the ovary apex; therefore, the relative diameter is more significant than the measured diameter. In most taxa, the diameter of the style is between 1.5 and 2.3 mm, but exceeds this in five species with styles 2.5–2.6 mm in diameter and in *C. castula* with the style 3 mm in diameter. The diameter of the style, as given in descriptions of taxa that possess a mantle, refers to the maximum diameter of the mantle (at the base) rather than to that of the main body of the style beneath it and is the taxonomically significant character. Similarly, the length of the style, as applied in descriptions, refers to the length from the apex to the base of the mantle, which in species

with the mantle appressed to the ovary, can be greater than the length of the main body of the style, the base of which is obscured by the mantle.

In both aforementioned groups, the mantle can consist of one to two layers of hyaline or subspherical cells (Madison, 1978), or tuberculate cells, with few to numerous red chromoplasts visible in some taxa. Red chromoplasts were not observed, but possibly occur in the main body of the style beneath the mantle. In most taxa, the mantle lacks structural integrity, the cells being easily separated and the mantle itself easily scraped away in an amorphous mass. However, mantles comprised of subspherical cells, in some Type 4 and Type 3 styles and most Type 8 and Type 9 (see Fig. 1) styles, can be easily lifted off more or less intact (in living material but not pickled material), the cells not being easily separated.

The youngest inflorescences in sympodia were dissected in order to determine whether the mantle was excreted at some point in its development. The mantle was present in all dissections, which were performed at various stages of development and revealed no change other than an increase in size and moderate increase in color value as inflorescences matured. Therefore, though the mantle is not entirely fused to the main body of the style, it is integral with it. It would appear that the mantle is not homologous to the discoid style of *Xanthosoma*, since it represents only a portion of the style in *Chlorospatha* and is neither similarly fused to the ovary nor typically entirely coherent with adjacent styles as it is in *Xanthosoma*. There appeared to be fusion of the innermost layer of cells near the stigma in taxa in *Chlorospatha* sect. *Chlorospatha*, and along the attenuated portion below the stigma in species in *Chlorospatha* sect. *Occidentales*.

The mantle is somewhat deliquescent after female anthesis, with the surface becoming visibly liquid and the free portions of broadly spreading mantles collapsing against the ovary walls. However, the substance and form persist to some extent, through the pollen cycle and even after abscission of the spathe blade and fertile male portion of the spadix. Some vestiges of the mantle were visible in the early fruiting stages in some cases. Understanding of the overall function of the mantle, if a single function exists, remains elusive. It seems likely, considering the remarkable diversity of form and coloration observed that it serves more than one purpose or perhaps different purposes in different taxa. However, all would certainly relate directly to pollination biology. The diversity of coloration in the mantle and the fact that color reaches maximum intensity at

anthesis and is quite bright in numerous taxa, suggest that color serves an important purpose, perhaps as an attractant for pollinators. Madison (1978, 1981) suggested that the mantle possibly served as an osmophore, a notion that can probably now be discounted (see Spadix above), or to bridge the gap between pistils and thereby provide an even surface over which stigmatic fluid could flow freely from one flower to the next. The latter possibility could be the case in some but not most *Chlorospatha*. The margin of the mantle is usually not at all coherent with those of adjacent mantles in taxa in *Chlorospatha* sect. *Chlorospatha* nor in 12 species in section *Occidentales*, although a few mantles can be weakly coherent on spadices of some taxa in both sections. By “weakly coherent” we mean that some, but not all, margins of some adjacent mantles are contiguous. Most of the remaining species in *Chlorospatha* sect. *Occidentales* have mantles that are weakly coherent, leaving only 11 species in the genus with more or less consistently coherent mantles. Therefore, the notion that the mantles serve the purpose of providing a continuous surface for the flow of stigmatic fluid between flowers does not pertain in most *Chlorospatha*.

The density of arrangement of mantles is not correlated with the density of arrangement of ovaries, which can be laxly or densely arranged, regardless of the arrangement of the associated mantles, depending on the taxon. This is dramatically illustrated in *Chlorospatha castula* (*Chlorospatha* sect. *Occidentales*) in which the ovaries are markedly laxly arranged and the mantles 3 times wider than the ovary apex, with the margins coherent with those of adjacent mantles and, therefore, densely arranged. In *C. kolbii* (*Chlorospatha* sect. *Chlorospatha*), the ovaries are laxly arranged and the mantle is narrow, with the margins not at all coherent. The density of arrangement of pistils, in our descriptions, refers only to arrangement of the ovaries, with that of the styles noted separately.

The style is not expanded into a mantle in species in Category B, which includes all species in *Chlorospatha* sect. *Orientalis* and can be further divided into two groups. In one group comprised of *C. cutucensis*, *C. portillae*, and *C. sizemoreae*, the style is briefly attenuated and as broad as or moderately narrower at the base than the ovary apex, with the margin obscure (Style Type 2, Fig. 1). Attenuation is not as pronounced as in most styles in *Chlorospatha* sect. *Occidentales*. Red chromoplasts were a primary means of distinguishing the styler region from the ovary in pickled material of *C. cutucensis*, although Madison (1981) describes the style as yellowish in living material. No chromoplasts were observed in the

dried or pickled material of *C. portillae* or *C. sizemoreae*. In the second group (Style Type 1, Fig. 1) comprised of *C. boosii*, *C. engleri*, *C. hannoniae*, *C. limonensis*, *C. longipoda*, *C. plowmanii*, *C. pubescens*, and *C. yaupiensis*, the styles are not usually attenuated, but obscure attenuation was observed in living material of *C. engleri* and some collections of *C. longipoda*, and possibly occurs in other species in this group. Styles in this group are as broad as or weakly narrower than the ovary apex, extremely thin, though somewhat thicker and tougher than the ovary walls, with the margins weakly or not at all coherent with those of adjacent styles.

The style and its margin are frequently difficult to distinguish from the ovary. Even in living material, the margin is difficult to discern in *Chlorospatha plowmanii* and *C. sizemoreae*, in which coloration of the style and ovary is identical and the typical rimlike margin is apparently obscure or absent. However, the margin is usually easily discernible in dried material in all species. Coloration and a surface texture that is different from that of the ovary serve to easily distinguish the style in living material of *C. boosii*, *C. engleri*, *C. hannoniae*, and most collections of *C. longipoda* and *C. pubescens* in the second group, and in *C. cutucensis* and *C. portillae* in the first group. In these species, the surface is usually somewhat colliculate (comprised of minute subhemispherical elevations) and appears somewhat matte or even velvety in living material, and less glossy than the ovary. In *C. plowmanii*, *C. sizemoreae*, and some collections of *C. longipoda* and *C. pubescens*, this texture was lacking. Red chromoplasts are usually visible in both living and dried styles in the second group of species and are helpful in determining the styler region. The style of *C. limonensis* is known only from pickled material and that of *C. yaupiensis*, only from dried material. The styles in this group (Category B) are possibly homologous to the discoid styles found in *Xanthosoma*. In both, the style lacks a mantle and is approximately as wide as the ovary apex; however, it is extremely thin and weakly or not at all coherent with adjacent styles in *Chlorospatha* sect. *Orientalis*, but is thick and coherent in *Xanthosoma*.

The stigma is sessile or apparently so in 30 taxa (Style Types 1, 3, and 4, Fig. 1), and more or less elevated on an attenuated style in 35 species (Style Type 2; Style Types 5–10). In taxa with sessile stigmas, living or pickled material must be examined microscopically (30 \times) to determine if the sessile condition is actual or merely apparent. The stigma was examined in living material of 23 species and pickled material of two additional species, and in all

cases were found to accord with Madison's (1978) description of the stigma of *Chlorospatha castula* as "brushlike." The stigma is densely papillate in *Chlorospatha*, as in most Araceae (Engler, 1920), with the papillae exceedingly thin and much longer than wide. In all living specimens examined, the individual papillae were clearly visible. In those species with elevated stigmas, the stigma was usually capitate or subcapitate, or cylindrical to obconical and truncate at the apex, or more or less coronate and broadly depressed medially, or in a few cases, weakly lobed. The shape of the stigma appeared to be disklike in dried material of a few species with elevated stigmas and in living material of *C. besseae*. More or less obconical stigmas that are broadest and truncate at the apex are also usually coronate and typical in *Chlorospatha* sect. *Orientalis*. Stigmas in *Chlorospatha* sect. *Chlorospatha* are usually disklike and conspicuously wider than long, occupying half or occasionally more than half of the apical surface of the pistil. In *C. croatianica* subsp. *croatianica*, the disklike stigma was conspicuously coronate. In most *Chlorospatha*, the stigma is approximately as long as wide and usually between 0.2 and 0.7 mm in diameter, though some species with larger pistils can have stigmas almost 1 mm in diameter. Taxa in *Chlorospatha* sect. *Chlorospatha* frequently have stigmas 1 mm in diameter or slightly less.

Styles, including the mantle (when present), and stigmas, in both living and dried material, appeared undisturbed, with no signs of having been eaten by insects, in either wild or cultivated material. The living pistillate portions of the spadix in some species from all three sections were tasted and chewed at anthesis (by the second author) and lacked sweetness, pleasant or unpleasant flavor, or stinging quality. The living specimens sampled were few and no conclusions could be drawn. The stigma and all or some portion of the style persist in fruit.

Coloration. Coloration of the pistils is known in 32 species and is taxonomically significant, usually being a consistent character on the species level. In all cases, coloration is attributable to the style and is exceedingly diverse in *Chlorospatha*, with greatest diversity occurring in species in *Chlorospatha* sect. *Occidentales*, which also have the most varied and highly modified styles, with coloration confined to the mantle. In these species, the mantle can be white, cream, more or less green, bright orange, pinkish orange, rose-colored, purplish, yellow to yellowish, or pink. Coloration is somewhat less diverse in *Chlorospatha* sect. *Chlorospatha* in which the mantle can be white, cream-colored, or green, with two exceptions: *C. mirabilis*, with pink, yellow, or orange

mantles, and *C. callejasii*, with red mantles. In *Chlorospatha* sect. *Orientalis*, a mantle is lacking and the style is white, cream, yellow, pale or medium green, or yellow-green in seven species, and white and densely dark purple-speckled in *C. hannoniae*. The color noted is always the perceived color, this being more significant in making determinations than actual color. As noted previously, the mantle, when present, can be exceedingly thin and, whether clear or to some degree colored, can therefore assume some of the coloration of the ovary or the main body of the style beneath it.

Coloration of the stigma is known in 21 species, 12 of which have white or cream-colored stigmas that can be somewhat greenish in three species. Exclusively greenish stigmas were observed in *Chlorospatha oblongifolia* and *C. sizemoreae*. The stigma of *C. bayae* is described as golden tan, but was possibly observed post-anthesis, similar coloration having been observed in numerous taxa after anthesis. Yellow or yellowish stigmas were observed in five species. Greatest variation was observed in *C. hastate*, with both orangish yellow and orangish white stigmas. In all cases, the stigma is somewhat translucent.

Style types. Style type is the most important gynoecial feature in *Chlorospatha* and frequently the critical delimiting character on the species level. The gynoecial classification presented in the present work is original and consists of 10 style types illustrated in Figure 1. Although the stigma is, with few exceptions, somewhat uniform superficially, the style is highly morphologically diverse. Each style type, except Type 7 (Fig. 1), is represented by at least one species, frequently more, known from living or pickled material, and although most taxa are known only from dried material, the drying characteristics of presumably similar taxa known from living or pickled material have been applied to interpretations of these. In most cases, the morphology of dried styles corresponds to that of living styles and only in rare instances, when pistils were poorly preserved, are style types deduced from what were considered other relevant factors, such as associated floral structures and/or their arrangement. Style type was determined in all taxa except Species 1–4, *C. munchiquensis*, and *C. queremalensis*, with only fruiting material available of *C. munchiquensis* and neither fruiting nor fertile material available of the remaining species.

FRUITS AND SEEDS

In the 27 species of *Chlorospatha* in which an infructescence was present, the developing pistils

were contained within the closed spathe tube after anthesis and pollination, presumably until fully ripe, with the tube persisting and ultimately separating at the margins at maturity. Mature infructescences with ripe berries were observed in only approximately half of these species, but these represent all sections and, therefore, all known floral morphologies in the genus. The spathe tube enlarges to accommodate the developing berries that eventually force the margins of the tube apart, thereby exposing the ripe berries (see Spathes, above).

The berries of *Chlorospatha* are depressed-globose, as long as wide or somewhat wider than long, and more or less 2- to 4-furrowed (or 5-furrowed [Mayo et al., 1997]), with the furrows usually coinciding with the position of the locule walls and their number equal to the number of locules. Remnants of the stigma are persistent, and the margins of the style are clearly visible on ripe berries, also occasionally some remnants of the mantle as the berries develop, in those taxa with a mantle. The size of the berries is known in 21 species and is between 1.5 and 5 mm long, and 2 and 5 mm in diameter, in most cases. The berries of *C. dodsonii* are as much as 7 mm in diameter, the largest in the genus, possibly to accommodate the numerous seeds that usually occur in this species, which, although usually 3- to 4-locular, can have as many as 15 ovules per locule, the greatest number observed in locules of plurilocular ovaries in *Chlorospatha*. Berries are fleshy in *Chlorospatha*, with the seeds usually clearly visible through the sides, which are quite thin and easily ruptured.

Nothing is known about fruit dispersal in *Chlorospatha*. Dehiscence is apical and the mesocarp surrounding the seeds is gelatinous and sticky, which would suggest animal or bird dispersal. It is not known if flavor or fragrance occurs in the ripe berries. Coloration of the berries is known in only 10 species, but could possibly provide some clues regarding dispersal. The berries are entirely greenish white, pale green, or creamy green in four species, *C. atropurpurea*, *C. engleri*, *C. gentryi*, and *C. stellarsarreae*, but can also be yellow in *C. atropurpurea*. Greenish yellow berries were reported for *C. narinoensis*. The cream or pale green berries of *C. longipoda* (Croat et al. 86561) were violet-tinged and those of *C. plowmanii* (Croat et al. 88008A) purple-speckled. In *C. croatiana* subsp. *croatiana*, *C. cutucuensis*, and *C. dodsonii*, the berries were white. The absence of orange or red berries in this sample is possibly significant.

Little is known about the seeds of *Chlorospatha*. However, those observed were minute, ovoid to

ellipsoid and terete, or slightly obtusely 3-sided (Croat et al. 86561), white to somewhat creamy in color or pale green (Croat et al. 88008A), somewhat brownish when dry, and contained copious amounts of endosperm (Mayo et al., 1997). Seeds were 1–2 mm long and 0.8–1 mm in diameter, with the testa longitudinally costate except in *Croat et al. 88008A*, a collection of *C. plowmanii* from the eastern slopes of the Andes in Ecuador, in which the testa was smooth. Smooth seeds are possibly typical of this species, but the seeds of this collection were the only ones of this species available for examination. Grayum (1986) noted that seeds of *C. croatiana* were brown-strophiolate and that there were 15 to 25 in each berry. Most ovaries of this species are 3-locular, with seven to 10 ovules per locule, the number of ovules corresponding well with the number of seeds observed. Such is not the case in *C. cutucuensis* and *C. longipoda*, wherein the number of seeds is significantly less than the number of ovules. In *C. cutucuensis*, the ovaries are 3- to 4-locular, with four to 10 ovules in each locule, yet only three to five seeds (mostly three) were observed in the berries (Madison, 1981). There are seven to eight seeds in berries of *C. longipoda* in which most ovaries are 2- to 3-locular, with eight to 12 ovules per locule. Madison (1981) suggested, regarding *C. cutucuensis*, that this disparity in the number of ovules and seeds might indicate recent evolution toward an increase in seed size and a decrease in the number of seeds. However, it is possible that not all ovules were properly pollinated, and when berries are carefully examined, the remains of undeveloped ovules are frequently observed. It is possibly significant that these dissimilar species, *C. cutucuensis* and *C. longipoda*, are from the eastern slopes of the Andes in Ecuador, whereas *C. croatiana* is from Central America. The largest seeds were observed in *C. longipoda*, these being as much as but frequently less than 2 mm long. However, this is not significantly larger than the maximum length of 1.5 mm observed in other taxa.

The embryo is elongate and axile in *Chlorospatha* (Mayo et al., 1997).

POLLINATION BIOLOGY

Little is known about the pollination biology of *Chlorospatha* in the wild, beyond reports that flies and small beetles (Scarabaeidae, Staphylinidae) have been collected in the inflorescences (Madison, 1981). Mayo et al. (1997) list only Staphylinidae as possible pollinators. Label notes for *L. Bittner 2493* (MO) indicate that black beetles pollinate *C. bogneri*; however, it is possible that the beetles were merely

present in the spathe and are not necessarily the true pollinators. Staphylinidae are often found in rotting fruit but more frequently in rotting animal and vegetable matter in which they lay their eggs, and the adults and their larvae feed on flies and fly larvae, possibly on other beetle larvae (Dr. Bob Woodruff, pers. comm.). Interestingly, Julius Boos (pers. comm.), an expert on beetle behavior, suggests that the Staphylinidae are possibly attracted either by the usually fruity fragrance of the *Chlorospatha* inflorescence or by the flies that are attracted to that fragrance, and thereby become coincidental pollinators as they feed on the flies. It would seem equally plausible that the flies themselves are the pollinators and that the presence of the Staphylinidae is entirely coincidental. However, pollen is essentially smooth, not spinose, in *Chlorospatha*, and smooth pollen is generally correlated with pollination by beetles, whereas spinose pollen is correlated with pollination by flies (Grayum, 1984, 1985, 1990). None of the sterile flowers or parts of the pistils had been eaten in the living or dried material examined by the authors, which frequently occurs in association with pollination by beetles. Grayum (1990) noted that protogyny is frequently seen in association with beetle pollination. As with most Araceae, the flowers are strongly protogynous in *Chlorospatha*, with the stigma receptive approximately 12 to 24 hours before the onset of anther dehiscence, with the phases not overlapping. In cultivation, pollen was frequently observed in the spathe tubes during and after anther dehiscence.

Prior to this treatment, it was generally assumed that at anthesis, the spathe of *Chlorospatha* opened only narrowly on the blade portion, which would greatly limit the size of pollinators, the spathe tube typically being quite narrow (pre-anthesis), usually less than 1 cm in diameter. During a period of one to seven years, the authors studied 19 diverse species representing the full geographical distribution and presumably most if not all pollination strategies in the genus, and observed conditions contrary to those described by Madison (1981) (see Spathes, above). The entire spathe opened either narrowly to broadly at anthesis, with the opening comprising between two thirds and three fourths of its length in seven species, to within 1–2 mm of the base in seven species, and in all cases, had some or most of the pistillate portion of the spadix exposed. In five species, only the blade opened more or less broadly at anthesis, with some of the apical portion of the tube also open (Fig. 6B), usually exposing some of the pistillate portion of the spadix, to as much as one third of that portion in some species. Even when the pistillate portion is not visible from a forward position, it is clearly visible

when viewing from above since the apex of the tube is much expanded at anthesis. Although the considered sample is small, exposure of some of the pistillate portion at anthesis is apparently significant, this being the predominant condition in the sampled taxa. It is possible that exposure of the pistils is coincidental to the increased accessibility to pollinators afforded by the openness and considerable increase in size of the spathe tube.

Coloration of the pistils is diverse, attributable to the style, frequently intense and often considerably different from that of the fertile and sterile male portions of the spadix (see Spadix above). Color is most intense at anthesis and clearly visible in most taxa observed. For color to be manifest implies, to some level of certainty, that it is necessary. While it might be possible for colors to be differentiated at night, it would require spectral perception beyond the norm, on the part of pollinators, specifically perception of infrared, ultraviolet, or both wavelengths. There are no studies of color perception in beetles, but ultraviolet perception is possibly involved, many flowers in various families having clearly marked ultraviolet pathways invisible to the human eye, leading to the sexual areas of the flowers (Dr. Bob Woodruff, pers. comm.). It is more likely that color in *Chlorospatha* flowers evolved to appeal to conventional visual perception. Since color-differentiating sight cells, compared to broad-spectrum (black-and-white) light-sensing cells, are traditionally inversely sensitive to light by a factor of 100,000 to one, it is generally accepted that animals with good color vision are primarily diurnal or active in high light times. Considerable visual acuity is sacrificed for color perception; therefore, it seems likely that color plays a critical role in what must certainly be a diurnal pollination syndrome in *Chlorospatha*, all known relevant factors indicating such a syndrome.

The spathe began to open after dawn, between 0600 and 1000 hours of day 1, and was fully expanded by 1200 to 1400 hours in the 18 species examined. The expansion and disposition of the spathe as it approaches and reaches anthesis were observed in the wild and confirmed in most species examined and in a number of additional species that were not observed over time or in cultivation. This behavior coincides with the onset and subsequent increase in intensity of fragrance observed in 17 of the 18 species (see Sterile Flowers above). No fragrance was detected in *Chlorospatha plowmanii*, although the species has the same pattern of spathe expansion. Both conditions were affected by the amount of available light, and on overcast days, the onset and development of both were somewhat

delayed; therefore, the discrepancies in timing noted above are possibly correlated with available light or other prevailing conditions rather than with species-specific behavior. Fragrance peaked between 1200 and 1400 hours and was noticeably diminishing by approximately 1700 hours and undetectable by nightfall of day 1. It is possible that fragrance persists, but is not detectable by human beings, and, in fact, faint fragrance was detected on day 2 and day 3 of the flowering event in two species, *C. hannoniae* and *C. kolbii*, which was possibly attributable to pollen or the decay of floral structures.

The following is a detailed though somewhat imprecise analysis of the flowering strategies observed in nine species representative of the three sections of *Chlorospatha*. Each section has a distinct floral morphology; however, the various flowering strategies do not appear to be exclusive on the sectional level, even within this small sampling, except possibly in *Chlorospatha* sect. *Orietales*. Observations of inflorescences were made over a period of three to four days, at 1- to 2-hr. intervals beginning at 0400 hours and terminating at approximately midnight. In *C. mirabilis*, the flowering of only four inflorescences in a single sympodium was observed (Croat & Mora 83686).

In *Chlorospatha kolbii*, a member of *Chlorospatha* sect. *Chlorospatha*, the spathe opened on day 1, as described above, and remained open to the same degree, through the first night and until approximately 1700 hours on day 2, with the diameter of the apex of the spathe tube maintained at approximately twice the diameter of the spadix (Fig. 28B). At 1700 hours on day 2, the spathe was beginning to close slightly and pollen was being produced, with the apex of the tube sufficiently open to allow a clear view of the pistils until approximately midnight. At 0600 hours on day 3, the spathe had completely though somewhat loosely closed. The flowering strategy described above is identical to that observed in *C. atropurpurea*, a member of *Chlorospatha* sect. *Occidentales*, but with the diameter of the apex of the spathe tube 3 to 4 times greater than that of the spadix at 1800 hours on day 1.

In *Chlorospatha dodsonii*, another member of *Chlorospatha* sect. *Occidentales*, the flowering strategy was the same as that described above on day 1, but with a slight occlusion of the spathe tube at 2000 hours, leaving only the apex open. At 0600 hours on day 2, some pollen was visible and the tube had closed slightly, but the pistils were clearly visible from its apex. The spathe remained in this slightly closed position through the night of day 2, and at 0600 hours on day 3 the fertile staminate portion of

the spadix was covered with pollen. At noon, the pollen had collapsed, but no further constriction of the apex of the tube was observed. At 0600 hours of day 4, the spathe was closed. In *C. mansellii* (Fig. 35C), possibly a primary hybrid with *C. dodsonii* as one of its parents, the strategy was similar except for a somewhat greater occlusion of the tube at 1800 hours on day 1 and during day 2, and in the timing of anther dehiscence, which did not begin until 1400 hours on day 2 and continued until 2000 hours on day 3. At 0600 hours on day 4, the pollen had collapsed and the spathe was loosely closed.

Four species in *Chlorospatha* sect. *Orietales* were observed, *C. hannoniae*, *C. longipoda*, *C. plowmanii*, and *C. pubescens*, all exhibiting the same basic flowering strategy, one different from those described above. It is noteworthy that the spathes of these species are among the smallest in the genus and open almost to the base at anthesis on day 1. The process on day 1 was the same as that described above until 1800 to 2200 hours. At this time, the sides of the spathe tube were closed, occluding the pistillate portion of the spadix, but the apex of the tube was slightly open, with a diameter approximately 2 mm greater (ca. 2 times wider) than that of the spadix and the pistils visible (looking down the tube). The disposition of the spathe was the same throughout the night of day 1 and most of day 2, with some pollen visible at 1800 hours on day 2. At 2000 hours on day 2, pollen covered the fertile staminate portion of the spadix, and the diameter of the apex of the tube was approximately 1 mm greater than that of the spadix. At noon on day 3, the spathe was closed and the pollen had collapsed. *Chlorospatha plowmanii* differed from the other species in several respects, most notably in the post-anthesis disposition of the spathe blade, which was starting to reflex by 2000 hours on day 1 (Fig. 41D), frequently earlier, and by 0400 hours of day 2, was completely reflexed (Fig. 41B). Anther dehiscence began at approximately 1200 hours on day 2 in *C. plowmanii*, six hours earlier than in the other three species, and continued for 42 hours on some occasions, until 0600 hours on day 4. The spathe blades of the other species in *Chlorospatha* sect. *Orietales* remained more or less erect to erect-spreading, but with that of *C. pubescens* occasionally assuming a spreading position, but persisting in that position until abscission of the fertile staminate portion of the spadix, the typical condition in *Chlorospatha*. In *C. plowmanii*, the blade was quickly deciduous, abscising soon after anthesis, frequently before it had completely withered.

The flowering strategy of *Chlorospatha mirabilis*, a member of *Chlorospatha* sect. *Chlorospatha*, was

similar to that of the four species in *Chlorospatha* sect. *Orientalis* on day 1 of the flowering event, with the apex of the tube approximately 2 times wider than the spadix at anthesis and with a diameter only 2 mm wider than that of the spadix at 2100 hours. At 2300 hours on day 1, the only portion of the spathe that remained open was a narrowly elliptical one on the blade portion. At 0600 hours on day 2, the apical halves of the spathe and spadix were prominently curved forward and almost U-shaped. Anther dehiscence began at approximately 0700 hours on day 2, with the opening in the blade 2 cm long and 5 mm wide, and at 1030 hours the fertile male portion of the spadix was covered with pollen and the blade was loosely closed. Pollen had collapsed at 1600 hours on day 2.

The pollination strategies described are not precise and could not presently be considered distinct or representative of all possible strategies in *Chlorospatha*. There is considerable variation in the timing and amount of spathe expansion and occlusion in any given species, even in single plants, on different occasions. However, in the absence of any information regarding these conditions, the limited information provided here should prove useful in future investigations. In all strategies, female anthesis occurred during the day on day 1, with little or no occlusion of the spathe tube in *C. kolbii* and *C. atropurpurea*, slight occlusion in *C. dodsonii*, and moderate occlusion in *C. mansellii* until the end of day 2 of the flowering event. The openness of the tube through female anthesis and anther dehiscence is indicative of the marked protogyny of the flowers, no self-pollination having been observed in the four species cited above, during three to seven years in cultivation, though pollen falls onto the pistils during each flowering cycle.

In *Chlorospatha mirabilis* and the four species in *Chlorospatha* sect. *Orientalis*, the spathe tube was significantly more occluded than in the other species at 1800 to 2200 hours on day 1 (post-anthesis), but with the apex slightly open and remaining so through anther dehiscence. In spite of the narrower apex of the spathe tube after female anthesis, pollen was observed within the tube during and after anther dehiscence. Greatest constriction of the tube occurred near the base of the sterile portion of the spadix in these five species. This possibly serves as a well for dislodged pollen that accumulates, through which pollinators could presumably pass as they exited the tube. No such accumulation or mechanisms for accumulation were observed in *C. atropurpurea* or *C. kolbii*. In *C. dodsonii* and *C. mansellii*, the condition is intermediate between that observed in *C.*

atropurpurea and *C. kolbii* and that observed in the species in *Chlorospatha* sect. *Orientalis*, with the tube apex less occluded than in the last two species and more occluded than in *C. atropurpurea* and *C. kolbii*. In *C. dodsonii* and *C. mansellii*, the greatest constriction occurred along the length corresponding to the entire length of the sterile portion of the spadix, and in the latter species, the constriction was sufficient to allow pollen accumulation at 0600 hours on day 3. In all cases, when the spathe closes, it is less turgid than at or prior to anthesis and easily manipulated, though somewhat less so on the tube than on the blade, which suggests that any pollinators that might remain could easily escape. The tube is more rigid throughout the process in *C. mansellii* and species in *Chlorospatha* sect. *Orientalis*.

The timing of the processes in the flowering event is similar in most species examined, with the onset of anther dehiscence in the late afternoon to early evening on day 2, approximately 24 hours after termination of female anthesis, and continuing for 12 to 18 hours, with the pollen collapsing by noon on day 3. *Chlorospatha dodsonii*, *C. mansellii*, *C. mirabilis*, and *C. plowmanii* are exceptions. Pollen production began approximately 12 hours after female anthesis and continued for approximately 34 hours in *C. dodsonii*, until afternoon on day 3. Anther dehiscence began approximately 20 hours after female anthesis and continued for approximately 32 hours in *C. mansellii*, until after midnight on the morning of day 4. In *C. mirabilis*, anther dehiscence began 12 hours after female anthesis and continued for approximately 10 hours. In *C. plowmanii*, anther dehiscence began 18 hours after female anthesis and continued for approximately 42 hours, until early morning on day 4.

The flowering event, from the onset of anthesis until the pollen collapses and the spathe closes, requires 34 to 48 hours or slightly more, to as much as 54 to 72 hours, depending on the species. The patterns described in each strategy are somewhat artificial and not entirely distinct from each other, particularly as regards the onset and duration of anther dehiscence, which begins approximately 12 to 24 hours after termination of female anthesis and continues for approximately 10 to 42 hours, depending on the species. However, the duration of female anthesis appears to be consistent in all species examined and, as treated herein, is circumscribed by the onset of spathe expansion and emission of fragrance and some subsequent occlusion of the spathe and termination of fragrance emission, a period of approximately 12 hours. At the end of this period, the stigma and style deliquesce and are

presumably no longer receptive. However, the receptive period is possibly considerably less than 12 hours long, since full spathe expansion and maximum fragrance emission are brief, lasting no more than a few hours. The stigma and pollen are somewhat sticky, as is the style, though only weakly so, in all species examined except those in *Chlorospatha* sect. *Orietales*, which lack a mantle. No resin canals were observed in the spathe. Minute fluid droplets, slightly more viscous than water and faintly acrid in taste, were observed on the inner surface of the spathe tube from the beginning of day 2 through the end of anther dehiscence, which possibly assists in the adherence of pollen to the bodies of beetles. No fluid droplets were observed during day 1, but the inner surface of the tube was almost imperceptibly tacky. However, the droplets are possibly attributable to condensation caused by thermogenesis in the spadix within the confines of the spathe tube. The presence or absence of thermogenesis, the rapid oxidation of stored starch or lipids (Walker et al., 1983; Gottsberger, 1990), could not be confirmed. Thermogenesis or other attractants associated with the staminate spadix presumably exist during anther dehiscence, possibly both, to ensure pollen collection and dispersal, particularly in *C. atropurpurea* and *C. kolbii*, wherein the apex of the spathe tube is open broadly for two days and pollinators could conceivably come and go at will. Considering the apparent absence of mechanisms for entrapment and the length of time between termination of anthesis and onset of anther dehiscence in these two species, and to some extent in *C. dodsonii* and *C. mansellii*, it is possible that some form of reward is provided in these and other species, which causes the pollinators to remain in the spathe tube through the pollen cycle. Clearly, a significant amount of fieldwork is needed in this area of study, during which the behavior of the pollinators would, no doubt, answer most of the many questions raised.

PHENOLOGY

No field-oriented studies of phenology have been conducted for *Chlorospatha*, and the pollination biology of most species is poorly known; therefore, no broad base of information exists from which a comprehensive understanding of the relevant processes involved in flowering might be deduced. Twenty-seven species are known only from single flowering collections and five additional species from sterile collections or those with only infructescences or no collection dates reported. In taxa represented by two or more collections, flowering was usually

staggered, with one to many months between recorded flowerings, or occasionally occurred in consecutive months, rarely in the same month. To imply any seasonality in flowering based on so few collections would be misleading and, at this time, any apparent patterns are best attributed to the timing of collections. Based on the historical record of herbarium collections, the greatest number of taxa flowered during the period from July through August, with 23 and 17 flowering taxa recorded, respectively, for those months. Twenty-one taxa flowered in April, 18 in November, and 17 in December. The least number of flowerings is recorded for January, with fertile collections of only seven species. For each of the remaining months, between 11 and 15 flowering taxa were recorded.

It is possibly significant that the seven species represented by numerous collections from habitat flowered in almost every month and possibly flower throughout the year: *Chlorospatha atropurpurea*, *C. croatica* subsp. *croatica*, *C. dodsonii*, *C. ilensis*, *C. longipoda*, *C. plowmanii*, and *C. pubescens*. Although only five flowering months were recorded for *C. mirabilis*, it is possible that this species also flowers throughout the year. That flowering can occur in almost every month would seem to accord with the more or less constant climatic conditions in the consistently mesic habitats occupied by *Chlorospatha*. Twelve species, including seven of the eight mentioned above, excluding *C. mirabilis*, were observed in cultivation in a state of presumably legitimate flowering cycles considered sufficiently healthy and robust that could be verified and recorded. The records made during cultivation of these seven species correspond to the historical record of flowering of these species in the wild. Flowering is virtually continuous in some cultivated species in *Chlorospatha* sect. *Orietales*, with flowering occasionally occurring on almost every new growth in *C. plowmanii*. Another cultivated species, *C. kolbii*, flowered during seven months, but could not be maintained in a sufficiently healthy state to confirm flowering (or not) throughout the year. Plants were cultivated at approximately 28°N latitude and maintained at 15.5°C–30°C (60°F–86°F) throughout the year. *Chlorospatha* occurs at approximately 10°20'N–4°16'S latitude, where the photoperiod is considerably less variable than at the higher latitude of the cultivated plants, but other as yet undetermined conditions are undoubtedly more variable than those provided in cultivation. Variation in the amount of precipitation would presumably be an important factor, as would the availability of pollinators, which possibly coincides with variations

in precipitation. Dry seasons occur in some areas that support populations of *Chlorospatha*, but these are neither prolonged nor what could be considered "dry." Precipitation is either somewhat reduced overall or occurs less frequently and thus provides some variation in prevailing conditions, however slight.

Three cultivated species consistently exhibited periodic flowering cycles every year during a four- to seven-year period. *Chlorospatha mansellii* flowered only during the months of October and November. *Chlorospatha boosii* and *C. hannoniae* flowered only between May and September. In all three species, flowering was vigorous, coinciding with almost every new leaf growth. In *C. mansellii*, only two to three new leaves are produced during its flowering season, whereas in the two small-growing species, more numerous leaves were produced, production and maturation of leaf growth being more rapid in the these species, which raises an interesting point. As has been stated previously, growth is more or less continuous throughout the year in *Chlorospatha*, but the rate at which new leaves are produced and mature varies among taxa and is presumably, to some extent, correlated with the mature size of a given taxon. Large-growing species produce fewer leaves during the year and each leaf requires more time to mature than the smaller and more numerous leaves of small-growing species. Therefore, it is likely that some taxa flower throughout the year, but that individual plants are not necessarily in flower in every month, particularly as regards large-growing species, which is almost certainly the case in *C. croatiana* subsp. *croatiana*. The periodic flowering of the three aforementioned species cannot be explained, but similar cycles probably occur in the wild in other, poorly known species. *Chlorospatha boosii* and *C. hannoniae* are sympatric with *C. longipoda*, probably also with *C. plowmanii* and *C. pubescens*, yet flowering is virtually continuous in the last three species, both in the wild and in cultivation. *Chlorospatha boosii* and *C. hannoniae* were collected in a sterile state, in the month of March, a month in which these species would also have been sterile in cultivation.

Fruiting phenology in *Chlorospatha* is too poorly known to report on here. Fruit presumably develops fairly rapidly in the small inflorescences of species in *Chlorospatha* sect. *Orientalis*, which reach anthesis in quick succession. In these species, developing infructescences were observed in sympodia with inflorescences, with apparently ripe infructescences in the sympodium immediately below (Figs. 4B, 19D). In this case, maturation could conceivably

occur in a matter of weeks, vegetative growth in these relatively small-growing species being quite rapid. It is assumed that more time would be required for the maturation of larger infructescences.

CYTOLOGY

No karyological studies were made for this revision. Keating (2003) reported $2n = 26$ for the three species he studied, which corresponds to the finding of Bogner (1985) for *Chlorospatha corrugata*. Mayo et al. (1997) also report $2n = 26$.

GEOGRAPHICAL DISTRIBUTION AND ENDEMISM

Chlorospatha occurs from Costa Rica and Panama in Central America, southward through northwestern South America into southern Ecuador and would be expected to occur in the Amazonian regions of Peru and Colombia, possibly also in southeastern Nicaragua in Central America.

Greatest diversity is found at elevations of 1000–2000 m in Colombia and southward to the western Andes of northern Ecuador, with progressively fewer species encountered to the south on the western slope, but with considerable diversity on the eastern slopes of the Andes in Ecuador. Diversity diminishes also in northernmost Colombia into Central America. Colombia has 45 taxa, Ecuador 24, Panama three, and Costa Rica one. Endemism is highest in the Cordilleras Occidental and Central in Antioquia and Valle departments of Colombia, with 34 endemic species, almost all of which are associated with the Cordillera Occidental. Ecuador has 23 endemic species, 11 occurring only on the western slopes of the Andes and 12 only on the eastern slopes. Central America has two endemic species, one of which is endemic to Panama.

Greatest diversity in *Chlorospatha* occurs in Colombia with 45 taxa (66% of all taxa), 43 of which are endemic (93%). Twenty-four species, 23 of which are endemic (96%), occur in Ecuador, a remarkable number for an area one fourth the size of Colombia. The relatively high number of Ecuadorian species is somewhat misleading and probably reflects more extensive collecting over a longer period of time, with 226 total collections made and most species represented by numerous collections. Many Colombian species are represented by only one or two collections. Future collecting, comparable to that done in Ecuador, would be expected to result in many new collections, including new species, considering the vastness of the geographical area and the presence of a profound diversity of geological and ecological elements that could support *Chlorospatha*,

and thus provide a better understanding of distribution and endemism in that country.

Chlorospatha occurs between sea level and 3000 m elevation, with most taxa occurring only in the wet to very wet areas of tropical wet forest (Holdridge, 1967), premontane wet forest, lower montane wet forest, tropical rainforest, premontane rainforest, lower montane rainforest, or montane rainforest, with few taxa reported from the somewhat drier areas of tropical moist forest, premontane moist forest, and lower montane moist forest. The taxa that occasionally occur in these drier life zones are mainly confined to the eastern slopes or the southern portions of the western slopes of the Andes in Ecuador, the current southern limit of distribution in the genus. Sixty percent of all taxa occur exclusively or occasionally in premontane wet forest, the predominant life zone for the genus, approximately 30% in tropical wet forest, and 30% in tropical rainforest, premontane rainforest, or montane rainforest.

Diversity diminishes southward in Ecuador, on the increasingly drier Pacific slopes of the Andes. Most of the area along the coast, south of the equator, is tropical dry forest (T-df), tropical very dry forest (T-vmf), or even tropical thorn woodland (T-tw) and would not support *Chlorospatha*. *Chlorospatha* has been collected in most provinces on the western slopes, excluding Loja on the southwestern border; however, only three species have been collected in the provinces that lie south of Pichincha Province, *C. atropurpurea*, *C. dodsonii*, and *C. ilensis*, relatively widespread species that also occur northward, at least into Pichincha Province in Ecuador. The life zones indicated by the GPS coordinates of some collections of these species, made in the southern or coastal provinces, are clearly not conducive to *Chlorospatha* and are presumably erroneous. It has been the experience of the authors that small pockets of suitable habitat frequently occur within broader, incompatible hostile regions. In fact, some suspect coordinates fall quite near suitable areas. The coordinates for some collections of *C. ilensis* fall in montane dry forest (TM-df) or premontane dry forest (P-df) in El Oro Province, and tropical dry forest in Los Ríos, whereas the coordinates of most collections of this species indicate premontane wet forest, occasionally premontane moist forest or lower montane moist forest. Even these last two life zones are unusual for *Chlorospatha* and are, with few exceptions, confined to collections of some species from the eastern slopes of the Andes, made within the pervasive moist forest ecology in that portion of the Amazon drainage. A similar diminution of diversity to

the south does not occur on the eastern slopes where more or less mesic conditions prevail. Diversity is actually somewhat more limited in the northern provinces of Napo and Sucumbíos in Ecuador, with three and five species, respectively, and is greatest to the south, with nine species in Morona-Santiago Province. Collections have been made in all provinces on the eastern slopes in Ecuador, many near and along the length of the Peruvian border, and *Chlorospatha* will undoubtedly be found in Peru, since there are few geological or ecological barriers to distribution there.

Only three taxa (two species, one variety) are recorded for Panama and one species for Costa Rica (*Chlorospatha croatiana* subsp. *croatiana*), and these occur in tropical wet forest, premontane wet forest, lower montane wet forest, and montane wet forest, also premontane rainforest and lower montane rainforest or transitional forest between these. Of these (*C. croatiana* subsp. *croatiana*, *C. croatiana* var. *enneaphylla*, *C. hammeliana*, and *C. mirabilis*), only *C. croatiana* subsp. *croatiana* and *C. hammeliana* are endemic to Central America, but the first species will probably eventually be collected in South America, possibly also in southeastern Nicaragua. Central America has been well collected, 55 collections of *Chlorospatha* having been made there. *Chlorospatha* occurs throughout Panama, with the exceptions of Herrera and Los Santos, which are generally too dry, comprised primarily of areas that are drier parts of tropical moist forest as well as tropical dry forest and premontane moist forest, all life zones in which *Chlorospatha* does not occur in Central America. The three taxa are members of *Chlorospatha* sect. *Chlorospatha* and, therefore, share similar floral and vegetative morphology. The similarities of these taxa, the absence of dissimilar species, and the pronounced dry seasons in the areas west of Costa Rica and southeastern Nicaragua would suggest that southern Central America is the northern limit of the genus and that *Chlorospatha* probably originated and evolved in Colombia.

Far greater diversity occurs in Colombia, possibly reflecting its isolation from Central America during periods when the oceans were at much higher levels than today and it was not connected to Central America, with subsequent development occurring from Colombia into Panama after the emergence of the isthmus. Similarly, since no species of *Chlorospatha* occurs on both the eastern and western sides of the Andes, the evolution of the respective Amazonian and Pacific taxa presumably occurred independently, after the Andes began to rise toward the end of the Cretaceous (Raven & Axelrod, 1974).

As treated herein, taxa of the western slopes of the Andes include those occurring in the Magdalena River drainage; therefore, *C. huilensis* could be considered the exception to the exclusivity of eastern and western Andean taxa, its collection sites being uniquely situated at the southern end of the Cordillera Oriental, where it joins the Cordilleras Central and Occidental in the Andean range and the separation of the Cordilleras Central and Oriental is no longer distinct. All but one of the collections of this species were made on what could be loosely considered either the western slopes of the Cordillera Oriental or eastern slopes of the Cordillera Central, within the Magdalena River drainage, in montane rainforest and lower montane rainforest, with access to further distribution onto the eastern slopes of the Andes within a broad band of lower montane wet forest with broad extensions of montane rainforest around the perimeter. One collection was made in lower montane wet forest to the south, between Pasto and Mocoa, in the Amazon drainage and represents the northernmost collection of *Chlorospatha* on the eastern slopes of the Andes. The species bears a strong resemblance to *C. sucumbensis* from Sucumbíos Province, Ecuador, collected in lower montane wet forest near the Colombian border on the eastern slopes of the Andes. Styler morphology in both species is distinct from that of all Amazonian species, which suggests that these probably originated in the Magdalena River drainage and not the eastern slopes of the Andes. As such, *C. huilensis* and *C. sucumbensis*, the only members of *Chlorospatha* sect. *Occidentales* that occur in the Amazon drainage, represent the only existing link between the eastern and western taxa. Only from this point southward, in Ecuador, does *Chlorospatha* develop on the eastern slopes, though apparently not from these two species or their progenitors. The remaining species from the eastern slopes comprise *Chlorospatha* sect. *Orientales* and manifest several distinctive characters not found in other *Chlorospatha*. These species are clearly members of *Chlorospatha*, possessing numerous characters unique to the genus, but apparently evolved independently of the taxa that developed in the Colombian mountain ranges. It is likely that some species in *Chlorospatha* sect. *Orientales* occur at the latitudes of *C. huilensis* in southern Amazonian Colombia, possibly northward in lower montane wet forest or premontane wet forest, the predominant life zones on the eastern slopes of the Cordillera Oriental, north of the areas where *C. huilensis* was collected.

It is curious that only *Chlorospatha huilensis* and one other taxon are reported from the Cordillera Oriental in Colombia, *C. croatianana* var. *enneaphylla*,

which is the only taxon from Boyacá Department and occurs only once on the western slopes of the Cordillera Oriental, approximately 370 km north of the collections of *C. huilensis*, with no collections of *Chlorospatha* having been recorded for the extensive intervening area. The area south of this collection site, to the approximate latitude of Bogotá, is mostly lower montane dry forest with intervening patches of montane moist forest and lower montane moist forest that could possibly contain *Chlorospatha*. The area from Bogotá southward to the Ecuadorian border is apparently not conducive to populations of *Chlorospatha* and the void there would appear to reflect collecting patterns. Although most of the basin of the southern Magdalena River drainage is tropical dry forest and the lower western slopes of the Cordillera Oriental are regions of premontane moist forest, the areas above these are tropical wet forest, lower montane wet forest, montane wet forest, and montane moist forest. The area north of Tunja, on the western slopes in Boyacá Department, north of the collection site of *C. croatianana* var. *enneaphylla*, is comprised of large areas of premontane moist forest and premontane wet forest, with montane wet forest in Santander Department, north of Boyacá Department, all of which could possibly support *Chlorospatha*, but the areas have apparently been poorly collected in Colombia.

The current isolation of the Central and South American taxa is more problematic, since the forest elements and consistently wet conditions required by *Chlorospatha* are present in southern Central America, and no prominent geological barriers exist between the two areas. The northwestern part of Chocó Department in Colombia that borders Panama consists of several floristic elements. Most of the vast drainage area of the Río Atrato, which empties into the Golfo de Urabá in the north, lies only a few meters above sea level and consists of tropical moist forest near the coast that transitions into tropical wet forest toward the south and eventually tropical rainforest farther south, near Quibdó. Annual precipitation often exceeds 11,700 mm in the region of tropical rainforest (Gentry, 1982). The Serranía de los Saltos and Serranía Baudó serve as the western perimeter of the Río Atrato drainage for much of its length, extending from the Panamanian border southward, along the Pacific Coast in Colombia. These are not high mountain ranges and only the Alto de Buey reaches approximately 1000 m elevation. The Cordillera Occidental represents the eastern perimeter of this lowland region. The entire region, including the coastal ranges, is heavily forested, but the tropical rainforest does not extend to the Pacific

coast and is displaced by a narrow band of tropical wet forest along the coast. It would appear that low elevation and the somewhat drier conditions north of the region of tropical rainforest were possibly significant limiting factors, with this region serving as a barrier to distribution of the more numerous species of the Colombian mountain ranges. Of the 12 Colombian taxa that occur only below 1000 m elevation (26% of Colombian taxa), nine occur in the lowlands of Chocó Department, including *C. croatianana* var. *enneaphylla* and *C. mirabilis*, the only taxa common to both Central and South America, and of these, six species are endemic in this department. The remaining three species occur in lowland areas in Valle and Cauca departments immediately south of Chocó.

Sixty percent of all *Chlorospatha* (41 species) occur only above 1000 m elevation and almost half of these also occur above 2000 m, with 13% of all taxa occurring only above 2000–3000 m (Croat, pers. obs.). Within Colombia, greatest taxonomic/species diversity occurs in the region from the northern ends of the Cordilleras Occidental and Central in Antioquia Department, southward to Cali in Valle Department, with 34 taxa represented, almost half of all *Chlorospatha*. Of these, 60% occur only above 1000 m elevation in the Cordilleras Occidental and Central and apparently have not diversified into the vast lowland forests between the Cordillera Occidental and the mountains in Panama or the Serranías de los Saltos and Baudó along the Pacific Coast of Colombia. Only three species, *C. croatianana* var. *enneaphylla*, *C. corrugata*, and *C. mirabilis*, have been collected below 1000 m elevation in the area from the Panamanian border southward, between the Pacific coast and the Cordillera Occidental, to the approximate latitude of Quibdó, more than 200 km south of the Panamanian border. The first taxon occurs near sea level, near Acandí, at the northern end of the region, near the Panamanian border in Colombia, in transitional forest between premontane wet forest and tropical moist forest. The other two species, *C. corrugata* and *C. mirabilis*, occur in the Nutibara area in Antioquia Department, in premontane rainforest at 890–900 m elevation on the western slopes of the Cordillera Occidental. Interestingly, *C. corrugata* is the only Colombian endemic that occurs both below and above 1000 m elevation (890–1350 m) and could not be considered a lowland species. The collection of *C. mirabilis* is somewhat suspect, being morphologically atypical of the species and the only collection of this species made on the eastern side of the lowland region, and therefore, possibly another species. The three taxa, *C. croatianana* var.

enneaphylla, *C. corrugata*, and *C. mirabilis*, are confined to the perimeter of the region in question. It is only at and below the latitude of Quibdó, approximately 5°45'N, that the other lowland taxa (from below 1000 m) occur, as well as the remaining populations of *C. mirabilis*, and are more widely dispersed through the lowlands: *C. chocoensis*, *C. grayumii*, *C. hastifolia*, *C. kolbii*, *C. kressii*, *C. maculata*, *C. morae*, *C. oblongifolia*, *C. timbiquensis*, *C. yatacuensis*, and *Chlorospatha* sp. indet. 2. Possibly of significance is the fact that the tropical rainforest more or less begins at this point, near the latitude of Quibdó, and extends southward, coinciding with a reversal of the river drainage system. An almost imperceptible ridge located near Istmina, south of Quibdó, is responsible for this reversal from the north-flowing Río Atrato drainage to the south-flowing Río San Juan drainage that empties into the Pacific. The northernmost western collection of *C. mirabilis* was made at the southern end of the Serranía Baudó, near the latitude of Quibdó, where all modern collections of *C. kolbii* were also made, and it is possible that this low coastal range provided the conditions necessary for distribution into Central America. Certainly, these species would be expected to occur northward in the range. At present, it appears that *Chlorospatha* evolved in the montane regions of Colombia and developed into distinct floras on the eastern and western sides, with the rising of the Andes (Croat, pers. obs.). The western ancestral forms subsequently diversified into the tropical rainforest, but not the tropical wet forest or tropical moist forest to the north, in the western lowlands of Chocó Department, with the low coastal Pacific range ultimately serving as a bridge for distribution into Panama. Admittedly, the lowland region from Quibdó northward has not been well collected, and except for the collections made by A. Forero and A. Gentry in the late 1970s and early 1980s, few botanists have visited the area; therefore, the notion that the region serves as a barrier to distribution is possibly derived from a coincidental absence of pertinent information.

Chlorospatha croatianana var. *enneaphylla* occurs in Panama and in Colombia on the eastern border with Panama, with distribution eastward into the northern end of the Cordillera Central and to the south, on the western slopes of the Cordillera Oriental, and it seems plausible that it evolved in Panama. However, the possibility of evolution in and distribution from the east should be considered, perhaps with evolution of the taxon occurring independently of the species. Diversity of taxa with divided leaf blades is concentrated in the region of the Cordilleras Occidental and Central in Antioquia Department,

and it would seem that distribution could have occurred from either or both sides of these mountain ranges, given the necessary ecological conditions. The floral morphology common to all taxa, i.e., the small slender inflorescences often with long peduncles and tightly enveloped by the petiole sheath with divided leaf blades (except *C. corrugata*), reinforces this possibility. The three Colombian populations of *C. croatian* var. *enneaphylla* are widely separated geographically and occur in an unusually wide range of life zones, though all are below 900 m elevation, with the collection from the Cordillera Oriental made in premontane wet forest and those from the Cordillera Central in what is either premontane rainforest or tropical wet forest. The northern population on the Panamanian border is in transitional forest between premontane wet forest and tropical moist forest. It is possible that these apparently disjunct populations approached contiguity in earlier times, when the life zones were possibly less disparate, or that later encroachment of unfavorable ecological or human elements caused subsequent isolation of the populations. It is also possible that intervening areas have not been collected.

Seventeen taxa of *Chlorospatha* (24%) occur only below 1000 m elevation and are herein described as lowland taxa (Croat, pers. obs.). Interestingly, of the 12 lowland taxa in Colombia, seven have divided leaf blades (*C. chocoensis*, *C. croatian* var. *enneaphylla*, *C. kolbii*, *C. kressii*, *C. maculata*, *C. mirabilis*, *C. morae*), and although there are no truly wide-ranging *Chlorospatha*, two of these, *C. mirabilis* and *C. croatian* var. *enneaphylla*, are significantly more wide-ranging than most *Chlorospatha*, occurring widely within Colombia and extending into Panama, though at higher elevations in Panama. Excluding the Panamanian taxa, the remaining group of nine species of *Chlorospatha* with divided blades, with one exception (*C. ilensis*), are confined to elevations of 1200–2800 m in the Cordilleras Occidental and Central and occur only in Antióquia Department, with five endemic species (*C. betancurii*, *C. callejasii*, *C. cogolloi*, *C. gentryi*, *C. luteynii*), and the two departments on its southern border: Caldas, with one endemic species (*C. caldasensis*), and Risaralda, with two endemic species (*C. cedralensis* and *C. risaraldensis*). No species with divided blades occurs to the south of these departments except *C. ilensis*, the northernmost collection of which was made over 500 km to the south, on the western slopes of the Andes in Pichincha Province, Ecuador. Although some collections of *C. ilensis* have hastate or subhastate leaf blades, other collections have 3-lobed blades, thus rendering it the only 3-lobed species in Ecuador.

This species shares the distinct floral morphology of all taxa in *Chlorospatha* sect. *Chlorospatha* (i.e., blades trifid, trisect, pedatifid, or pedatisect; sessile stigmas with Style Type 3 where the style is expanded into a more or less disklike mantle approximately as broad as the ovary apex). The isolation of this Ecuadorian endemic cannot be explained; however, it is one of the more wide-ranging species in Ecuador, in terms of geography and elevation, occurring in Pichincha and four provinces to the south, at 550–1530 m elevation.

A similar pattern of wide distribution is found in six of the additional seven Ecuadorian species that occur both below and above 1000 m elevation, *Chlorospatha atropurpurea*, *C. dodsonii*, and *C. litensis*, from the western slopes of the Andes, and *C. longipoda*, *C. plowmanii*, and *C. pubescens* from the eastern slopes. Of these, *C. litensis* is the only species not endemic to Ecuador, occurring also in southern Colombia, only above 1000 m elevation, but only below 1000 m in Ecuador. Interestingly, there is little or none of the variation in the floral or vegetative morphology that would be expected in these species throughout their considerably diverse elevational ranges and life zones. The three species from the eastern slopes occur between 250 and 1700 m elevation, usually in tropical wet forest, premontane wet forest, and lower montane wet forest, occasionally in premontane rainforest, and rarely in tropical moist forest, premontane moist forest, and/or montane moist forest. *Chlorospatha hastata* occurs at 375–1800 m elevation, but is known only from Esmeraldas and Carchi provinces and, therefore, does not fit the pattern of wide distribution described above. All of the aforementioned Ecuadorian species and the lowland Colombian taxa are apparently more adaptable in the wild than most *Chlorospatha*, considering the diversity of elevations and life zones in which they occur, and most have proven relatively easy to maintain in cultivation. The five Ecuadorian species that occur only below 1000 m elevation, *C. besseae*, *C. longiloba*, and *C. mansellii* from the western slopes, and *C. boosii* and *C. hannoniae* from the eastern slopes, also adapt well to cultivation, but would appear to be rather narrowly distributed, each being known from only one or two provinces, which is somewhat puzzling, particularly as regards the Amazonian species, since species of Amazonian Araceae are usually more wide-ranging, especially those from the large areas of tropical moist forest in the Amazon Basin (Croat, 1998). The narrow distribution of the two Amazonian species possibly reflects both undercollecting and life zone ecology. *Chlorospatha boosii* is the only species from the

eastern slopes that has been collected in the pervasive tropical moist forest of that region, though most species occur at least once in premontane moist forest, which is true of *C. hannoniae*, as well as in numerous wetter life zones. However, Ecuador has been well collected compared to Colombia, and life zone ecology is probably a significant factor in the high level of provincial endemism exhibited in these and other Ecuadorian species and presumably the even greater levels of departmental endemism indicated in the Colombian species, particularly regarding those species confined to elevations exceeding 1000 m. *Chlorospatha* can be found in small, isolated pockets of suitable forest, as was the case with *C. sagittata*, which was encountered unexpectedly on the western slopes in Imbabura Province, in a small patch of forest associated with a small stream by a road bordered by large remnants of partially disturbed virgin forest. It is endemic to and the single species known from that province.

Chlorospatha sagittata was collected at almost 1700 m elevation and is one of 11 species in Ecuador that occur only above 1000 m elevation (between 1200 and 2350 m), each of which is endemic to a single province: *C. carchiensis*, *C. castula*, and *C. jaramilloi*, also from the western slopes, and *C. cutucuensis*, *C. engleri*, *C. feuersteiniae* (Croat & Bogner) Bogner & L. P. Hannon, *C. limonensis*, *C. sizemoreae*, *C. sucumbensis*, and *C. yaupiensis* from the eastern slopes. Of these, only two species occur above 2000 m elevation, *C. jaramilloi*, in premontane wet forest, and *C. sucumbensis*, known only from above 2000 m in montane or lower montane wet forest. Coordinates (GPS) indicate that *C. sizemoreae* possibly also occurs occasionally or exclusively above 2000 m elevation, but no elevation was indicated in the label notes for this species. These species are known from only one or two collections and might eventually prove to be more widely distributed, except perhaps *C. cutucuensis* and *C. yaupiensis*, which are known only from the lower montane wet forest of the Cordillera de Cutucú, an area known for a high level of endemism in Araceae. This mountain range lies in Morona-Santiago Province in which nine of the 11 species in *Chlorospatha* sect. *Orientalis* occur, including *C. cutucuensis* and *C. yaupiensis*, which suggests that these species evolved in this region. The two remaining species in the section, *C. portillae* and *C. sizemoreae*, are known only from Zamora-Chinchipec Province immediately to the south, in the vicinity of El Panguí, in premontane wet forest and lower montane wet forest, respectively. Greatest diversity in Ecuador occurs in Morona-Santiago, with nine species, six of which are endemic:

C. boosii, *C. cutucuensis*, *C. engleri*, *C. hannoniae*, *C. limonensis*, and *C. yaupiensis*.

Forested areas that can support *Chlorospatha*, which have been isolated by human encroachment, are frequently encountered throughout Colombia and Ecuador and could explain actual or apparent endemism in some cases. Additionally, it appears that almost all South American collections have been made around cities, along roads or in national parks, which is well illustrated in the region of the Cordillera Occidental, from approximately 4°N latitude in Colombia southward to the Ecuadorian border. *Chlorospatha* has not been recorded from the western slopes of the Cordillera Central or the valley of the Río Cauca to the east at these latitudes, these areas being quite arid in general. At the aforementioned latitudes, all collections were confined to the eastern or western slopes of the Cordillera Occidental, in three widely separated areas directly or closely associated with one of only three existing major roads in the Cordillera Occidental, with no collections recorded for the intervening areas. Greatest diversity occurs at the northern end of this region, around Cali in Valle Department and westward along the road to Buenaventura on the coast, with 10 of the 12 species occurring there being endemic to the department. Nine of these species occur only above 1000 m elevation (1020–2200 m) usually in tropical wet forest, premontane wet forest, or lower montane wet forest, or occasionally in tropical rainforest or premontane rainforest. The endemic species are: *C. bayae*, *C. bullata*, *C. caliensis*, *C. noramurphyae*, *C. queremalensis*, *C. stellasarreae*, *C. tokioensis*, *C. yatacuensis*, *Chlorospatha* Species 2, and *Chlorospatha* Species 3. The southernmost collection of *C. mirabilis* was made in this area.

The area around Parque Nacional Munchique lies to the south, in Cauca Department in Colombia, along a road running westward from the Pan-American Highway, and represents the greater portion of a second area of diversity. Four species are endemic to the department, *Chlorospatha congensis*, *C. lehmannii*, *C. munchiquensis*, and *C. timbiquensis*, and one species occurs also in Chocó and possibly Valle, *C. grayumii*, in tropical wet forest and tropical rainforest. *Chlorospatha munchiquensis* occurs within the park, in premontane wet forest and lower montane wet forest, whereas *C. congensis* and *C. lehmannii* occur outside the park, probably in premontane rainforest.

An isolated region to the south, in Nariño Department, represents the third area of diversity in Colombia, with seven species, six of which are

endemic: *Chlorospatha bogneri*, *C. nambiensis*, *C. narinoensis*, *C. planadensis*, *C. ricautensis*, and Species 1. *Chlorospatha litensis* also occurs here in premontane wet forest and in northernmost Ecuador in premontane wet forest and lower montane rain-forest. All collections were made along or near the road that runs from the Pan-American Highway westward to the coast, near and almost parallel to the border with Ecuador, at between 1100 and 2050 m elevation. Most collections were made in either the La Planada Reserve, in lower montane wet forest or premontane wet forest, or Río Ñambí Reserve, in premontane wet forest. In Ecuador, excluding Morona-Santiago Province, which has the greatest number of species (nine), the greatest concentration of species, as to province, occurs in the two provinces adjoining this area on the western slopes, Carchi and Esmeraldas. Of the 12 species known from the western slopes in Ecuador, six occur only in one or both of these provinces, *C. besseae*, *C. carchiensis*, *C. hastata*, *C. litensis*, *C. longiloba*, and *C. mansellii*, or in the case of *C. litensis*, also in Nariño Department, Colombia. A total of seven species occur in Esmeraldas and six in Carchi. Species that occur only in the provinces of Ecuador and departments of Colombia that lie along the length of their common border have been designated herein as frontier species, and all would be expected to occur in the adjoining country. No geographical barriers are present and the varied ecological conditions that occur at any point along the border are similar or identical on both sides. A separate key to these species has been provided (see Key to Species of *Chlorospatha*, below). Pichincha Province, to the south of the frontier region, and Zamora-Chinchipec, on the eastern slopes of the Andes in the southeast, hold the next highest concentrations of species in Ecuador, with five species occurring in each province. Two species are endemic to Pichincha and one species to Zamora-Chinchipec. Between one and four species are reported for each of the remaining provinces, none of which is endemic, except as previously noted.

Sixty-four percent of all *Chlorospatha* are found exclusively on the western slopes of the Cordillera Occidental in Colombia and the Andes in Ecuador. In Colombia, most taxa are confined to the Cordillera Occidental: with 72% of Colombian taxa (33 species) occurring only on the western slopes; one species, *C. giraldoi*, occurring on both the eastern and western slopes; and two species occurring only on the eastern slopes, *C. macphersonii* and *C. noramurphyae*. *Chlorospatha corrugata* is the only species that occurs on the western slopes of both the Cordillera

Occidental and Cordillera Central. Seven species occur only in the Cordillera Central: two known only from the eastern slopes, *C. amalfiensis* and *C. betancurii*; two known only from the western slopes, *C. caldasensis* and *C. cedralensis*; two known only from the northern end, *C. callejasii* and *C. luteynii*; and one known from both the eastern and western slopes, *C. antioquiensis*. *Chlorospatha croatiana* var. *enneaphylla* also occurs here, but is also known from Panama, northern Chocó Department, and the western slopes of the Cordillera Oriental. The greatest concentrations of taxa occur in Antioquia and Valle departments, Colombia, each with 12 taxa, with 10 endemic in each department; followed by Chocó with 10 taxa, six of which are endemic; Nariño with seven species, six of which are endemic; and Cauca with six species, four of which are endemic. These statistics coincide with the high number of total collections made in these departments, which is significantly greater than the number made in other departments. The greatest number of collections was made in Antioquia with 40 collections, followed by Chocó with 28 collections, Valle with 27 collections, Nariño with 24 collections, and Cauca with seven collections (Croat, pers. obs.). It is possible that the high number of taxa in Antioquia and Valle departments is coincidental to the greater number of collections made there. However, considering the diversity of the floral and vegetative morphology of the taxa involved, it seems more likely that the perceived significance of the numbers, regarding evolution of the genus, is actual rather than coincidental and affirms the opinion (of the authors) that *Chlorospatha* originated in and evolved from these regions in the Cordilleras Occidental and Central. Development in Nariño Department appears to be aligned with that of the northwestern Ecuadorian species, with the combined area serving as a subsequent secondary center of development.

Two species occur in Risaralda Department in Colombia, both of which are endemic. One species occurs in each of the remaining departments, Boyacá, Caldas, Huila, and Putumayo, none of which is endemic to a department except *Chlorospatha caldasensis*, from Caldas Department. *Chlorospatha* is not known from the departments east of the Cordillera Oriental, except Putumayo, nor from those north of Antioquia, though *Chlorospatha* possibly occurs into Córdoba, at the northern limit of the Cordillera Occidental, along the border with Antioquia. No taxa have been reported from the five departments in and between the Cordilleras Central and Oriental: Cundinamarca, Norte de Santander, Quindío, Santander, and Tolima, but *Chlorospatha*

Table 1. *Chlorospatha* species and section distributions in Costa Rica (CR), Colombia (COL), Ecuador (ECU), and Panama (PAN).

Species	Section	Country
<i>amalfiensis</i>	<i>Occidentales</i>	COL
<i>antioquiensis</i>	<i>Occidentales</i>	COL
<i>atropurpurea</i>	<i>Occidentales</i>	ECU
<i>bayae</i>	<i>Occidentales</i>	COL
<i>besseae</i>	<i>Occidentales</i>	ECU
<i>betancurii</i>	<i>Chlorospatha</i>	COL
<i>bogneri</i>	<i>Occidentales</i>	COL
<i>boosii</i>	<i>Orientales</i>	ECU
<i>bullata</i>	<i>Occidentales</i>	COL
<i>caldasensis</i>	<i>Chlorospatha</i>	COL
<i>caliensis</i>	<i>Occidentales</i>	COL
<i>callejasii</i>	<i>Chlorospatha</i>	COL
<i>carchiensis</i>	<i>Occidentales</i>	ECU
<i>castula</i>	<i>Occidentales</i>	ECU
<i>cedralensis</i>	<i>Chlorospatha</i>	COL
<i>chocoensis</i>	<i>Chlorospatha</i>	COL
<i>cogolloi</i>	<i>Chlorospatha</i>	COL
<i>congensis</i>	<i>Occidentales</i>	COL
<i>corrugata</i>	<i>Occidentales</i>	COL
<i>croatiana</i>	<i>Occidentales</i>	COL, CR, PAN
<i>croatiana</i> ssp. <i>croatiana</i>	<i>Chlorospatha</i>	CR, PAN
<i>croatiana</i> var. <i>enneaphylla</i>	<i>Chlorospatha</i>	COL, CR, PAN
<i>cutucucensis</i>	<i>Orientales</i>	ECU
<i>dodsonii</i>	<i>Occidentales</i>	ECU
<i>engleri</i>	<i>Orientales</i>	ECU
<i>feuersteiniae</i>	<i>Occidentales</i>	ECU
<i>gentryi</i>	<i>Chlorospatha</i>	COL
<i>giraldoi</i>	<i>Occidentales</i>	COL
<i>grayumii</i>	<i>Occidentales</i>	COL
<i>hammeliana</i>	<i>Chlorospatha</i>	PAN
<i>hannoniae</i>	<i>Orientales</i>	ECU
<i>hastata</i>	<i>Occidentales</i>	ECU
<i>hastifolia</i>	<i>Occidentales</i>	COL
<i>huilensis</i>	<i>Occidentales</i>	COL
<i>ilensis</i>	<i>Chlorospatha</i>	ECU
<i>jaramilloi</i>	<i>Occidentales</i>	ECU
<i>kolbii</i>	<i>Chlorospatha</i>	COL
<i>kressii</i>	<i>Chlorospatha</i>	COL
<i>lehmannii</i>	<i>Occidentales</i>	COL
<i>limonensis</i>	<i>Orientales</i>	ECU
<i>litensis</i>	<i>Occidentales</i>	COL, ECU
<i>longiloba</i>	<i>Occidentales</i>	COL
<i>longipoda</i>	<i>Orientales</i>	ECU
<i>luteynii</i>	<i>Chlorospatha</i>	COL
<i>macphersonii</i>	<i>Occidentales</i>	COL
<i>maculata</i>	<i>Chlorospatha</i>	COL
<i>mansellii</i>	<i>Occidentales</i>	ECU
<i>mirabilis</i>	<i>Chlorospatha</i>	COL, PAN
<i>morae</i>	<i>Chlorospatha</i>	COL
<i>munchiquensis</i>	<i>Occidentales</i>	COL
<i>nambiensis</i>	<i>Occidentales</i>	COL
<i>narinoensis</i>	<i>Occidentales</i>	COL
<i>nicolsonii</i>	<i>Occidentales</i>	COL
<i>noramurphyae</i>	<i>Occidentales</i>	COL
<i>oblongifolia</i>	<i>Occidentales</i>	COL
<i>planadensis</i>	<i>Occidentales</i>	COL

Table 1. Continued.

Species	Section	Country
<i>plowmanii</i>	<i>Orientales</i>	ECU
<i>portillae</i>	<i>Orientales</i>	ECU
<i>pubescens</i>	<i>Orientales</i>	ECU
<i>queremalensis</i>	<i>Occidentales</i>	COL
<i>ricaurtensis</i>	<i>Occidentales</i>	COL
<i>risaraldensis</i>	<i>Chlorospatha</i>	COL
<i>sagittata</i>	<i>Occidentales</i>	ECU
<i>sizemoreae</i>	<i>Orientales</i>	ECU
<i>stellasareae</i>	<i>Occidentales</i>	COL
<i>sucumbensis</i>	<i>Occidentales</i>	ECU
<i>timbiquensis</i>	<i>Occidentales</i>	COL
<i>tokioensis</i>	<i>Occidentales</i>	COL
<i>yatacuensis</i>	<i>Occidentales</i>	COL
<i>yaupiensis</i>	<i>Orientales</i>	ECU
Indets.		
sp. indet. 1	<i>Occidentales</i>	COL
sp. indet. 2	<i>Occidentales</i>	COL
sp. indet. 3	<i>Occidentales</i>	COL
sp. indet. 4	<i>Occidentales</i>	COL

would be expected to occur in at least some of these, particularly in the montane wet forest in Santander Department.

Collection of additional taxa in Central America would not be expected. Although Ecuador has seen more extensive collecting over a longer period of time than Colombia, the recent experience (of the authors) indicates that many suitable areas have not been investigated and that discovery of additional species is likely. The ultimate number of species of *Chlorospatha* can only be surmised, when or if the vast, less easily accessible, and unexplored montane areas are reached, particularly those in Colombia. The Amazonian areas, both montane and lowland, of Peru and Colombia will surely eventually prove to contain members of the genus, possibly some new to science. See Table 1 for species and sectional distribution.

TAXONOMIC TREATMENT

I. *Chlorospatha* Engl., *Gartenflora* 27: 97. 1878, tab. 933. TYPE: *Chlorospatha kolbii* Engl.

Caladiopsis Engl., *Bot. Jahrb. Syst.* 37: 140. 1905. TYPE: *Caladiopsis lehmannii* Engl.

Terrestrial, evergreen herb, occasionally \pm arborescent and 0.3–2 m tall or hemiepiphytic and 0.3–4 m, occasionally emergent aquatic, occasionally in small colonies, rarely widespread; growth sympodial, polyphyllous; new growth sylleptic, the first leaf a sylleptic prophyll; stem unbranched, fleshy, caulescent, elongate, erect or decumbent and

epigaeous, usually in part subterranean, with cataphylls retained intact, semi-intact or \pm fibrous along part or all of its length or only at upper nodes, or not at all, occasionally also or only with remnants of old petiole bases persisting \pm intact or fibrous; fibers \pm linear, pale to medium brown; sap milky or transparent, rarely pink; bulbils absent or produced randomly along its length, solitary, rarely in clusters of two to six, $5\text{--}20 \times 3\text{--}12$ mm, emerging green, becoming brown, cylindrical, conical or ovoid, \pm acute at apex or rounded and briefly attenuate; internodes \pm cylindrical, $0.5\text{--}8 \times 0.5\text{--}4$ cm, usually as long as or slightly longer than wide (1–2 cm long), occasionally much longer or shorter than wide, usually glabrous, occasionally scurfy, rarely weakly and minutely costate near nodes or with the epidermis peeling back, matte to glossy, pale to dark green, yellow-green, olive-green, brownish or grayish green, occasionally purple-tinged or brown, rarely red, occasionally becoming entirely brown with age or only at nodes; roots adventitious along the length of stem, usually white to greenish, occasionally pinkish green, the cortex comprised of un lignified parenchyma cells lacking resin canals; cataphylls attached around circumference of stem, (1)2 to 4, produced with each new leaf or only with sympodial leaves, marcescent and persistent or quickly to ultimately deciduous, narrowly triangular to narrowly lanceolate, frequently weakly to prominently inequilateral, acute, acuminate or cuspidate at apex, or more frequently obtuse with acumen or apical or subapical apiculum, entirely obtusely or acutely 1- to 2-ribbed abaxially or in part only at or toward apex, thin but firm, occasionally \pm fleshy (in larger taxa), glabrous, rarely puberulent (*Chlorospatha pubescens*), matte to semiglossy, pale to medium green, rarely dark green, occasionally pink, purple, purple-tinged or purple- or dark green-mottled in narrow transverse bands. LEAVES with spiral phyllotaxy, several to numerous, long-petiolate, erect to erect-spreading, occasionally also spreading to reflexed-spreading (in some species); sympodial leaf a fully expanded foliage leaf or cataphyll; **petioles** lacking a geniculum, 10–125 cm, as long as or longer than blades, spongy to moderately firm, rarely brittle (*C. maculata*), usually glabrous, entirely or in part \pm puberulent or pubescent in some species, occasionally entirely minutely many-ribbed or in part only in the free portion, entirely green, purple or purplish brown, or green and purple-tinged or purple-, brown-, black-, or dark green-mottled in narrow transverse bands, rarely brown, gray-mottled, reddish pink or with a glaucous bloom toward the base,

sheathed basally, (1/10 to) 1/4 to 3/4 of or nearly entire length (1/3 to 2/3 in ca. 70% of taxa), usually less on juvenile and foliage leaves than on sympodial leaves; sheath decurrent or free-ending at apex, occasionally with one side decurrent and the opposite side free-ending; sides convolute or erect to erect-spreading with margins erect or in-rolled, rarely broadly spreading and appearing winged; free portion 3–10 mm diam. midway (usually less than 5 mm), entirely or in part terete, subterete or D- or U-shaped with margins acute and occasionally raised, or obtuse, rarely with acute lateral ribs becoming alate toward the apex (*C. kolbii*), entirely or in part sulcate or not, with or without a low medial keel; **blades** with supervolute venation, 9.5–62 cm, entire and oblong, ovate or ovate-elliptic, rounded or acute at the base and occasionally inequilateral, or simple and cordate, sagittate, subsagittate, hastate or subhastate and weakly to prominently or not at all constricted in area of petiole attachment, or variously divided and trifid or pedatifid, auriculate or not, or compound and trisect or pedatisect, membranaceous to coriaceous, rarely fleshy (*C. macphersonii*), glabrous, weakly to conspicuously bicolorous, maculate in some species, the margins \pm smooth, occasionally weakly sinuate, occasionally broadly to narrowly undulate or crispate-undulate; upper surface smooth and flat, wrinkled or quilted, or corrugate, bullate, sub-bullate, or rugose, velvety to glossy, medium to markedly dark green, yellow-green, olive-green, or grayish green, rarely purplish medially or entirely brown, occasionally with dark purple-brown, punctiform or cream-colored, punctiform or pale linear cellular inclusions; lower surface \pm smooth, reticulate or rarely areolate, occasionally narrowly colliculate along all orders of venation, glossy to matte-subvelvety, \pm green, occasionally purple, purple-tinged, purple-mottled, or discolorous and dark purple along midrib and major veins; venation colocasioid, occasionally reticulate; midrib and major veins usually flat and featureless on upper surface, rarely bluntly angular or convex, moderately to deeply or narrowly sunken, occasionally obtusely sunken, rarely etched or etched-sunken, glabrous, rarely sparsely puberulent (*C. pubescens*), moderately to prominently raised on lower surface, variously shaped in cross-section, occasionally minutely many-ribbed or 1-ribbed medially, \pm green and concolorous or weakly to conspicuously paler or darker than surface, occasionally purple, purple-tinged or purple-mottled in narrow transverse bands; midrib concolorous on upper surface, occasionally paler than surface; primary lateral

veins pinnate, in 2 to 11 pairs, concolorous on upper surface, occasionally paler than surface, rarely weakly darker than surface (*C. sizemoreae*), conspicuous on lower surface, \pm straight, arcuate, or irregularly ascending, loop-connected into submarginal collective vein; submarginal veins 2 to 4, the innermost \pm straight or weakly to prominently scalloped, occasionally remote from margin; **basal veins** coalesced into weak or prominent posterior rib, in pairs or branching off and acroscopic or basispic; posterior rib (when present) well-developed, naked along the sinus or not, occasionally with the laminar tissue narrowly confluent on the posterior side at the base and obscuring petiole apex; interprimary veins occasionally present (in some species); minor veins structurally indistinct and entirely or in part flat, weakly to moderately sunken, etched, etched-sunken, or narrowly or obtusely sunken, glabrous, usually concolorous on upper surface, rarely with secondary veins weakly darker than surface (*C. sizemoreae*), entirely glabrous or entirely or in part \pm puberulent, granular-puberulent, or granulose on lower surface, concolorous, weakly paler or weakly to moderately darker than surface; secondary veins weakly to prominently raised or in part prominulous on lower surface; tertiary veins \pm raised, prominulous or flat and visibly distinct on lower surface; reticulate veins \pm raised or prominulous, or flat and visibly distinct or obscure on lower surface. INFLORESCENCES terminal (appearing axillary), erect to erect-spreading, emitting sweet fragrance at anthesis, rarely odorless (*C. plowmanii*), 2 to 8 (to 10) per sympodium, emerging successively at or near apex of petiole sheath or from a subtending sympodial cataphyll near the base; sympodial cataphylls marcescent, ultimately deciduous, 1- to 2-ribbed, glabrous, rarely puberulent (*C. pubescens*); peduncle usually longer than spathe, 10–88 cm \times 2–5 mm, usually 3 mm diam. or less, much shorter than or slightly longer than petiole, terete or occasionally variously shaped in cross-section, rarely in part sulcate, usually glabrous, rarely puberulent, subtended by inflorescence cataphyll; inflorescence cataphylls glabrous, whitish green, 1- to 2-ribbed abaxially; **spathe** surrounding spadix, occasionally curved somewhat forward, with margins convolute, weakly or not at all constricted between tube and blade, narrow, elongate, 3–20 cm, usually less than 1 cm diam., 10 to 20 (to 25) times longer than wide, narrowly \pm cylindrical, ovoid or ellipsoid, frequently thicker than broad, longer than spadix, thin to thinly coriaceous, glabrous on inner surface, narrowly ovate, elliptical, or obovate when flattened

or with blade conspicuously narrower than tube, opening narrowly or broadly 2/3 to almost its entire length at anthesis or only \pm broadly on blade portion, narrowly to broadly funnel-shaped or tubular, remaining \pm open 1 to 3 days, frequently colorful, concolorous or weakly to prominently bicolorous on outer surface; spathe tube \pm cylindrical, ellipsoid or ovoid, occluding pistillate and most or all of sterile staminate portions of spadix, decurrent onto peduncle at base, as long as or occasionally shorter or longer than blade, persisting in fruit, glabrous on outer surface or \pm entirely or in part puberulent in some species, matte to glossy, white, cream, whitish, yellow, red, or purple, or \pm green and purple-tinged or not, matte to glossy on inner surface and concolorous or weakly to prominently paler than outer surface; spathe blade \pm erect or weakly to prominently cucullate, occasionally much longer than tube, frequently entirely obtusely 1-ribbed abaxially or in part toward apex (rib \pm acute toward apex), with margins \pm in-rolled (at anthesis), glabrous on outer surface, rarely in part puberulent, matte to glossy, white, cream, whitish, yellow, red, maroon, or purple, or \pm green and purple-tinged or not, matte to glossy on inner surface and concolorous or weakly to moderately paler, marcescent, rarely occasionally somewhat caducous (*C. plowmanii*), erect after anthesis, rarely spreading or reflexed, ultimately deciduous after anther dehiscence, rarely quickly deciduous after female anthesis (*C. plowmanii*); **spadix** monoecious, slender, 2.2–16.5 cm \times 2–8 mm, contained within and slightly to conspicuously shorter than spathe, \pm cylindrical or weakly thicker than broad, sessile or stipitate, \pm erect, frequently curved somewhat forward at anthesis, rarely also recurved midway and erect at apex (*C. congensis*), entirely or in part adnate to spathe at base, usually 1/2 or more of length of pistillate portion, occasionally also entirely or in part along length of sterile staminate portion, occasionally only along stipe, divided into pistillate portion at base and fertile male portion at apex, separated by sterile flowers arranged in spirals; stipe and axis usually \pm green, rarely dark violet, white or dark maroon; fertile male portion white, cream, yellow, bright orange, pink, red, green, dark purple, brown, yellowish, or greenish, the color frequently different from that of pistillate and sterile portions, cylindrical, tapering, ellipsoid, or clavate, 1.1–7.2 cm, as long as or shorter or longer than pistillate portion, usually much longer than sterile portion, densely flowered, occasionally with some flowers at apex

lacking microsporangia, rarely with 1 or 2 staminodes present (*C. atropurpurea*); sterile male portion white, cream, pink, green, yellow, yellow-orange, bright orange, dark purple, maroon, or purplish, (0–) 1–27 mm long or rarely lacking, weakly, moderately or conspicuously shorter than pistillate and fertile male portions, rarely longer (*C. atropurpurea*), occasionally weakly narrower than pistillate and fertile male portions, laxly or densely flowered; pistillate portion white, cream, yellow, green, orange, red, pink, maroon, rose-colored, yellowish, greenish, or purplish, with coloration attributable to the style and usually different from that of fertile and sterile male portions, \pm cylindrical or weakly broadest midway, 0.7–9 cm long, as long as or longer or shorter than fertile male portion, usually much longer than sterile male portion, rarely slightly shorter (*C. atropurpurea*), densely to laxly flowered, 1 to 6 flowers across axis (as viewed from above); stamens fused into syndandria, with connectives thickened; thecae extending almost to the base, dehiscing by terminal pores or longitudinal slits; syndandria densely arranged 1 to 2 (rarely less) \times 1–2.5(–3) mm, 2- to 6-androus (usually 3 or 4), deeply or shallowly lobed, obpyramidal, usually subprismatic and \pm regularly polygonal (viewed from above), \pm truncate at apex or occasionally broadly concave medially and moderately to prominently elongated in direction of axis, with margins of lobes thickened; pollen extruded in strands as permanent tetrahedral tetrads (rarely linear), inaperturate, starchless, binucleate, 33–48 μm diam., psilate and obscurely punctate, obscurely verruculate, reticulate, foveolate-reticulate, smooth or variable-perforated, rarely with small holes; grains 24–29 μm diam., spheroidal or subspheroidal; sterile flowers laxly or densely arranged, 0.5–2 \times 0.6–2.2 mm, comprised of free or fused staminodes lacking thecae, subprismatic, prismatic, evenly to irregularly lobed, branched or fungiform, with or without red chromoplasts; female flowers laxly or \pm densely arranged, (0.5–)1–3.2 mm; ovaries white, cream, green, or greenish, rarely dark maroon, lavender-tinged, or purple-streaked, usually \pm terete in cross-section, subglobose or obtusely conical, subcuboidal, ovoid, or obconical, 1.3–3.2 mm diam., usually narrowest at apex and as long as or weakly longer than wide, occasionally broadest at or near apex and as wide as long or ca. 2 times wider than long (in some species), (1)2- to 4-locular (possibly 5 or 6 in *C. mirabilis*), rarely plurilocular becoming unilocular toward the apex (*C. castula* and some *C. atropurpurea*); placentation axile, pseudoaxile or subaxile, rarely sub-basal or basal; ovules

anatropous or hemianatropous, presumably bitegmic, 0.15–0.22 mm, subhemispherical in longitudinal section or rarely dorsiventrally compressed and longer than wide, 3 to 14 in plurilocular ovaries, 8 to 20 in unilocular ovaries, 1- to 2(3)-seriate or disorganized, rarely 3- to 4-seriate (*C. lehmannii*), with funicles shorter, longer, or as long as ovules; stylar region 0.3–2 mm, extremely short to conspicuously longer than ovary, as broad as or weakly to conspicuously broader than ovary apex, briefly to prominently attenuate and elongate, occupying 1/4 to 2/3 of the length of the pistil, or occasionally obscurely so or not at all, expanded or not into mantle, usually with red chromoplasts present; mantle (when present) frequently colorful, occluding and partially fused to main body of style, disklike, less than 0.5 mm long and as broad as to weakly broader or narrower than ovary apex, with margins usually not coherent with those of adjacent styles, or \pm attenuate or not, spreading, appressed to ovary or not, as broad as or weakly to conspicuously broader than ovary apex, with margins weakly to moderately coherent or not with those of adjacent styles, deliquescing after anthesis; **stigma** brushlike and densely papillate, white, cream, green, greenish, yellow, yellowish, golden tan, orangish yellow, or orangish white, 0.2–1 mm diam., usually about as broad as long, occasionally much broader than long (when disklike), sessile or apparently so, or weakly to prominently elevated on style, capitate, \pm cylindrical, obconical or disklike, occasionally weakly lobed, truncate or broadly depressed medially at apex, deliquescing after anthesis, persisting in fruit. INFRUCTESCENCE nutant, green, purple, or cream-colored, 4–12.5 \times 0.5–1.5 cm, 4 to 10(to 12) times longer than wide; berries exposed by re-opening spathe, depressed-globose, as long as wide or somewhat wider than long, 2- to 4(5)-furrowed, 1.5–5 \times 2–7 mm, fleshy, greenish white or cream, pale green, yellow-green, yellow or white, rarely violet-tinged green; seeds white, cream-colored or pale green, 3 to 25 per berry, 1–2 \times 0.8–1 mm, ovoid to ellipsoid, terete or obtusely 3-sided, longitudinally costate, rarely smooth; embryo axile, elongate; endosperm copious; chromosomes: $2n = 26$.

Chlorospatha consists of 69 taxa (68 species, one variety) from Costa Rica and Panama in Central America, and Colombia and Ecuador in South America. Ecologically, the genus is tropical, in perpetually wet areas in deep shade of forest understory, frequently along small streams, on steep banks or in boggy areas, at 0–3000 m elevation.

Etymology. From the Greek “chloro-,” meaning “green,” and “-spatha,” meaning “spathe,” referring to the spathe of the type *Chlorospatha kolbii*.

INFRACENERA RELATIONSHIPS

Chlorospatha is not currently divided into sections or subgenera. However, the taxa fall into three natural and reasonably distinct groups, based on vegetative characters, floral morphology, and geographical distribution, with stylar morphology

serving as the primary delimiting character in these groups, based on the 10 distinct style types observed in the genus. The style type or types (see Style and Stigma Morphology) that occur in each group are exclusive to that group. Based on these findings, an original system of sectional classification is presented here, comprised of three sections: *Chlorospatha* sect. *Chlorospatha*, *Chlorospatha* sect. *Occidentales*, and *Chlorospatha* sect. *Orietales*.

KEY TO THE SECTIONS OF *CHLOROSPATA*

- 1a. Style expanded into a mantle; leaf blades erect to erect-spreading; ovaries longer than wide or as wide as long, not wider than long, usually plurilocular; rarely occurring on eastern slopes of the Andes.
 - 2a. Mantle disklike; stigma sessile or apparently so; ovaries usually longer than wide, plurilocular; leaf blades divided and simple or compound (with segments separated); not occurring on eastern slopes of the Andes *Chlorospatha* Engl. sect. *Chlorospatha*
 - 2b. Mantle spreading, not disklike; stigma usually elevated on style, rarely sessile or apparently so; ovaries as long as wide, plurilocular, rarely semi-unilocular; leaf blades entire or with posterior lobes, rarely trifid; rarely occurring on eastern slopes of the Andes *Chlorospatha* sect. *Occidentales* Croat & L. P. Hannon
- 1b. Style with mantle lacking; leaf blades erect to erect-spreading, or also spreading to reflexed-spreading (in some species); ovaries frequently wider than long, occasionally 1-locular; occurring only on eastern slopes of the Andes *Chlorospatha* sect. *Orietales* Croat & L. P. Hannon

Ia. *Chlorospatha* Engl. sect. *Chlorospatha*, sect. nov. TYPE: *Chlorospatha kolbii* Engl.

Caudex plerumque erectus. Folia erecta vel erecto-potentia; lamina trifida, trisecta, pedatifida vel pedatisecta, interdum maculata. Flos stylo in amiculum plus minusve disciforme latitudine ovarii apicem subaequans expanso; stigmatibus apertis sessilibus.

Terrestrial or rarely hemiepiphytic, occasionally large and 1.5–2 m tall, not colonial; stem frequently erect. LEAVES (1)2 to 5, erect to erect-spreading; sympodial leaf a fully expanded foliage leaf; sides of petiole sheath convolute; blades trifid, trisect, pedatifid, or pedatisect, rarely with leaves not divided in some species (*Chlorospatha hammeliana*, *C. ilensis*), occasionally maculate. INFLORESCENCE with pistils ± densely arranged, rarely laxly arranged; ovaries usually longer than wide, plurilocular; placentation axile, pseudoaxile, or subaxile (not basal); style expanded into disklike mantle, ± truncate, rarely obscurely attenuate, occupying ca. 1/10 of the length of pistil (Style Type 3); margins conspicuous; stigma sessile or apparently so, usually conspicuously broader than long; synandria 2- to 5- androus, ± prismatic, truncate at apex; sterile flowers subprismatic, prismatic, lobed, fungiform, or branched (see Sterile Flowers), densely or laxly arranged.

Species list. Species included in *Chlorospatha* sect. *Chlorospatha*: *C. betancurii*, *C. caldasensis*, *C. callejasii*, *C. cedralensis*, *C. chocoensis*, *C. cogolloi*,

C. croatiana, *C. gentryi*, *C. hammeliana*, *C. ilensis*, *C. kolbii*, *C. kressii*, *C. luteynii*, *C. maculata*, *C. mirabilis*, *C. morae*, and *C. risaraldensis* (17 spp., Costa Rica, Panama, northwestern Colombia, and western Ecuador).

Etymology. The type species of the genus, *Chlorospatha kolbii*, is a member of this section.

Discussion. *Chlorospatha* sect. *Chlorospatha* is comprised of 18 of the 19 taxa with divided or deeply lobed leaf blades that are either simple or compound and occurs from Costa Rica southward, through Panama in Central America and northwestern Colombia and western Ecuador in South America and is not known from the eastern slopes of the Andes: *C. betancurii*, *C. caldasensis*, *C. callejasii*, *C. cedralensis*, *C. chocoensis*, *C. cogolloi*, *C. croatiana* subsp. *croatiana*, *C. croatiana* var. *enneaphylla*, *C. gentryi*, *C. hammeliana*, *C. ilensis*, *C. kolbii*, *C. kressii*, *C. luteynii*, *C. maculata*, *C. mirabilis*, *C. morae*, and *C. risaraldensis*. Blades of these taxa are trifid, trisect, pedatifid, or pedatisect. All have sessile stigmas or apparently so (see Style and Stigma Morphology), and all have the same style type (see Style Type 3, Fig. 1), in which the style is expanded into a more or less disklike mantle approximately as broad as the ovary apex.

The combination of sessile stigmas and prominent, disklike styles (Style Type 3) is found exclusively in taxa with divided leaf blades (with leaf segments divided from one another). However, the blade shapes

of two species are intermediate; some collections of each having blades that are not divided are *Chlorospatha hammeliana* and *C. ilensis*. The typical leaf blade of *C. hammeliana* from Panama is ovate-cordate (Fig. 21A); however, one specimen (Croat & Zhu 76881) (Fig. 21C) from an area isolated from the type locality is clearly 3-lobed, whereas the blades of another specimen of the same collection are ovate-cordate. Several collections from that area are intermediate between the typical and 3-lobed forms and some collections from the type locality could also be considered intermediate (Fig. 21B), though less obviously so, these having subhastate blades somewhat less constricted in the area of petiole attachment than those of the 3-lobed specimen and long, prominent posterior lobes, which suggests the possibility that these plants could also eventually consistently or occasionally produce divided blades (with the segments freely separated from one other). The leaf blades of *C. ilensis* can be hastate or even subhastate (Fig. 26B) as well as trifid. Interestingly, numerous collections of *C. ilensis* have been misidentified as *C. mirabile*, the dried blades of the two species often being remarkably similar in shape, with the posterior lobes directed toward the apex and all lobes markedly constricted at their bases, with the laminar tissue frequently only about 1 cm wide between the point of constriction and the posterior rib.

The largest plants in the genus are found in *Chlorospatha* sect. *Chlorospatha*, although most, as for the genus as a whole, are approximately 1 m tall or less. *Chlorospatha croatianana* subsp. *croatiana* and *C. caldasensis* are erect-growing and can be as much as 2 m tall, and several other erect-growing species in this section can be as much as 1.5 m tall. Only 13 taxa of *Chlorospatha* are known to be erect-growing and eight of these are members of *Chlorospatha* sect. *Chlorospatha*, the other five being species in *Chlorospatha* sect. *Occidentales* occasionally reaching 1.5 m tall. Maculate leaf blades occur exclusively in *Chlorospatha* sect. *Chlorospatha*. Taxa in section *Chlorospatha* have three to five erect to erect-spreading leaves; the sympodial leaf is always a fully expanded foliage leaf, and the sides of the petiole sheath are convolute, with the inflorescences held within the sheath and emerging at or near the apex of the sheath. The combination of the somewhat arborescent habit relatively densely arranged pistils, more or less elongated ovaries, disklike styles, and usually broad, prominent, sessile stigmas makes section *Chlorospatha* at least superficially strikingly similar to that found in *Xanthosoma* sect. *Xanthosoma* and suggests possible affinities with that genus. Interestingly, for years, all collections of *C. croatianana*

were misidentified as specimens of *Xanthosoma*, until Grayum's publication of the species in 1986.

Ib. *Chlorospatha* sect. *Occidentales* Croat & L. P. Hannon, sect. nov. TYPE: *Chlorospatha lehmannii* (Engl.) Madison.

Caudex erectus vel decumbens. Folia erecta vel erecto-patentia; lamina integra vel in lobos posteriores divisa. Flos stylo plerumque attenuato in amiculum plus minusve patens expanso, stigmatate plerumque stylo insidente.

Terrestrial or hemiepiphytic, 0.3–1.5 m tall, usually 1 m or less, rarely colonial (*Chlorospatha besseae*); stem usually decumbent, occasionally erect. LEAVES (1)2 to 5, rarely 6 to 8, erect to erect-spreading; sympodial leaf usually a fully expanded foliage leaf, rarely a cataphyll (*C. longiloba*, *C. yatacuensis*); sides of petiole sheath convolute; blades entire and ovate or ovate-elliptic, or simple and sagittate to hastate, rarely trifid (*C. corrugata*), not maculate. INFLORESCENCE with pistils laxly or densely arranged; ovaries approximately as long as wide, plurilocular, rarely semi-unilocular (*C. atropurpurea*, *C. castula*); placentation axile, pseudoaxile, or subaxile, rarely basal (*C. castula*); style expanded into a \pm broadly spreading mantle, usually briefly to prominently attenuate and occupying 1/4 to 2/3 of the length of pistil, rarely obscurely or not at all attenuate (Style Types 4–10); margins conspicuous; stigma \pm elevated on attenuated style, rarely sessile or apparently so, about as broad as long, rarely disklike and wider than long; synandria 2- to 5-androus or occasionally 6-androus, \pm prismatic, truncate at apex.

Species list. Species included in *Chlorospatha* sect. *Occidentales*: *C. amalfiensis*, *C. antioquiensis*, *C. atropurpurea*, *C. bayae*, *C. besseae*, *C. bogneri*, *C. bullata*, *C. caliensis*, *C. carchiensis*, *C. castula*, *C. congensis*, *C. corrugata*, *C. dodsonii*, *C. feuersteiniae*, *C. giraldoi*, *C. grayumii*, *C. hastata*, *C. hastifolia*, *C. huilensis*, *C. jaramilloi*, *C. lehmannii*, *C. litensis*, *C. longiloba*, *C. macphersonii*, *C. mansellii*, *C. munchiquensis*, *C. nambiensis*, *C. narinoensis*, *C. nicolsonii*, *C. noramurphyae*, *C. oblongifolia*, *C. planadensis*, *C. queremalensis*, *C. ricartensis*, *C. sagittata*, *C. stellaris*, *C. sucumbensis*, *C. timbiquensis*, *C. tokioensis*, and *C. yatacuensis*.

Etymology. From the Latin “occidentalis,” meaning “western,” referring to distribution confined almost exclusively to the western slopes of the Andes.

Discussion. *Chlorospatha* sect. *Occidentales* consists of 40 species mostly confined to the western slopes of the Andes in Colombia and Ecuador, and

Cordillera Central or Magdalena River drainage region in Colombia.

Chlorospatha huilensis and *C. succumbens* are the only species that occur on the eastern slopes of the Andes, in a region where the Cordillera Oriental merges somewhat indistinctly with the Cordillera Central. These two mountain ranges serve as the eastern and western boundaries of the Magdalena River drainage. Maps clearly indicate access from the region of the Magdalena River drainage into the Amazon Basin, where some collections of *C. huilensis* were made, and it is likely that these two species originated in this region rather than in the Amazon drainage (see Geographical Distribution and Endemism). The stylar morphology of these two species, with the style expanded into a mantle, is significantly different from that of all other species from the eastern slopes, all of which have styles lacking mantles.

The style is expanded into a conspicuous, more or less broadly spreading mantle in all species in section *Occidentales* and is more or less attenuated in all but four species: *Chlorospatha castula*, *C. corrugata*, *C. hastata*, and *C. sagittata*. In these four species, the style is obscurely or not at all attenuated and the stigma is actually or apparently sessile, but differs from the style morphology of *Chlorospatha* sect. *Chlorospatha*; the mantle is conspicuously broader than the ovary apex and not at all disklike. Of these four species, only *C. corrugata* is not endemic to Ecuador, occurring instead in northwestern Colombia, significantly distant from the other three species. Additionally, *C. corrugata* is the only member of *Chlorospatha* sect. *Occidentales* with divided leaf blades, these being trifid (i.e., 3-lobed, not divided into segments). *Chlorospatha corrugata* is a 3-lobed species with a style that is expanded into a broadly spreading mantle that is not disklike; therefore, the 3-lobed condition appears to have evolved independently of the other taxa with divided blades, all of which exhibit strong affinities in floral characters. Therefore, *C. corrugata* is a member of *Chlorospatha* sect. *Occidentales*. Comprehensive molecular work has not been done on *Chlorospatha* and would probably be informative in this regard, as would intersectional and interspecific breeding studies.

Otherwise, species in *Chlorospatha* sect. *Occidentales* have three to five erect to erect-spreading leaves with blades that are not divided or maculate and the sympodial leaf is usually a fully expanded foliage leaf, rarely a cataphyll (*C. longiloba*, *C. yatacuensis*). All but four species in *Chlorospatha* sect. *Occidentales* have decumbent stems and most are only occasionally more than 1 m tall. The sides of the

petiole sheath are invariably convolute, regardless of the nature of the sympodial leaf.

The greatest diversity of floral morphology in *Chlorospatha* occurs in *Chlorospatha* sect. *Occidentales*, most significantly in the highly diverse stylar morphology. Seven of the 10 types of styles that occur in the genus are found exclusively in this section (see Style Types 4–10, Fig. 1). Synandria that are 6-androus occur only in *Chlorospatha* sect. *Occidentales*, with *C. ricauertensis* having 5- to 6-androus flowers (mostly 5-androus), with a few flowers 4-androus, and *C. sagittata* having 4- to 6-androus flowers, with a few flowers 3-androus. Exclusively branched flowers occur in some species of section *Occidentales* and in no taxa in other sections.

Ic. *Chlorospatha* sect. *Orientalis* Croat & L. P. Hannon, sect. nov. TYPE: *Chlorospatha longipoda* (K. Krause) Madison.

Caudex decumbens. Folia saepe patentia usque reflexo-patentia vel erecta usque erecto-patentia; lamina integra vel in lobos posteriores divisa. Flores fertiles in synandriis saepe mediano concavis et apicem versus manifeste elongatis, loborum marginibus exterioribus conspicue incrassatis; stylus in amiculum non expansus. Flores steriles prismatici vel subprismatici.

Terrestrial, hemiepiphytic or emergent aquatics, less than 70 cm tall, usually less than 50 cm, frequently colonial; stem usually decumbent, rarely erect. LEAVES several to numerous, 3 to 14, erect to erect-spreading or also spreading to reflexed-spreading in some species; sympodial leaf frequently a cataphyll, occasionally a fully expanded foliage leaf; sides of petiole sheath usually erect, occasionally broadly spreading, rarely convolute; blades entire and narrowly ovate, or simple and sagittate or hastate, not maculate. INFLORESCENCE with pistils \pm densely arranged; ovaries frequently wider than long, plurilocular or unilocular; placentation axile, pseudoaxile, subaxile, sub-basal, or basal; style not expanded into a mantle, usually \pm truncate, rarely briefly attenuate (in 3 species), extremely thin and occupying 1/10 or less of the length of pistil or occupying ca. 1/4 of the length (in attenuated styles); margins usually \pm obscure (Style Types 1, 2); stigma sessile or apparently so, or elevated on style, ca. as broad as long; synandria 2- to 5-androus, usually elongated in direction of axis, twice as long as wide (viewed from above), and broadly concave medially, with margins of lobes prominently thickened, or truncate at apex (in some species); sterile flowers subprismatic or prismatic, densely arranged.

Species list. Species included in *Chlorospatha* sect. *Orientalis*: *C. boosii*, *C. cutucuensis*, *C. engleri*, *C. hannoniae*, *C. limonensis*, *C. longipoda*, *C.*

plowmanii, *C. portillae*, *C. pubescens*, *C. sizemoreae*, and *C. yaupiensis*.

None of the species from the Eastern slopes of the Andes, Ecuador, in *Chlorospatha* sect. *Orientales*, have leaf blades that are divided or maculate. The style is not expanded into a mantle and is somewhat obscure, being extremely thin, as broad as or somewhat narrower than the ovary apex, with the margins frequently difficult to discern unless coloration of the style differs from that of the ovary (see Style Type 1, Fig. 1), and in all but three species, the stigma is sessile or apparently so. In *C. cutucuensis*, *C. portillae*, and *C. sizemoreae*, the stigma is elevated on a relatively short, attenuated style that occupies approximately one fourth of the length of the pistil or less (see Style Type 2, Fig. 1). These species also differ from the other members of *Chlorospatha* sect. *Orientales* in having the lower leaf blade surface smooth rather than reticulate, and in *C. cutucuensis* and *C. portillae*, the surface is not narrowly colliculate along all venation as it is in the remaining species. Additionally, these three species, as well as *C. engleri* and *C. limonensis*, have synandria that are more or less truncate at the apex, similar to those found in most other *Chlorospatha*. The unusual synandria found only in the remaining six species are more or less elongated in the direction of the axis, frequently markedly so, broadly concave medially and irregularly lobed, with the outer margins of the lobes moderately to prominently thickened and conspicuously sinuate-undulate, interlocking with the margins of adjacent flowers.

Several additional unusually expressed characters are found exclusively, or nearly so, in species of *Chlorospatha* sect. *Orientales*. All but three species have ovaries that are somewhat broadly cylindrical or obtusely obconical, frequently almost twice as wide as long, obtusely truncate at the apex and frequently also somewhat broadly concave medially. *Chlorospatha* in

other sections have ovaries that are about as long as wide or in some taxa in *Chlorospatha* sect. *Chlorospatha*, longer than wide. Obconical ovaries have been observed only in *Chlorospatha* sect. *Orientales*. Unilocular ovaries occur exclusively in *Chlorospatha* sect. *Orientales*, with exclusively 1-locular ovaries observed in only two collections (*Plowman et al.* 3979 and *Croat et al.* 88008A) of one species, *C. plowmanii*, although a semi-unilocular condition at the apex was reported for *C. castula* and *C. atropurpurea* (in *Chlorospatha* sect. *Occidentales*) by Madison (1978, 1981). In the remaining species with some unilocular ovaries in *Chlorospatha* sect. *Orientales*, most ovaries are 2-locular, with 1-locular ovaries occurring only at the base of the spadix or occasionally interspersed with 2-locular ovaries.

Most species in this section are relatively small plants no more than 50 cm tall, usually colonial, and all have decumbent stems except *Chlorospatha cutucuensis*. Four species, *C. boosii*, *C. hannoniae*, *C. plowmanii*, and *C. pubescens*, have numerous leaves (eight to 14) that are typically spreading to reflexed-spreading as well as erect to erect-spreading. All other taxa of *Chlorospatha* have approximately five or fewer leaves that are exclusively erect to erect-spreading. Leaves are not maculate, and in seven of the 11 species in *Chlorospatha* sect. *Orientales*, the sympodial leaf is a cataphyll, an unusual state that occurs only in two species not in this section (*C. longiloba*, *C. yatacuensis*). The sides of the petiole sheath are rarely convolute in *Chlorospatha* sect. *Orientales* and are usually more or less erect or, as in *C. boosii* and *C. hannoniae*, broadly spreading, thus appearing winged, a condition found in no other taxon in the genus.

Etymology. From the Latin “orientalis,” meaning “eastern,” referring to the distribution of these species exclusively on the eastern slopes of the Andes.

KEY TO SPECIES OF *CHLOROSPATHA*

- 1a. Species from Central America.
 - 2a. Leaf blades simple, ovate, cordate to sagittate at base; Panama (Cooclé), 710–1150 m *C. hammeliana* Grayum & Croat
 - 2b. Leaf blades with 3 or more lobes.
 - 3a. Leaf blades with 3 lobes, lacking auricles.
 - 4a. Leaf blades usually maculate, drying weakly to moderately bicolorous, weakly glossy to semiglossy and ± purple, purple-tinged, or purple-mottled abaxially; petiole matte to weakly glossy, the free portion flattened adaxially, usually with acute margins, sheathed 1/2 to 2/3 of its length; Panama (Darién), 550–1400 m *C. mirabilis* (Mast.) Madison
 - 4b. Leaf blades lacking maculations, drying markedly bicolorous, glossy, green abaxially; petiole semiglossy, the free portion ± terete, sheathed 1/6 to 1/4 of its length; Panama (Veraguas), 800–1030 m *C. hammeliana* Grayum & Croat
 - 3b. Leaf blades with 3 to 5 lobes and moderately to prominently auriculate or ± rounded at the base on outermost segments or with 5 to 7 lobes and ± acute at the base, lacking auricles.
 - 5a. Leaf blades with 3 to 5 lobes and moderately to prominently auriculate or ± rounded at the base; segments broad, broadly attached at the base; primary lateral veins 5 to 7 pairs, arising at 35°–

- 60°; Costa Rica (Heredia, Limón, Puntarenas), 200–750 m; Panama (widespread), 200–1400 m
..... *C. croatiana* Grayum subsp. *croatiana*
- 5b. Leaf blades with 5 to 7 lobes, \pm acute at base, lacking auricles; segments narrow, narrowly attached at base; primary lateral veins 2 to 4 pairs, arising at 15°–35°; Panama (Chiriquí, Coclé, Panamá, Veraguas), 710–1135 m *C. croatiana* var. *enneaphylla* Grayum
- 1b. Species from South America.
- 6a. Species of Magdalena River drainage, occurring on western slopes of Cordillera Oriental, eastern slopes of Cordillera Occidental, and on both slopes of Cordillera Central in Colombia, rarely in Amazon drainage (not occurring on western slopes of Cordillera Occidental in Colombia or western slopes of Andes in Ecuador).
- 7a. Leaf blades simple, sagittate, with posterior lobes directed toward the base.
- 8a. Spathe tube green; spadix adnate to spathe entire length of pistillate portion; sterile staminate portion comprising 1/10 of total length; style broadly spreading, not appressed to ovary; synandria 3- to 4-androus; sterile flowers densely arranged in 3 to 5 whorls.
- 9a. Leaf blades drying matte to weakly glossy, yellow-brown on lower surface, with all but reticulate venation \pm raised and granular-puberulent; primary lateral veins 3 to 5 pairs; peduncle less than 15 cm long; style comprising 1/2 of the length of pistil; Colombia (Huila, Putumayo, sometimes also in Amazon drainage), 2000–2420 m
..... *C. huilensis* Croat & L. P. Hannon
- 9b. Leaf blades drying semiglossy, yellow-green on lower surface, with all venation \pm flattened and glabrous; primary lateral veins 4 to 7 pairs; peduncle more than 20 cm long; style comprising 1/3 of the length of pistil; Colombia (Antióquia), 1800–3000 m
..... *C. antioquiensis* Croat & L. P. Hannon
- 8b. Spathe tube purplish brown; spadix adnate to spathe 1/3 of the length of pistillate portion; sterile staminate portion comprising 1/4 of total length; style not broadly spreading, appressed to ovary; synandria 3-androus; sterile flowers laxly arranged in 9 whorls; Colombia (Antióquia), 1200–1300 m
..... *C. amalfiensis* Croat & L. P. Hannon
- 7b. Leaf blades with 3 or more lobes to palmatisect, with segments directed toward apex.
- 10a. Leaf blades deeply 3-lobed to tristect.
- 11a. Leaf blades with lateral lobes both narrower than and usually shorter than medial lobe; all venation glabrous on lower surface; major venation drying darker than surface; tertiary and reticulate venation \pm obscure; petiole glabrous, sheathed ca. 1/2 of its length; peduncle 42–46 cm long, more than 1/2 as long as petiole.
- 12a. Segments long-acuminate at apex, drying weakly glossy, green on upper surface, with pale maculations; major and secondary venation drying moderately darker than lower surface; spathe tube green; spadix less than 6.5 cm long; fertile staminate portion brown; Colombia (Antióquia), 1550–1850 m
..... *C. betancurii* Croat & L. P. Hannon
- 12b. Segments acute at apex, drying matte, yellowish brown on upper surface, with maculations lacking; major and secondary venation drying markedly darker than lower surface, almost black; spathe tube purple; spadix more than 8 cm long; fertile staminate portion white; Colombia (Antióquia), 1710–1900 m ...
..... *C. callejasii* Croat & L. P. Hannon
- 11b. Leaf blades with lateral lobes both broader than and usually as long as or longer than medial lobe; all venation \pm puberulent on lower surface; major venation drying \pm concolorous; tertiary and reticulate venation conspicuously raised or prominulous; petiole \pm puberulent, sheathed 1/4 to 1/3 of its length; peduncle 3–13 cm long, less than 1/4 as long as petiole; Colombia (Antióquia), 890–1350 m
..... *C. corrugata* Bogner & Madison
- 10b. Leaf blades with 5 or more lobes to palmatisect.
- 13a. Leaf blades with 5 lobes to palmatisect; occurring above 2000 m.
- 14a. Leaf blades with segments free to the base or alate between segments, the confluent portion no more than 1 mm wide, drying matte to weakly glossy on lower surface; petiole sheathed ca. 3/4 of its length; peduncle ca. 60 cm long, almost as long as petiole; Colombia (Risaralda), 2200–2300 m
..... *C. cedralensis* Croat & L. P. Hannon
- 14b. Leaf blades broadly confluent between segments, the confluent portion 1.5–4 cm wide, drying semiglossy to glossy on lower surface; petiole sheathed ca. 1/2 of its length; peduncle 20–43 cm long, ca. 1/2 as long as petiole.
- 15a. Leaf blades brown when fresh, drying moderately bicolorous; primary lateral veins 7 to 8 pairs on innermost lateral segments; petioles brown when fresh, drying semi-intact, \pm fibrous, medium-dark brown; epidermis not separating; spathe tube green, blade white; Colombia (Caldas), 2250 m
..... *C. caldasensis* Croat & L. P. Hannon
- 15b. Leaf blades green when fresh, drying weakly bicolorous; primary lateral veins 4 to 5 pairs on innermost lateral segments; petioles green when fresh, drying intact, almost black, with epidermis in part separated from main body of petiole, glossy, semi-transparent; spathe tube and blade entirely pale green; Colombia (Antióquia; possibly Risaralda), 2440–2800 m
..... *C. luteynii* Croat & L. P. Hannon
- 13b. Leaf blades with 7 to 9 lobes; occurring below 1000 m; Colombia (Antióquia, Boyacá, Chocó), 150–820 m
..... *C. croatiana* var. *enneaphylla* (Grayum) Croat & L. P. Hannon
- 6b. Species of eastern slopes of Andes and Amazon drainage or mostly western slopes of Cordillera Occidental in Colombia and western slopes of Andes in Ecuador.

- 16a. Species mostly of western slopes of Cordillera Occidental in Colombia and western slopes of Andes in Ecuador.
- 17a. Leaf blades with 3 or more divisions or lobes.
- 18a. Leaf blades with 3 lobes.
- 19a. Leaf blades with lateral lobes both broader than and usually as long as or longer than medial lobe.
- 20a. Leaf blades with all venation drying glabrous and \pm flattened on lower surface, much darker than surface; petiole glabrous, sheathed ca. 1/2 or more of its length, drying dark blackish brown; peduncle glabrous, more than 34 cm long; Colombia (Risaralda), 1500–1550 m *C. risaraldensis* Croat & L. P. Hannon
- 20b. Leaf blades with all venation drying \pm puberulent and \pm raised on lower surface, concolorous to weakly darker than surface; petiole entirely or in part \pm puberulent, sheathed 1/4 to 1/3 of its length, drying medium to medium-dark brown; peduncle granular-puberulent, 3–13 cm long; Colombia (Antioquia), 890–1350 m *C. corrugata* Bogner & Madison
- 19b. Leaf blades with lateral lobes narrower and usually shorter than medial lobe.
- 21a. Species occurring above 1200 m; leaf blades thin; major and secondary veins drying \pm raised on lower surface; petiole sheathed 3/4 or more of its length; sterile staminate portion comprising ca. 1/10 of the length of spadix, with flowers densely arranged; Colombia (Antioquia), 1250–1800 m ... *C. cogolloi* Croat & L. P. Hannon
- 21b. Species occurring below 1000 m; leaf blades thinly coriaceous to subcoriaceous; major and secondary veins drying \pm flattened on lower surface; petiole sheathed 1/3 to 2/3 of its length; sterile staminate portion comprising 1/4 or 2/3 of the length of spadix, with flowers laxly arranged.
- 22a. Leaf blades green on both surfaces; upper surface matte, flat (not quilted); all lobes broadly concave (on mature specimens); primary lateral veins 7 to 10 pairs on lateral segments of mature specimens, aggregated toward base; petiole green, brittle; Colombia (Chocó), 240–825 m *C. maculata* Croat & L. P. Hannon
- 22b. Leaf blades weakly glossy to glossy, green on upper surface, purple to purple-tinged on lower surface; upper surface quilted; all lobes broadly convex; primary lateral veins usually 5 to 6 pairs (rarely 7) on lateral segments of mature specimens, evenly distributed; petiole purple to purplish, spongy.
- 23a. Leaf blades with all segments broadly confluent at base; confluent portion 3.5–4 cm wide; posterior rib not naked; petiole sheathed ca. 1/3 of its length; peduncle less than 20 cm long; sterile staminate portion comprising ca. 1/4 of the length of spadix, the flowers broadly concave medially, fungiform, with undulate margins; Colombia (Chocó), less than 50 m *C. chocoensis* Croat & L. P. Hannon
- 23b. Leaf blades with all segments narrowly confluent at base; confluent portion less than 1 cm wide; posterior rib naked 1–1.5(–2) cm per side; petiole sheathed 1/2 or more of its length; peduncle 30–56 cm long; sterile staminate portion comprising ca. 1/3 of the length of spadix, the flowers obtusely truncate, subprismatic; Colombia (Antioquia, Chocó, Valle), sea level to 150(–900) m *C. mirabilis* (Mast.) Madison
- 18b. Leaf blades with 5 or more lobes.
- 24a. Leaf blades with 5 to 9 segments; segments broadly ovate, elliptical or obovate, to 12 cm wide, less than 4 times longer than wide, \pm acute and free to the base, narrowly attached, moderately inequilateral; spadix sessile.
- 25a. Leaf blades with 5 to 7 segments; all orders of venation crispy-puberulent on lower surface; petiole scurfy-pubescent, sheathed 1/4 to 1/3 of its length; peduncle less than 11 cm long, crispy-puberulent; spathe in part crispy-puberulent abaxially; synandria green; Colombia (Antioquia), 1200–1800 m *C. gentryi* Grayum
- 25b. Leaf blades with 5 to 9 segments; all orders of venation \pm glabrous on lower surface; petiole glabrous, sheathed ca. 1/2 of its length; peduncle 25 cm long, glabrous, striate-ridged; spathe glabrous throughout; synandria white; Colombia (Chocó), 285–825 m *C. morae* Croat & L. P. Hannon
- 24b. Leaf blades with (7 to)9 to 15 segments; segments narrowly elliptical, to 3 cm wide, more than 5 to 10 times longer than wide, broadly attached at base, narrowly confluent between segments, markedly inequilateral; spadix stipitate.
- 26a. Leaf blades velvety on upper surface; spathe more than 7 cm long, green on inner surface; spadix more than 5.5 cm long; axis pale green; sterile staminate spadix ca. 1 cm long or more; Colombia (Chocó), near sea level *C. kolbii* Engl.
- 26b. Leaf blades matte on upper surface; spathe less than 6.5 cm long, dark violet 3/4 of its length on inner surface; spadix less than 5 cm long; axis violet; sterile staminate spadix 4 mm long or less; Colombia (Chocó), less than 500 m *C. kressii* Grayum

- 17b. Leaf blades simple and hastate, sagittate, cordate or cordulate at base.
- 27a. Leaf blades purplish violet-tinged on lower surface.
- 28a. Leaf blades narrowly ovate-sagittate to sagittate; posterior lobes rounded, not acutely pointed at apex; upper surface minutely bullate; all orders of venation prominently raised on lower surface, with sunken areoles; posterior rib not naked; sterile staminate portion comprising ca. 1/10 of total length of spadix, the flowers irregularly lobed; Colombia (Valle), 1020–2000 m *C. bullata* Croat & L. P. Hannon
- 28b. Leaf blades sagittate, sagittate-subhastate, or markedly hastate; posterior lobes acute to acuminate at apex; upper surface \pm smooth (not at all bullate); major, secondary, and tertiary veins weakly to moderately raised or prominulous on lower surface, with areoles lacking; posterior rib naked 1–3.5 cm per side; sterile staminate portion comprising 1/4 to 1/3 of total length of spadix, the flowers fungiform, not lobed.
- 29a. Leaf blades sagittate to occasionally weakly subhastate; anterior and posterior lobes not markedly constricted at base; petiole sheathed 1/2 of its length or more; sheath decurrent at apex; spathe cucullate.
- 30a. Leaf blades with posterior lobes narrow, more than 3 times longer than wide; spathe tube \pm purple; spadix sessile, adnate to spathe most of the length of pistillate portion; style white, broadly spreading, the margins \pm coherent with those of adjacent styles, truncate; stigma sessile; Ecuador (Pichincha), 1200 m *C. castula* (Madison) Madison
- 30b. Leaf blades with posterior lobes broad, less than 2.5 times longer than wide; spathe tube green or cream; spadix stipitate, adnate to spathe only along stipe or occasionally narrowly onto pistillate portion; style orange, appressed to ovary, the margins not coherent with those of adjacent styles, narrowly attenuate; stigma elevated on style; Ecuador (widespread), 100–1200 m *C. atropurpurea* (Madison) Madison
- 29b. Leaf blades hastate to markedly hastate; anterior and posterior lobes markedly constricted at base; petiole usually sheathed less than 1/2 of its length; sheath free-ending at apex; spathe \pm erect; Ecuador (Carchi, Esmeraldas), 375–1800 m *C. hastata* Croat & L. P. Hannon
- 27b. Leaf blades not at all purplish violet-tinged on lower surface.
- 31a. Leaf blades hastate to markedly hastate at base, the posterior lobes prominently spreading.
- 32a. Leaf blades with posterior lobes weakly or not at all constricted at or near base.
- 33a. Petiole sheathed 1/2 of its length (rarely 2/3); leaf blades with posterior lobes broad, less than 2 times longer than wide; peduncle ca. 2/3 as long as petiole; spadix more than 8.5 cm long; sterile flowers densely arranged; Ecuador (Esmeraldas), 647–701 m *C. mansellii* Croat & L. P. Hannon
- 33b. Petiole sheathed 3/4 or more of its length; leaf blades with posterior lobes narrow, more than 2 times longer than wide; peduncle longer than petiole; spadix less than 6.5 cm long; sterile flowers markedly laxly arranged; Colombia (Cauca), ca. 100 m *C. timbiquensis* Croat & L. P. Hannon
- 32b. Leaf blades with posterior lobes markedly constricted near base, the constriction substantially narrower than middle of lobes.
- 34a. Petiole sheathed ca. 1/3 of its length; peduncles less than 20 cm long.
- 35a. Leaf blades drying green, moderately bicolorous; major veins drying mostly weakly paler than lower surface; petiole medium green, with sheath green; fertile staminate spadix cream; sterile staminate spadix less than 9 mm long, the flowers subprismatic to shallowly lobed, densely arranged; Colombia (Nariño), 1100–1325 m *C. narinoensis* Croat & L. P. Hannon
- 35b. Leaf blades drying dark brown to brownish, weakly bicolorous; major veins drying darker than lower surface; petiole pale green, with sheath maroon; fertile staminate spadix brown; sterile staminate spadix more than 1 cm long, the flowers mostly fungiform (like toadstools) to branched, laxly arranged; Colombia (Nariño), 1325 m *C. nambiensis* Croat & L. P. Hannon
- 34b. Petiole sheathed more than 1/2 of its length; peduncles more than 30 cm long.
- 36a. Stems tan or brown, \pm scurfy; petiole smooth, terete or subterete, sheathed 1/2 to 2/3 of its length, \pm purplish to purple-mottled; peduncle 1/2 to 2/3 as long as petiole; style white, cream, or green (rarely weakly orangish yellow-tinged), weakly broader than ovary apex (not broadly spreading), the margins not coherent; stigma sessile or markedly elevated on style; sterile staminate spadix less than 1 cm long, densely flowered.

- 37a. Leaf blades moderately smooth; lower surface not reticulate; spadix less than 10.5 cm long; pistillate portion adnate to spathe 1/3 to 1/2 of its length; style green; stigma sessile; ovaries 2-locular; fertile staminate spadix cream to greenish; Ecuador (widespread), 550–1530 m..... *C. ilensis* Madison
- 37b. Leaf blades weakly to moderately wrinkled; lower surface conspicuously reticulate; spadix more than 11 cm long; pistillate portion adnate to spathe most or all of its length; style white to cream (rarely weakly orangish yellow-tinged); stigma markedly elevated on style; ovaries 3- to 4-locular; fertile staminate spadix bright orange; Ecuador (widespread), 100–1500 m *C. dodsonii* (G. S. Bunting) Madison
- 36b. Stems dark green or gray-green, smooth; petiole finely many-ribbed, sharply D-shaped with erect, acute margins, sheathed 3/4 or more of its length, \pm entirely dark green; peduncle 3/4 as long as or longer than petiole; style usually orange (rarely white), much broader than ovary apex, the margins \pm coherent; stigma weakly elevated on style; sterile staminate spadix 1.5–2.5 cm long, laxly flowered; Colombia (Nariño), 1100–1325 m; Ecuador (Esmeraldas), 350–425 m *C. litensis* Croat & L. P. Hannon
- 31b. Leaf blades sagittate, subhastate, cordulate to cordate or acute to rounded at base.
- 38a. Leaf blades cordate to cordulate or rounded to acute at base.
- 39a. Leaf blades rounded to acute at the base (rarely weakly cordulate).
- 40a. Petiole sheathed 1/4 to 1/3 of its length; sheath decurrent at apex; leaf blades lanceolate or oblong-elliptic, more than 15 cm long, 3.5 to 5.6 times longer than wide; spadix less than 4 cm long; Colombia (Chocó), 410–465 m..... *C. oblongifolia* Croat & L. P. Hannon
- 40b. Petiole sheathed more than 3/4 of its length; sheath free-ending at apex; leaf blades ovate to ovate-elliptic, less than 10 cm long, 1.7 to 1.9 times longer than wide; spadix more than 5 cm long; Colombia (Valle), 2000–2100 m *C. stellasarrae* Croat & L. P. Hannon
- 39b. Leaf blades cordate to cordulate at base.
- 41a. Leaf blades moderately smooth, not bullate or rugose; petiole sheathed 1/3 to 2/3 of its length; sheath decurrent at apex.
- 42a. Leaf blades thin, 12.5–23 \times to 14 cm; upper surface \pm velvety, drying olive-green or dark brown; primary lateral veins less than 7 pairs.
- 43a. Petiole matte, lacking markings; leaf blades with major veins drying raised on lower surface; tertiary and reticulate veins prominulous; primary lateral veins 4 to 6 pairs; spathe tube entirely matte, pale green to cream; Ecuador (Carchi, Esmeraldas), 550–814 m *C. besseae* Madison
- 43b. Petiole semiglossy, with weakly darker transverse markings; leaf blades with major veins drying \pm flattened on lower surface; tertiary and reticulate venation obscure; primary lateral veins 3(4) pairs; spathe tube matte, medium green toward base, semiglossy dark purple at apex; Colombia (Nariño), 1100–1130 m *Chlorospatha* sp. indet. 1
- 42b. Leaf blades subcoriaceous, 38 \times 21.5 cm; upper surface weakly glossy, drying blackened, gray-green; primary lateral veins 8 to 9 pairs; Colombia (Valle), 1250 m *C. queremalensis* Croat & L. P. Hannon
- 41b. Leaf blades bullate or rugose; petiole sheathed most or all of its length; sheath free-ending at apex.
- 44a. Leaf blades minutely rugose; spathe less than 9 cm long; spadix less than 7 cm long; fertile staminate spadix bright orange; Colombia (Nariño), 1700–2050 m ... *C. bogneri* Croat & L. P. Hannon
- 44b. Leaf blades bullate; spathe more than 14 cm long; spadix more than 12 cm long; fertile staminate spadix white; Colombia (Antióquia), 2750–2830 m *C. macphersonii* Croat & L. P. Hannon
- 38b. Leaf blades sagittate or subhastate at base.
- 45a. Leaf blades sagittate at base; posterior lobes directed toward base or weakly outward (at least on drying).
- 46a. Species occurring below 900 m.
- 47a. Leaf blades narrow, more than 2.5 times longer than wide; posterior lobes narrow, more than 2 times longer than wide.

- 48a. Leaf blades narrowly triangular, drying markedly bicolorous; primary lateral veins 4 pairs; Colombia (Valle), 210–230 m *Chlorospatha* sp. indet. 2
- 48b. Leaf blades oblong-elliptic, drying concolorous or weakly to moderately bicolorous; primary lateral veins more than 4 pairs.
- 49a. Petiole sheathed ca. 1/2 of its length; sheath decurrent at apex; free portion subterete, lacking medial keel; primary lateral veins 5 to 6 pairs; inflorescence emerging from sympodial cataphyll; Ecuador (Carchi, Esmeraldas), 300–800 m *C. longiloba* Croat & L. P. Hannon
- 49b. Petiole sheathed ca. 1/3 of its length; sheath free-ending at apex; free portion sharply D-shaped, with low medial keel; primary lateral veins 6 to 9 pairs; inflorescence emerging from apex of petiole sheath; Colombia (Cauca, Chocó), 90–275 m *C. grayunii* Croat & L. P. Hannon
- 47b. Leaf blades broad, less than 2 times longer than wide; posterior lobes broad, less than 1.7 times longer than wide; Colombia (Valle), 700–900 m *C. yatacuensis* Croat & L. P. Hannon
- 46b. Species occurring above 1000 m.
- 50a. Leaf blades \pm bullate or rugose.
- 51a. Leaf blades minutely bullate, with lower surface densely reticulate and areoles deeply sunken, drying green (rarely purplish); Colombia (Valle), 1020–2000 m *C. bullata* Croat & L. P. Hannon
- 51b. Leaf blades weakly bullate (at least on drying) or rugose, with lower surface not densely reticulate, lacking areoles, drying brown.
- 52a. Internodes less than 2 cm long; petiole sheath decurrent at apex; leaf blades weakly bullate and dark purplish brown-speckled on upper surface on drying; anterior lobe more than 2 times longer than posterior lobes; Colombia (Cauca), 1400–1800 m *C. congensis* Croat & L. P. Hannon
- 52b. Internodes 3–4 cm long; petiole sheath free-ending at apex; leaf blades rugose, lacking dark purplish brown speckles on upper surface on drying; anterior lobe less than 1.7 times longer than posterior lobes; Colombia (Cauca), 2580 m ... *C. munchiquensis* Croat & L. P. Hannon
- 50b. Leaf blades \pm smooth, not at all bullate or rugose.
- 53a. Leaf blades with posterior lobes broad, less than 2 times longer than wide.
- 54a. Leaf blades sagittate-subhastate, moderately broadest at base, 1.5 times broader at base than across anterior lobe (measured tip to tip across posterior lobes); spathe tube green; Colombia (Valle), 1400 m ... *Chlorospatha* sp. indet. 3
- 54b. Leaf blades sagittate to ovate-sagittate, weakly broadest at base, 1 to 1.2 times broader at base than across anterior lobe (measured tip to tip across posterior lobes); spathe tube purple.
- 55a. Leaf blades subcoriaceous; most venation drying \pm wrinkled on lower surface; spathe more than 12 cm long; spadix more than 10.5 cm long; Colombia (Valle), 1100–1200 m ... *C. bayae* Croat & L. P. Hannon
- 55b. Leaf blades thin or thinly coriaceous; all venation drying smooth on lower surface (not wrinkled); spathe less than 12 cm long; spadix less than 9.5 cm long.
- 56a. Petiole sheathed 1/2 of its length, sheath decurrent at apex; peduncle 20 cm long; pistillate portion of spadix adnate to spathe most of its length; stigma elevated on style; sterile flowers densely arranged, branched; Ecuador (Pichincha), 1800–2200 m *C. jaramilloi* Croat & L. P. Hannon
- 56b. Petiole sheathed more than 3/4 of its length; sheath free-ending at apex; peduncle 88 cm

- long; pistillate portion of spadix adnate to spathe ca. 1/2 of its length; stigma sessile; sterile flowers laxly arranged, subprismatic; Ecuador (Imbabura), 1600–1700 m
. *C. sagittata* Croat & L. P. Hannon
- 53b. Leaf blades with posterior lobes narrow, more than 2 times longer than wide.
- 57a. Leaf blades conspicuously narrower at base than across anterior lobe (measured tip to tip across posterior lobes); posterior lobes weakly confluent at base, obscuring petiole apex; posterior rib not naked; Colombia (Chocó), 1000–1900 m *Chlorospatha* sp. indet. 4
- 57b. Leaf blades broadest at base; posterior lobes not confluent at base; posterior rib naked 6–15 mm per side.
- 58a. Leaf blades with anterior and posterior lobes markedly constricted at base on one side; Ecuador (Carchi), 1740–1800 m
. *C. carchiensis* Croat & L. P. Hannon
- 58b. Leaf blades with anterior and posterior lobes weakly or not at all constricted at base.
- 59a. Petiole sheathed less than 1/2 of its length; sheath decurrent at apex; leaf blades drying discolorous, pinkish tan along major veins on lower surface; peduncle less than 14 cm long; spathe less than 8 cm long; Colombia (Valle), 1800–2200 m . . . *C. caliensis* Croat & L. P. Hannon
- 59b. Petiole sheathed 2/3 of its length; sheath free-ending at apex; leaf blades drying brownish green, not at all discolorous; peduncle more than 22 cm long; spathe more than 12 cm long; Colombia (Nariño), 1800–1850 m
. *C. ricautensis* Croat & L. P. Hannon
- 45b. Leaf blades subhastate; posterior lobes directed \pm outward (at least on drying).
- 60a. Leaf blade with anterior lobe broadly triangular; posterior lobes broad, less than 1.8 times longer than wide; peduncle more than 48 cm long; spathe tube purple; Colombia (Nariño), 1780–1800 m
. *C. planadensis* Croat & L. P. Hannon
- 60b. Leaf blade with anterior lobe narrowly triangular; posterior lobes narrow, more than 2.5 times longer than wide; peduncle less than 40 cm long; spathe tube cream, yellow, green, or red.
- 61a. Petiole sheathed ca. 1/3 of its length; peduncle less than 16 cm long; spathe less than 10 cm long; spadix less than 8.5 cm long.
- 62a. Internodes short, 1–1.5 cm long; spathe tube green; spathe blade white; sterile staminate portion of spadix less than 2 mm long, laxly flowered; Colombia (Valle, Microndas Tokio), 2000–2100 m *C. tokioensis* Croat & L. P. Hannon
- 62b. Internodes long, 2–4 cm long; spathe entirely cream or yellow; sterile staminate portion of spadix 3–8 mm long, densely flowered; Colombia (Antióquia, possibly also Chocó), 1500–1800 m *C. nicolsonii* Croat & L. P. Hannon
- 61b. Petiole sheathed ca. 1/2 or more of its length; peduncle more than 19 cm long; spathe more than 10 cm long; spadix more than 8.5 cm long.
- 63a. Petiole sheathed ca. 1/2 of its length; sheath free-ending; leaf blades coriaceous, drying densely dark purplish brown-speckled on upper surface, matte on lower surface; spathe tube green; spathe blade white; sterile staminate spadix less than 1 cm long; Colombia (Cauca), 1500–1800 m
. *C. lehmannii* (Engl.) Madison
- 63b. Petiole sheathed 2/3 or 3/4 of its length; sheath decurrent; leaf blades thin or thinly coriaceous, drying without dark purplish brown speckles on upper surface, weakly glossy to semiglossy on surface; spathe entirely \pm yellow or red; sterile staminate spadix more than 1.2 cm long.

- 64a. Petiole sheathed 2/3 of its length or slightly less; posterior lobes markedly narrow, 3.5 to 5 times longer than wide; spathe creamy yellow; fertile staminate spadix creamy yellow; sterile staminate spadix 1.3–1.8 cm long; Colombia (Valle), 1700–2000 m
C. giraldoi Croat & L. P. Hannon
- 64b. Petiole sheathed ca. 3/4 of its length; posterior lobes moderately narrow, 2.6 to 3.2 times longer than wide; spathe red; fertile staminate spadix pink; sterile staminate spadix 1.8–2.5 cm long; Colombia (Valle), 1700 m
C. noramurphyae Croat & L. P. Hannon
- 16b. Species of eastern slopes of Andes and Amazon drainage in Colombia and Ecuador.
- 65a. Leaf blades purple on the lower surface; Ecuador (Morona-Santiago, Cordillera de Cutucú), ca. 700 m
C. feuersteiniae (Croat & Bogner) Bogner & L. P. Hannon
- 65b. Leaf blades green on the lower surface.
- 66a. Style expanded into a mantle, broader than ovary apex.
- 67a. Leaf blades more than 25 cm long, 2.7 times longer than wide; prominently constricted in area of petiole attachment; posterior lobes 3.5 to 3.7 times longer than wide
C. hastifolia Bogner & L. P. Hannon
- 67b. Leaf blades less than 23 cm long, less than 2 times longer than wide, weakly constricted or not at all constricted in area of petiole attachment; posterior lobes less than 3 cm longer than wide; Colombia (Amazonas), less than 300 m.
- 68a. Style briefly attenuate, comprising 1/3 of the length of pistil, appressed to ovary; petiole sheathed 1/3 of its length; leaf blades drying green; anterior lobe broad, 1.2 times longer than wide; posterior lobes broad, 1.6 times longer than wide; upper surface matte; lower surface reticulate, narrowly colliculate along most veins, the veins drying paler than surface; Ecuador (Sucumbios), 2200–2350 m
C. sucumbensis Croat & L. P. Hannon
- 68b. Style long-attenuate, comprising 1/2 of the length of pistil, broadly spreading, not appressed to ovary; petiole sheathed 1/2 of its length; leaf blades drying yellow-brown; anterior lobe narrow, 1.7 to 1.9 times longer than wide; posterior lobes narrow, 2.3 to 2.9 times longer than wide; upper surface semiglossy; lower surface not reticulate and not colliculate along the veins, the veins drying darker than the surface; Colombia (Huila, Putumayo), 2000–2400 m
C. huilensis Croat & L. P. Hannon
- 66b. Style lacking a mantle, as broad as or narrower than ovary apex.
- 69a. Leaf blades with all venation glabrous on lower surface.
- 70a. Syandria truncate at apex, \pm symmetrical, \pm prismatic, the lobes not thickened.
- 71a. Leaf blades acute to rounded at base, lacking posterior lobes; sympodial leaf a cataphyll; Ecuador (Zamora-Chinchi), 900–1455 m
C. portillae Croat & L. P. Hannon
- 71b. Leaf blades with posterior lobes; sympodial leaf a full expanded foliage leaf.
- 72a. Leaf blades, ovate-elliptic, subsagittate at base; lower surface reticulate; spathe reflexing after anthesis; fertile staminate portion of spadix dark purple; style not attenuate; Ecuador (Morona-Santiago), 1200 m
C. limonensis Croat & L. P. Hannon
- 72b. Leaf blades sagittate or sagittate-subhastate at base; lower surface not reticulate; spathe erect after anthesis; fertile staminate portion of spadix white or pale greenish yellow; style attenuate.
- 73a. Leaf blades narrow, ca. 3.3 times longer than wide, with anterior lobe long, ca. 3 times longer than posterior lobes; spadix 4.1 cm long, adnate to spathe ca. 2/3 of length of pistillate portion at base; pistils green; ovaries 2- to 3-locular, with 12 to 14 ovules per locule; syandria 2- to 3-androus, pale greenish yellow; Ecuador (Zamora-Chinchi), 1200–2000 m (est.)
C. sizemoreae Croat & L. P. Hannon
- 73b. Leaf blades broad, 1.1 to 1.3 times longer than wide with anterior lobe short, ca. 1.5 to 2 times longer than posterior lobes; spadix 6–6.4 cm long, adnate to spathe ca. 1/4 of length of pistillate portion at base; pistils cream to pale yellow; ovaries 3- to 4-locular, with 4 to 10 ovules per locule; syandria 3- to 4-androus, white; Ecuador (Morona-Santiago), 1700–1900 m
C. cutucuenensis Madison
- 70b. Syandria broadly concave medially, \pm highly bilaterally symmetrical, \pm elongated in direction of axis, with the lobes \pm prominently thickened.

- 74a. Leaf blades hastate or subhastate, the posterior lobes directed outward, \pm acute at apex; spathe reflexing after anthesis; Ecuador (Napo, Sucumbíos), 250–1200(–1486) m *C. plowmanii* (Madison) Croat & L. P. Hannon
- 74b. Leaf blades \pm ovate or ovate-elliptic, sagittate or subsagittate at base, the posterior lobes directed toward base, broadly to narrowly rounded at apex; spathe erect after anthesis.
- 75a. Leaves numerous, 8 to 14, erect to reflexed spreading; blades \pm broadly ovate; sides of petiole sheath broadly spreading, appearing winged; cataphylls produced only when in flower, not appressed to petioles, ultimately deciduous.
- 76a. Upper surface of leaf blade sub-bullate, weakly glossy, dark blackish green; posterior lobes decurrent onto petiole; posterior rib not naked; spathe less than 6.5 cm long, the blade dark maroon; style white and densely dark purple-speckled; Ecuador (Morona-Santiago), 940 m *C. hannoniae* Croat
- 76b. Upper surface of leaf blade broadly quilted velvety, medium to dark green; posterior lobes decurrent onto posterior rib, the posterior rib naked 3–9 mm per side; spathe more than 7.5 cm long, the blade green; style pale green to yellow-green; Ecuador (Morona-Santiago), 500–944 m *C. boosii* Croat & L. P. Hannon
- 75a. Leaves several, 3 to 5, erect to erect-spreading; blades ovate-elliptic; sides of petiole sheath erect or in-rolled; cataphylls produced with each vegetative and sympodial length of stem; Ecuador (widespread), (265–)470–1700 m
..... *C. longipoda* (K. Krause) Madison
- 69b. Leaf blades with all or most venation \pm crispy-puberulent to granular-puberulent on lower surface.
- 77a. Stem red; inflorescence emerging from apex of petiole sheath; sympodial leaf a fully expanded foliage leaf; sympodium held within petiole sheath; Ecuador (Morona-Santiago), 1600–1800 m *C. yaupiensis* Croat & L. P. Hannon
- 77b. Stem green; inflorescence emerging from base of petiole sheath; sympodial leaf a cataphyll; sympodium held within sympodial cataphyll.
- 78a. Synandria truncate at apex, the lobes not thickened, \pm symmetrical; leaves erect to erect-spreading; leaf blades triangular-sagittate, bullate on upper surface; spathe, peduncle and cataphyll glabrous; Ecuador (Morona-Santiago), 1659 m *C. engleri* Croat & L. P. Hannon
- 78b. Synandria broadly concave medially, the lobes prominently thickened, highly bilaterally symmetrical, \pm elongated in direction of axis; leaves erect to reflexed-spreading; leaf blades hastate to subhastate, broadly quilted on upper surface, the intervening surface smooth; spathe, peduncle, and cataphyll usually \pm crispy-puberulent; Ecuador (widespread), 400–1551 m
..... *C. pubescens* Croat & L. P. Hannon

KEY TO SPECIES FROM THE FRONTIER REGION ALONG THE BORDER OF COLOMBIA (NARIÑO) AND ECUADOR (CARCHI, ESMERALDAS, SUCUMBÍOS), NOT KNOWN ELSEWHERE IN EITHER COLOMBIA OR ECUADOR

- 1a. Leaf blades cordate to cordulate or subtruncate at base, the width at base less than width of anterior lobe, the base 0.5 to 0.9 times as wide as anterior lobe (measured tip to tip across posterior lobes).
- 2a. Leaf blades \pm smooth, not rugose; petiole sheathed 1/3 to 2/3 of its length; sheath decurrent at apex.
- 3a. Petiole matte, lacking markings; leaf blades with major veins drying raised on lower surface; tertiary and reticulate venation prominulous; primary lateral veins 4 to 6 pairs; spathe tube matte, pale green to cream; Ecuador (Carchi, Esmeraldas), 550–814 m *C. besseae* Madison
- 3b. Petiole semiglossy, with weakly darker transverse markings; leaf blades with major veins drying \pm flattened on lower surface; tertiary and reticulate venation \pm obscure; primary lateral veins 3(4) pairs; spathe tube matte, medium green toward base, semiglossy, dark purple at apex; Colombia (Nariño), 1100–1130 m *Chlorospatha* sp. indet. 1
- 2b. Leaf blades minutely rugose; petiole sheathed most or all of its length; sheath free-ending at apex; Colombia (Nariño), 1700–2050 m *C. bogneri* Croat & L. P. Hannon
- 1b. Leaf blades sagittate to hastate at base, the width at the base greater than width of anterior lobe, the base 1.1 to 3.3 times wider than anterior lobe (measured tip to tip across posterior lobes when flattened).
- 4a. Leaf blades with anterior and posterior lobes scarcely or not at all constricted at the base.
- 5a. Leaf blades hastate to subhastate, the posterior lobes directed outward.
- 6a. Species occurring only on eastern slopes of Andes, above 2100 m; Ecuador (Sucumbíos), 2200–2350 m *C. sucumbensis* Croat & L. P. Hannon
- 6b. Species occurring only on western slopes of Andes, below 1900 m.

- 7a. Internodes short, 1–1.5 cm long; leaf blade surfaces matte to weakly glossy; lower surface reticulate; peduncle less than 35 cm long; spathe tube pale green to greenish cream; fertile staminate spadix bright orange; stigma weakly elevated on style; Ecuador (Esmeraldas), 700 m *C. mansellii* Croat & L. P. Hannon
- 7b. Internodes long, 3.5–8 cm; leaf blade surfaces semiglossy; lower surface smooth; peduncle more than 45 cm long; spathe tube dark purple-violet; fertile staminate spadix white or cream; stigma prominently elevated on style; Colombia (Nariño), 1700–1800 m *C. planadensis* Croat & L. P. Hannon
- 5b. Leaf blades sagittate, the posterior lobes directed toward the base.
- 8a. Petiole purple-tinged, sheathed 2/3 of its length; sheath free-ending at apex; primary lateral veins 3 pairs; spathe more than 12 cm long; spadix more than 11 cm long; stigma weakly elevated on style; sterile staminate spadix more than 1.4 cm long, the flowers mostly branched; synandria 5- to 6-androus, drying dark purplish, almost black; Colombia (Nariño), 1800–1850 m *C. ricaurtensis* Croat & L. P. Hannon
- 8b. Petiole green, sheathed ca. 1/2 of its length; sheath decurrent at apex; primary lateral veins 5 to 6 pairs; spathe less than 9 cm long; spadix less than 6 cm long; stigma prominently elevated on style; sterile staminate spadix less than 1 cm long, the flowers subprismatic; synandria 3- to 4-androus, drying cream-colored; Ecuador (Carchi, Esmeraldas), 300–800 m *C. longiloba* Croat & L. P. Hannon
- 4b. Leaf blades with anterior and posterior lobes markedly constricted at base, at least on one side.
- 9a. Leaf blades sagittate, the posterior lobes directed toward the base; Ecuador (Carchi), 1740–1800 m *C. carchiensis* Croat & L. P. Hannon
- 9b. Leaf blades markedly hastate, the posterior lobes directed outward.
- 10a. Leaf blades \pm dark purple-mottled on lower surface; Ecuador (Carchi, Esmeraldas), 375–1800 m *C. hastata* Croat & L. P. Hannon
- 10b. Leaf blades not at all purplish on lower surface.
- 11a. Leaf blades with upper surface corrugate; petiole sheathed 3/4 or more of its length; peduncle more than 35 cm long, more than 3/4 as long as to longer than petiole; spadix more than 8 cm long; fertile staminate portion orange; sterile staminate portion long, 1.5–2.5 cm long; stigma weakly elevated on style; Colombia (Nariño); Ecuador (Esmeraldas), 425–1325 m *C. litensis* Croat & L. P. Hannon
- 11b. Leaf blades with upper surface \pm smooth, not corrugate; petiole sheathed less than 1/2 of its length; peduncle less than 18 cm long, ca. 1/2 as long as petiole; spadix less than 6.5 cm long; fertile staminate portion cream or brownish; sterile staminate portion short, 0.5–1.1 cm long; stigma markedly elevated on style.
- 12a. Leaf blades drying green; major venation drying weakly paler than lower surface; petiole sheath green; fertile staminate spadix cream-colored; sterile flowers irregularly subprismatic, densely arranged; Colombia (Nariño), possibly Ecuador (Carchi), 800–1325 m *C. narinoensis* Croat & L. P. Hannon
- 12b. Leaf blades drying brown; major venation drying conspicuously darker than lower surface; petiole sheath maroon; fertile staminate spadix brownish; sterile flowers fungiform to branched, laxly arranged; Colombia (Nariño), 1150–2900 m *C. nambiensis* Croat & L. P. Hannon

1. *Chlorospatha amalfiensis* Croat & L. P. Hannon, *Aroideana* 27: 3. 2004. TYPE: Colombia. Antioquia: along Amalfi–Fraguas rd., NE of Salazar, 23–26.5 km from center of Amalfi, 1220–1300 m, 6°58'N, 74°59'W, 14 Feb. 1989, *J. MacDougal, J. Betancur, W. J. Kress & B. Echeverry 4034* (holotype, HUA!). Figure 4C.

Terrestrial herb, ca. 50 cm tall; stem (possibly decumbent) length not known, remnants of old cataphylls persisting \pm intact at upper nodes (all measurements made from dried material); internodes 1–1.5 \times 1.2–1.5 cm, drying matte, medium grayish brown, prominently wrinkled; cataphylls ca. 20 cm long, acuminate at apex, drying semiglossy, dark reddish brown. LEAVES 5, erect-spreading; **petioles** 36–37 cm long, drying glabrous, matte to weakly glossy, dark reddish brown, sheathed 20–24 cm (8–

12 cm on foliage leaves), ca. 1/2 of total length; sheath decurrent at apex; free portion 2–2.5 mm diam. midway; **blades** sagittate, 19–21 \times 11–11.5 cm (9.8–10 cm wide at base, measured tip to tip across posterior lobes), 1.7 to 1.8 times longer than wide, long-acuminate at apex, broadest across anterior lobe, drying thin, weakly bicolorous; upper surface drying matte to weakly glossy, dark yellow-brown, weakly grayish; lower surface drying weakly glossy to semiglossy; anterior lobe 14.5 \times 11–11.5 cm, 1.3 times longer than wide, 1.8 to 2 times longer than posterior lobes, broadest near base, \pm symmetrical; posterior lobes directed toward base, 7–8 \times 5.2–5.8 cm, 1.3 to 1.4 times longer than wide, narrowly rounded to bluntly acute at apex, broadest at base, prominently inequilateral, the inner side narrower, \pm acute and narrowly confluent with opposite lobe at

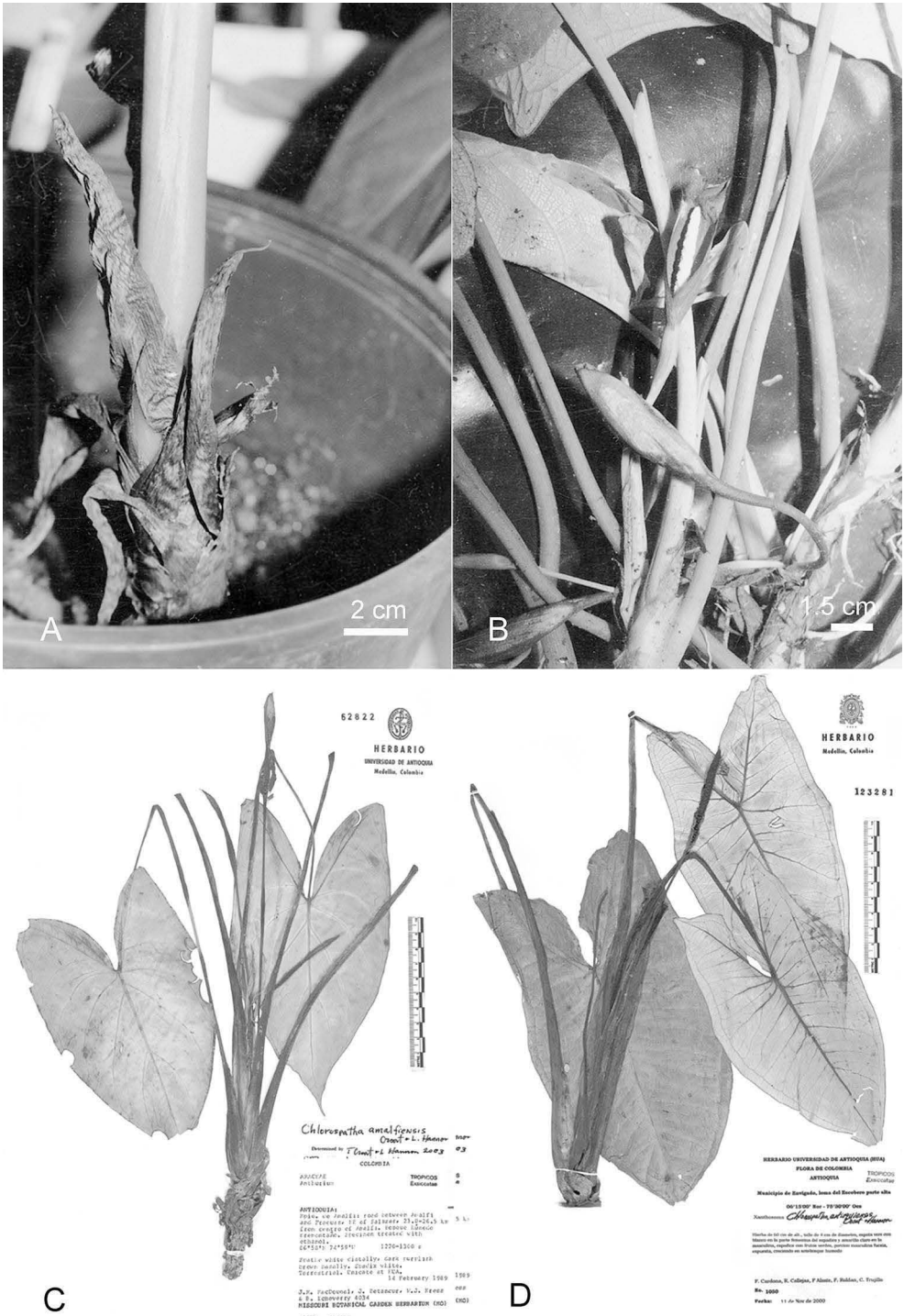


Figure 4. —A. *Chlorospatha hammeliana* Grayum & Croat, stem with dried cataphylls, Croat 44589 (MO). —B. *Chlorospatha longipoda* (K. Krause) Madison, stem with both inflorescence at anthesis and mature infructescence, Croat et al. 86561 (MO). —C. *Chlorospatha amalfiensis* Croat & L. P. Hannon, MacDougal et al. 40341 (HUA holotype). —D. *Chlorospatha antioquiensis* Croat & L. P. Hannon, Cardona et al. 1050 (HUA).

base, the confluent portion obscuring petiole apex; outer side 3.4 to 4.5 times wider than inner side midway; midrib and major veins drying weakly raised to flattened on lower surface, moderately darker than surface; **basal veins** 6, first free to the base, 5 coalesced into a prominent posterior rib, 3 acroscopic, 2 basicopic; primary lateral veins 2 pairs, arising at 25° – 32° , weakly arcuate; secondary veins drying weakly raised on lower surface, weakly darker than surface; tertiary veins drying flattened on lower surface, weakly darker than surface; reticulate veins drying obscure on lower surface, in part weakly darker than surface; collective veins 3, the innermost arising from lowermost lateral vein on inner side of posterior lobe, \pm parallel to and ca. 6 mm from margin. INFLORESCENCES erect, 5 per axil; peduncle held within the sheath, 18–23 cm \times 1–1.5 mm, drying matte to weakly glossy, dark brown; **spathe** erect, 7–7.5 cm long, cuspidate at apex; spathe tube purplish brown on outer surface, 3.8 cm \times 4.5–5 mm, drying matte, dark brown on outer surface; spathe blade white, 3.7 cm \times 4–4.5 mm, drying matte, medium reddish brown on outer surface, paler on inner surface, marcescent, erect after anthesis; **spadix** erect, 5.7 cm long, sessile, adnate to spathe 8 mm at base, ca. 1/3 of the length of pistillate portion; pistillate portion 2.2 cm \times 3 mm, drying brownish; fertile staminate portion 1.8–1.9 cm \times 3 mm, clavate, narrowly rounded at apex, drying medium dark brown; sterile staminate portion 1.3 cm \times 1.5 mm, \pm cylindrical, drying tan; pistils laxly arranged, ca. 3 across the axis (viewed from above), ca. 1.5–2 mm long; ovaries subglobose, ca. 1 \times 1–1.5 mm, drying dark brown; style Type 8 (Fig. 1), 0.7–1 \times ca. 1.5 mm, comprising 1/2 of the length of pistil, the margins weakly coherent with those of adjacent styles; **stigma** elevated on and weakly broader than narrowed portion of style, ca. 0.3 mm diam., drying dark brown; synandria ca. 1 \times 1–1.2 mm, coherent, truncate, 3-lobed, 3-androus; sterile flowers ca. 1 \times 1 mm, subprismatic to irregularly lobed, laxly arranged, in 9 whorls. Berries not known.

Phenology. Flowering is only known to occur in *Chlorospatha amalfiensis* during the month of February.

Discussion. *Chlorospatha amalfiensis* is known only from the type and is endemic to the eastern slopes of the Cordillera Central in Antioquia Department, Colombia, at 1200–1300 m elevation. The species was collected in tropical wet forest and would be expected to occur elsewhere in that department. The species is a member of *Chlorospatha* sect. *Occidentales* and distinguished by its ovate-

sagittate leaf blades that are narrower at the base than across the anterior lobe and dry grayish yellow-brown on the upper surface, with the inner margins of the posterior lobes narrowly confluent at the base, obscuring the petiole apex. It is also distinguished by its purplish brown spathe tube, white spathe blade, and short spadix (5.7 cm long), with the sterile portion comprising about one fourth of its length and the sterile flowers laxly arranged. The fertile staminate portion is clavate, with the synandria unusual in being strictly 3-androus.

Chlorospatha amalfiensis could be confused with only one species, *C. antioquiensis*, which also occurs on the eastern slopes of the Cordillera Central but at higher elevations, 1800–3000 m. The petiole of the latter species dries with the epidermis partially separated intact and semiglossy, with the sheath free-ending at the apex, differing from that of *C. amalfiensis*, which dries matte, with the sheath decurrent and the epidermis not separated. The leaf blade of the latter species has two pairs of primary lateral veins and dries more or less yellow-brown, whereas that of *C. antioquiensis* has four to seven pairs of primary lateral veins and dries greenish. The spathe tube of *C. antioquiensis* is green and the blade green or yellow, thus differing from *C. amalfiensis*, which has a purplish brown tube and white blade. The spadix of the latter species is adnate to the spathe only one third of the length of the pistillate portion and has somewhat laxly arranged pistils and a Type 8 style (Fig. 1) that comprises one half of the length of the pistil, whereas the spadix of *C. antioquiensis* is adnate to the entire length of the pistillate portion and has comparatively densely arranged pistils and a Type 6 style (Fig. 1) that comprises one third of the length of the pistil. The fertile staminate portion is cylindrical to tapering in the latter species, with the synandria 3- to 4(5)-androus, whereas that of *C. amalfiensis* is clavate, with the synandria no more than 3-androus. The sterile staminate portion comprises one fourth of the length of the spadix in the latter species, with the sterile flowers laxly arranged, whereas that of *C. antioquiensis* comprises one tenth of total length, with the sterile flowers densely arranged.

2. *Chlorospatha antioquiensis* Croat & L. P. Hannon, *Aroideana* 27: 6. 2004. TYPE: Colombia. Antioquia: along Medellín–Sonsón rd., 5–6 km SE of La Unión, 2400 m, 26 Mar. 1979, *J. Luteyn* & *M. Luteyn* 7110 (holotype, NY!; isotype, COL!). Figure 4D.

Terrestrial or hemiepiphytic herb, 50–60 cm tall; stem decumbent, at least 20 cm long, remnants of old

leaf bases and cataphylls persisting intact along its length (all measurements made from dried material); internodes 1.5–3 × 0.6–1.3(–4) cm, drying weakly glossy, dark brownish green; cataphylls 11–24 cm long, obtuse with acuminate at apex, drying weakly glossy to semiglossy, medium to dark reddish brown. LEAVES 2 to 4, erect-spreading; **petioles** 29–52 cm long, drying glabrous, weakly glossy to semiglossy, medium-dark to dark reddish brown or almost black, with epidermis in part separated ± intact and semi-transparent, sheathed 17–31 cm, slightly more than 1/2 of total length; sheath free-ending at apex; free portion 2–5 mm diam. midway; **blades** sagittate and broadly triangular or ovate-sagittate, (16.5–)20–26 × 8.5–14.5 cm, 1.9 to 2.2 times longer than wide, gradually to scarcely acuminate at apex, occasionally abruptly acuminate, usually broadest at base, rarely weakly narrower, (0.8 to) 1.1 times wider at base than across anterior lobe (measured tip to tip across posterior lobes), weakly or not at all constricted in area of petiole attachment (at least on one side), drying thin, weakly to moderately bicolorous, occasionally concolorous; upper surface drying matte, medium to dark yellow-green to olive-green; lower surface drying semiglossy to glossy; anterior lobe (11–)14–17 × (7.5–)9–14.5 cm, 1.1 to 1.5 times longer than wide, 1.4 to 1.9 times longer than posterior lobes, broadest near base, ± symmetrical; posterior lobes directed toward base or weakly outward, (6.1–)7.3–11 × (3.2–)4–6.8 cm, 1.5 to 1.9 times longer than wide, bluntly acute to narrowly rounded at apex, rarely bluntly rounded, weakly broader midway than at base, weakly inequilateral, the inner side narrower, rounded at base, briefly attenuate and usually weakly confluent with opposite lobe, the confluent portion obscuring petiole apex; outer side ± straight toward base; midrib and major venation drying ± flattened on lower surface, usually moderately darker to much darker than surface, rarely weakly darker; midrib round-raised on lower surface; **basal veins** 3 to 5 pairs, coalesced into a prominent posterior rib; primary lateral veins 4 to 7 pairs, arising at 50°–65°(–90°), weakly arcuate or straight, convex on lower surface; secondary veins drying in part weakly raised or prominulous on lower surface, otherwise ± flattened, in part concolorous, otherwise weakly darker than surface; tertiary veins drying visible, ± flat on lower surface, in part weakly darker than surface, otherwise concolorous; reticulate veins drying in part visible on lower surface; collective veins 3, the innermost arising from apex of posterior rib or from one of the lateral veins on inner side of posterior lobe, ± parallel to margin, occasionally moderately scalloped, 4–6(–12) mm

from margin. INFLORESCENCES erect, 2 per axil; peduncle held within the sheath, (21–)26–29 cm × ca. 2 mm, drying matte to weakly glossy, medium-dark brown; **spathe** erect, 7.2–9 cm long, abruptly acuminate at apex; spathe tube medium or pale green on outer surface, 2.8–4 cm × 3–5 mm, drying matte, dark reddish brown on outer surface, weakly glossy and paler on inner surface; spathe blade green or yellow, 4.5–6 cm × 5–7 mm (ca. 2 cm wide when flattened), drying matte, pale to medium reddish tan on both surfaces, marcescent, erect after anthesis; **spadix** erect, (6–)6.5–8.4 cm long, sessile, adnate to spathe 2.6–3 cm at base, the entire length of pistillate portion; pistillate portion green or white, 2.6–3 cm × 2.5–3.5 mm, drying reddish brown; fertile staminate portion red, yellow, or green, 3–5.1 cm × 3–6 mm, cylindrical or tapering, frequently curving forward, acute to narrowly rounded at apex, drying dark reddish brown; sterile portion 7–10 × 2–4 mm, broadest at apex, rarely broadest at base, with axis naked 1–1.5 mm at base, drying medium reddish brown; pistils weakly coherent, 3 to 4 across the axis (viewed from above), ca. 2 mm long; ovary subglobose, 1–1.5 × 1.5–2 mm, drying creamy tan with darker veins; style Type 6 (Fig. 1), ca. 0.6 × ca. 2 mm, comprising ca. 1/3 of the length of pistil (attenuate portion less than 0.5 mm long), the margins weakly coherent with those of adjacent styles; **stigma** weakly elevated on and drying weakly broader than narrowed portion of style; synandria 1–1.5 × 1–1.5 mm, coherent, truncate, 3- to 4(5)-lobed, mostly 3- to 4-androus; sterile flowers 1–1.5 mm long, 1.5–2 × 1–1.5 mm diam. and ± elongated in direction of axis, coherent, truncate, irregularly subprismatic, in ca. 5 whorls. Berries green.

Phenology. Flowering is only known to occur in *Chlorospatha antioquiensis* in March, April, October, and November.

Discussion. *Chlorospatha antioquiensis* is endemic to the eastern and western slopes of the Cordillera Central in Antioquia Department, Colombia, to the north and south of Medellín, at 1800–3000 m elevation, 3000 m being the highest elevation recorded for the genus. It occurs on the borders of four life zones, premontane rainforest, lower montane rainforest, premontane moist forest, and premontane wet forest, also in premontane wet forest or possibly either lower montane wet forest or premontane moist forest. The species is a member of *Chlorospatha* sect. *Occidentales* and is distinguished by its sagittate leaf blades that dry matte on the upper surface, more or less glossy on the lower surface, with the inner margins of the posterior lobes weakly confluent at the

base, obscuring the petiole apex, and by its red, yellow, or green synandria, a range of coloration unique in the genus. Consequently, the possibility that more than one species is involved was considered. All collections examined proved to be virtually identical in all other respects, both floral and vegetative, and, therefore, were determined to be representative of the same species.

Chlorospatha antioquiensis could be easily confused with only one species, *C. amalfiensis*, which also occurs on the eastern slopes of the Cordillera Central, but at lower elevations, 1220–1300 m (see discussion under *C. amalfiensis*).

Chlorospatha antioquiensis could possibly be confused with *C. huilensis* from the Magdalena River drainage in Huila and Putumayo departments, Colombia. In the latter species, the leaf blade dries yellow-brown and has three to five pairs of primary lateral veins and most venation granular-puberulent and raised on the lower blade surface, whereas the blade of *C. antioquiensis* dries yellow-green and has four to seven pairs of primary lateral veins and all venation glabrous and more or less flattened. The petiole of *C. antioquiensis* dries with the epidermis partially separated more or less intact from the main body and semiglossy to glossy, whereas that of *C. huilensis* dries weakly glossy, with the epidermis not separated. The peduncle is more than 20 cm long and the style is Type 6 (Fig. 1) in the latter species, whereas in *C. huilensis*, the peduncle is less than 15 cm long and the style is Type 5 (Fig. 1), in plants of comparable size.

Chlorospatha antioquiensis could be confused with *C. jaramilloi*, particularly in the sterile state, but the latter species is known only from Pichincha Province, Ecuador, on the western slopes of the Andes. The most significant differences between the species are found in the inflorescences. The spathe tube is purple and the blade cream-colored in *C. jaramilloi*, whereas in *C. antioquiensis*, the tube is green and the blade, yellow or green. The style is Type 6 (Fig. 1) in *C. antioquiensis* and Type 5 (Fig. 1) in *C. jaramilloi*. The fertile staminate spadix of *C. antioquiensis* is red, yellow, or green and either tapering or cylindrical, whereas that of *C. jaramilloi* is cream-colored and ellipsoid. The sterile flowers of *C. antioquiensis* are subprismatic, differing from the conspicuously 2- to 6-branched flowers found in *C. jaramilloi*.

Additional specimens examined. COLOMBIA. **Anti-
óquia:** Mpio. Sonsón, via Sonsón–La Soledad, rd. to Río Verde de los Montes, end of La Palmita–Río Verde de los Montes trail, Paramo de los Palomas, 3000 m, *R. Callejas et al. 6408* (HUA); Mpio. Yarumal, El Cedro trail, along rte. from Alto de Ventanas to El Cedro, 127 km NE of Medellín, 1600–1800 m, *R. Callejas et al. 10815* (HUA); Mpio.

Envigado, high part of Escobero hill, *F. Cardona et al. 1050* (HUA).

3. *Chlorospatha atropurpurea* (Madison) Madison, Selbyana 5(3–4): 354. 1981. Basionym: *Caldiospatha atropurpurea* Madison, Contr. Gray Herb. 208: 97. 1978. TYPE: Ecuador. Los Ríos: Río Palenque Science Center, Km. 56 on Quevedo–Santo Domingo rd., 150–220 m, 3 Aug. 1975, *C. Dodson 5911* (holotype, SEL!; isotypes, K!, MO!, RPSC not seen, US!). Figure 5A–C.

Terrestrial herb, to 1 m tall; stem erect or decumbent, occasionally with remnants of cataphylls persisting \pm intact at upper nodes; bulbils occurring randomly along its length, usually solitary, 0.5–2 cm long, \pm conical, pointed at apex; sap milky; internodes 0.5–1.5 \times 2–4 cm, weakly glossy, medium green, drying dark brown to greenish brown; cataphylls usually quickly deciduous, (10–)15–30 cm long, acuminate or obtuse with acumem or apiculum at apex (acumem or apiculum 1–1.5 cm long), occasionally inequilateral, acutely or obtusely 1-ribbed abaxially, weakly glossy, dark purple throughout or medium green and entirely or in part irregularly purple-mottled in narrow transverse bands, drying weakly glossy, dark reddish brown. LEAVES 3 to 5, erect-spreading; **petioles** 27–80 cm long, spongy, glabrous, matte, entirely dark purple, or medium green and irregularly dark purple-mottled in narrow transverse bands toward base, drying matte, dark brown or purplish brown to almost black, sheathed 13.5–52 cm, 1/2 to 3/4 of total length; sheath decurrent at apex; free portion 0.5–1 cm diam. midway, terete, subterete, or obtusely D-shaped, weakly and obtusely sulcate at apex; **blades** sagittate or sagittate-subhastate, 25–52 \times 15–33 cm, 1.3 to 2.2 times longer than wide, acute or gradually acuminate to long-acuminate at apex, usually broadest at base, 1 to 1.6 times wider at base than across anterior lobe (measured tip to tip across posterior lobes), weakly or not at all constricted in area of petiole attachment, thin to thinly coriaceous, weakly to moderately bicolorous; upper surface broadly quilted, velvety, dark green, occasionally weakly purple-tinged medially, drying matte to weakly glossy, dark green to brownish green; lower surface weakly glossy to semiglossy, entirely dark purple, or medium green and narrowly to broadly discolorous and dark purple along midrib and major veins, rarely entirely medium green with midrib and major veins dark purple, drying weakly glossy to semiglossy, green to purplish green or discolorous and dark purple-mottled along major veins, rarely purplish brown; anterior lobe 18.8–32.5 \times 15–21 cm,

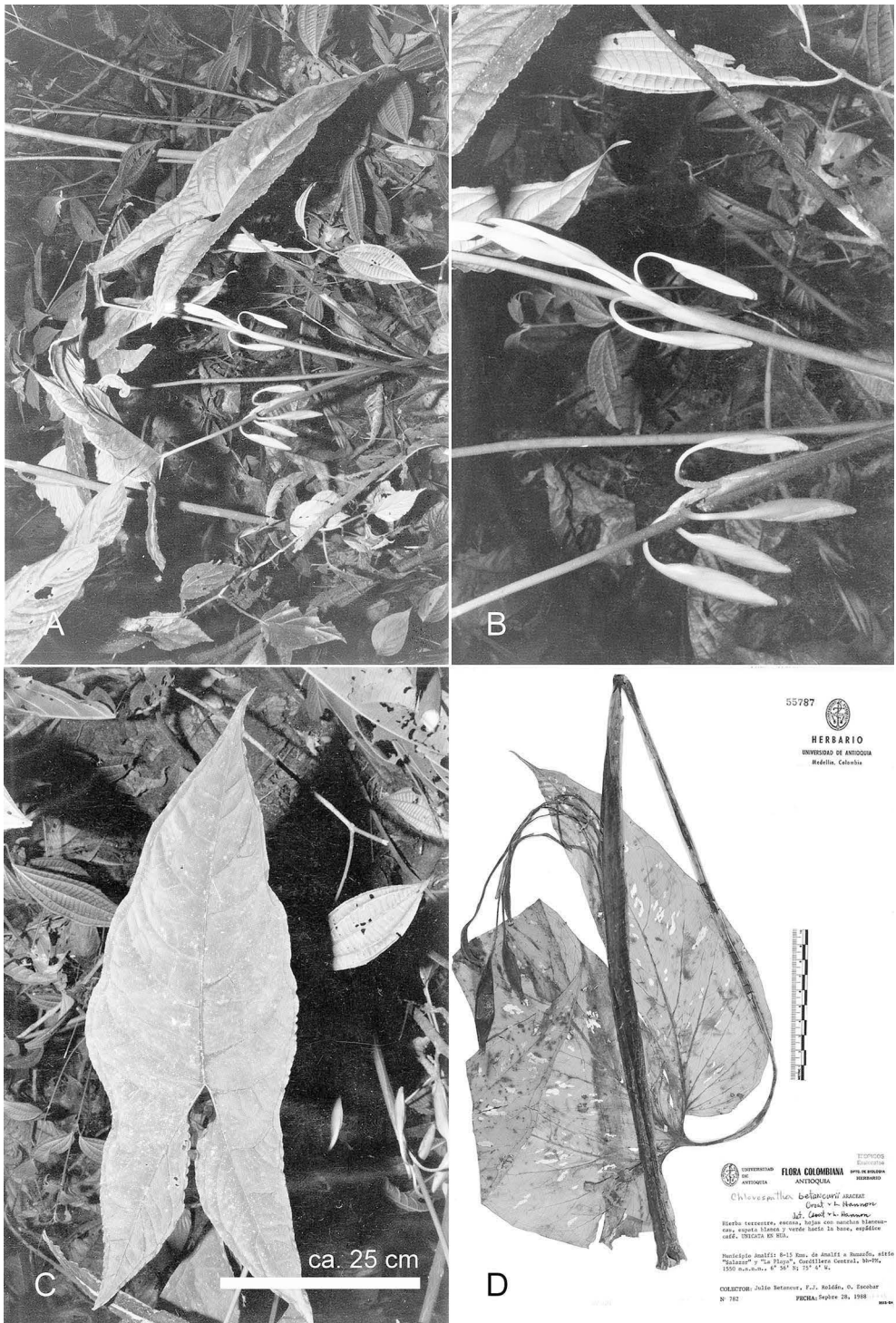


Figure 5. A–C. *Chlorospatha atropurpurea* (Madison) Madison, Croat & Rodríguez 61450. —A. Fertile habit. —B. Close-up of inflorescences. —C. Leaf blade, adaxial surface. —D. *Chlorospatha betancurii* Croat & L. P. Hannon, *Betancur et al.* 782 (HUA holotype).

1.4 to 1.7 times longer than wide, 1.4 to 1.8 times longer than posterior lobes, broadest at or near base, \pm symmetrical; posterior lobes directed toward the base or somewhat outward, $10\text{--}22 \times 4\text{--}10$ cm, 2.1 to 2.2 times longer than wide, acute to bluntly acute or acuminate at apex, occasionally broadly acuminate with the tip narrowly rounded, broadest near base, \pm symmetrical to weakly inequilateral, the inner side occasionally weakly narrower, \pm rounded toward base, briefly to gradually attenuate onto posterior rib; midrib deeply sunken on upper surface, concolorous or occasionally weakly paler than surface, round-raised and purple on lower surface, drying raised, purplish; **basal veins** 3 to 4 pairs, coalesced into prominent posterior rib; posterior rib naked (0.6–) 1.5–3.5 cm per side, occasionally with acute medial rib abaxially; primary lateral veins 5 to 8 pairs, arising at $40^\circ\text{--}65^\circ$, most acutely toward apex, \pm straight, occasionally weakly arcuate, quilted-sunken and concolorous on upper surface, convex to round-raised and purple on lower surface, drying raised, purplish; secondary veins in part obtusely sunken on upper surface, raised on lower surface, drying raised, purplish; tertiary veins raised or prominulous on lower surface, drying entirely or in part raised and otherwise prominulous, darker than surface; reticulate veins obscure; collective veins 3(4), the innermost arising from apex of posterior rib or from uppermost lateral vein on inner side of posterior lobe, loop-connected with all preceding lateral veins, moderately scalloped, 4–9 mm from margin. INFLORESCENCES erect, to 6 per axil, producing a strong, fruity fragrance at anthesis; inflorescence cataphyll 1-ribbed abaxially; peduncle held within the sheath, terete to subterete or weakly thicker than broad, $18\text{--}55$ cm \times 1–2 mm, matte, cream to greenish cream or pale yellow, drying tan or occasionally dark brown; **spathe** cucullate, 7.5–12 cm long (1–3 cm longer than spadix), acuminate at apex, obtusely 1-ribbed abaxially, opening \pm broadly 1/2 to 2/3 of its length at anthesis and tubular in shape, with blade margins directed forward, drying pale yellow-tan to tan, rarely dark brown; spathe tube weakly glossy to semiglossy, green to cream, rarely weakly purplish on outer surface, semiglossy on inner surface, $3.5\text{--}4.6 \times 0.5\text{--}1.5$ cm, thicker than broad, 3–3.5 cm wide (flattened); spathe blade matte to semiglossy, yellow, yellow-cream, or white on both surfaces, 3.5–3.9 cm long, ca. 1.5 cm wide (flattened), marcescent, erect after anthesis; **spadix** cylindrical, curving weakly forward, stipitate 0.5–1.3 cm, 5–6.3 cm long, adnate to spathe only along stipe or narrowly (to 5 mm) onto pistillate portion at base; stipe and axis pale green; pistillate portion orange (rarely white or magenta),

1.7–2.5 cm \times 3.5–4 mm, usually longer than fertile or sterile staminate portions; fertile staminate portion matte, cream, rarely greenish, $1.3\text{--}2$ cm \times 2.5–3 mm, bluntly acute at apex, cylindrical, occasionally with some synandrodia at and near apex or rarely 1 to 2 purplish staminodes; sterile staminate portion \pm cylindrical, dark purple to purplish white, $1.7\text{--}2.2$ cm \times 2 mm, weakly narrower than pistillate or fertile staminate portions, frequently longer than fertile staminate portion (rarely the pistillate portion); pistils \pm laxly arranged, 2 to 3(4) across the axis (viewed from above), ca. 2 mm long; ovaries pale green, subglobose or obtusely conical, 1.5–2 mm diam., 2- to 4-locular, with placentation pseudoaxile, the placentae fused toward base and 1-locular at apex, or axile, with placentae fused entire length; ovules 3 to 7 per locule, large, hemianatropous, biseriate; funicle shorter than ovule; style Type 8 (Fig. 1), ca. 1 \times ca. 1.5 mm, comprising slightly more than 1/2 to 2/3 of the length of pistil, the margins not coherent with those of adjacent styles; red chromoplasts present; **stigma** white, prominently elevated on and weakly broader at apex than narrowed portion of style, truncate; synandria ca. 1 \times 1.1–1.5 mm, coherent, truncate, rarely weakly concave medially and lobes thickened in some flowers toward apex, (2)3- to 4(5)-lobed, (2)3- to 4(5)-androus; pollen cream-colored, with holes in exine; sterile flowers markedly laxly arranged, ca. 1 \times 1.1–1.5 mm, fungiform, weakly to markedly concave medially, the concave portion dark purple or purplish white, the margins dark purple and sinuate-undulate, rarely entirely cream-colored, in 6 to 7 whorls. INFRUCTION 4.5–6.5 cm \times 7–10 mm; berries greenish white, yellow, or pale green, 3.5–4 mm diam.; seeds not known.

Phenology. Flowering occurs in *Chlorospatha atropurpurea* during all months except January and May, with fruiting recorded for the month of July. It is likely that flowering occurs throughout the year. Inflorescences emerge from the petiole sheath in rapid succession, each reaching anthesis no more than one to three days after anthesis of the preceding inflorescence.

Discussion. *Chlorospatha atropurpurea* is widespread on the western slopes of the Andes in Ecuador, having been reported at 100–1200 m elevation in every province except Azuay, Bolívar, Chimborazo, Cotopaxi, Imbabura, and Loja. It would be expected to occur in these provinces, possibly to the south, in Peru, and to the north, into Colombia. The species usually occurs in premontane wet forest but also is found in premontane rainforest and

tropical wet forest. In Cañar, El Oro, and Manabí provinces, it occurs in premontane moist forest. According to *Tipaz et al. 1389*, the local name for this species is chumbil pagande, in Carchi Province.

Chlorospatha atropurpurea is a member of *Chlorospatha* sect. *Occidentales* and characterized by its sagittate, velvety, dark green leaf blades that are occasionally purplish on the upper surface, either dark purple-mottled or entirely dark purple on the lower surface, and by its long, orange style that comprises more than one half to two thirds of the length of the pistil. Also noteworthy is the long sterile staminate portion of the spadix, which comprises approximately one third of the total length, is frequently longer than the fertile staminate portion, and has unusual concave, fungiform flowers. The sterile flowers are laxly arranged, deeply concave (cuplike), sessile or weakly stipitate, and are usually either entirely dark purple or purple with the concave portion white, cream, or purple-tinged. This combination of characters is found in only two other species of *Chlorospatha*, either of which might be confused with *C. atropurpurea* in the sterile state: *C. castula* and *C. hastata*. All three species have leaf blades that are somewhat velvety dark green on the upper surface and either purple-tinged, dark purple-mottled, or entirely dark purple on the lower surface.

Chlorospatha atropurpurea would be most easily confused with *C. castula*, both species having the petiole sheathed one half or more of its length, the sheath decurrent at the apex and the leaf blades sagittate to sagittate-subhastate, with the lobes not markedly constricted at the base, unlike *C. hastata* in which the petiole is sheathed only one third to one half, the sheath free-ending at the apex and the leaf blade hastate, with the lobes moderately to markedly constricted at the base. *Chlorospatha castula* differs from *C. atropurpurea* in having narrower lobes, particularly the posterior lobes, which are 3 to 4 times longer than wide, compared to the relatively broad posterior lobes of *C. atropurpurea*, which are only ca. 2 times longer than wide. Both species have cucullate spathes, but that of *C. castula* is usually shorter, with the tube dark purple. The tube is cream or green in *C. atropurpurea*, with only one report of a green and purplish tinged tube (*Croat 73025*). The spadices of *C. atropurpurea* and *C. hastata* are prominently stipitate and adnate to the spathe only along the stipe or also narrowly onto the pistillate portion, whereas that of *C. castula* is sessile and adnate to the spathe most of the length of the pistillate portion. The stylar morphology found in *C. castula* and *C. hastata* is conspicuously different from that of *C. atropurpurea*, both having Type 4 (Fig. 1)

styles and sessile stigmas, or apparently so. The style of *C. atropurpurea* is Type 8 (Fig. 1) and prominently attenuated, with the mantle thicker than that of the other two species, which have mantles only a few cells thick. In *C. castula*, the style is white, and in *C. hastata*, pink to purplish, very different from the orange style that characterizes *C. atropurpurea*.

The ovaries of *Chlorospatha castula* differ from those of *C. atropurpurea* in having basal placentation, rare in *Chlorospatha*, those of the latter species having axile or pseudoaxile placentation and *C. hastata*, subaxile placentation. *Chlorospatha castula* is known only from Pichincha Province in Ecuador, where it occurs with *C. atropurpurea*, with no collections indicating possible hybridization between the species. The same appears to be true of *C. hastata*, which is sympatric with *C. atropurpurea* in Carchi and Esmeraldas provinces in northern Ecuador. *Jaramillo et al. 5237* (QCA) from Reserva Endesa in Pichincha Province is possibly this species. However, only a Xerox copy was examined. The specimen could not be located at QCA.

Chlorospatha atropurpurea is a strikingly beautiful and colorful plant and has proven to be one of few species that can be maintained in cultivation. Perhaps because it is so wide-ranging, it is somewhat more adaptable than other species. It is one of only a few species known from such a broad area. Of particular note is the wide range of elevation at which the species occurs. However, there appears to be only minor variation in vegetative or floral characters throughout its range.

Additional specimens examined. ECUADOR. **Cañar:** Manta Real, 620 m, *S. Roponen & Á. Johannessen 25:129* (MO). **Carchi:** Tulcán Cantón, Parroquia Tobar Donoso, Sector Sabalera, Res. Indígena, 650–1000 m, *G. Tipaz et al. 1389* (MO, QCNE). **El Oro:** Hac. Daucay, Limón-Playa, 500 m, *X. Cornejo et al. 2442* (GUAY, MO). **Esmeraldas:** Vic. Lita, Lita–San Lorenzo rd., 5 km W of old Río Lita bridge below Lita (prior to 1999), *Croat et al. 82265* (CAS, MO); along Río Bogotá, Awá Community, Río Bogotá, 3 km SW of main Lita–San Lorenzo Hwy., 11.5 km NW of Alto Tambo, 30.5 km W of Río Lita bridge near Lita, *Croat 87557* (K, MO, QCNE); vic. Lita, on Ibarra–San Lorenzo rd., 550–650 m, *Madison et al. 5054* (QCA, SEL); Eloy Alfaro, Reserva Ecol. Cotacachi-Cayapas, Charco Vicente, Río San Miguel at jct. with Río Cayapas, 150 m, *W. Palacios et al. 11289* (MO, QCNE); Eloy Alfaro, Parroquia Luís Vargas Torres, Playa de Oro, Río Santiago, 200 m, *M. Tirado et al. 239* (MO, QCNE). **Guayas:** Cord. Chongón-Colonche, Bosque Protector Loma Alta, 600 m, *X. Cornejo et al. 5219* (GUAY, MO). **Los Ríos:** Río Palenque Science Center, Km. 56 on Quevedo–Santo Domingo rd., 150–220 m, *Dodson 6912* (SEL); Río Palenque Field Station, halfway betw. Quevedo & Santo Domingo de los Colorados, ca. 200 m, *A. Gentry 10130* (MO). **Manabí:** Pedernales Cantón, Res. Ecol. Mache-Chindul, Comun. Ambacha (via coastal edge of Chindul), 250 m, *J. Clark et al. 4174* (MO, QCNE). **Pichincha:** Res. Endesa, Km. 113 on Quito–Puerto Quito

rd., 9 km N of Km. 113, 750 m, *Croat & J. Rodríguez 61450* (K, MO, NY, US); Santo Domingo de los Colorados, vic. La Centinela, 0.2 km past Escuela Mixta La Centinela, 13 km E on trail from main Santo Domingo-Quevedo hwy. in Patricia Pilar, 1000 m, 0°32'S, 79°11'W, *Croat 73025* (MO); forest of the Coop. Santa Marta #2, at Km. 3 of bypass around Santo Domingo de los Colorados, 530 m, *Dodson et al. 8550* (SEL); path along ridge line at La Centinela, at crest of Montañas de Ila, Patricia Pilar-24 de Mayo rd., at Km. 12, 600 m, *Dodson & Benzing 13907A* (SEL), *Dodson & Gentry 12414* (SEL); E side of Río Lelia, ca. 16 km SE of Santo Domingo de los Colorados, *Grayum et al. 9425* (MO); Res. Endesa, Río Silanche, Corp. For. Juan Manuel Durini, Km. 113 on Quito-Puerto Quito hwy., 10 km N of main hwy., 650–700 m, *Jaramillo 6788* (MO, QCA), *Jaramillo 7020* (COL, QCA).

Cultivated specimens examined. ECUADOR. **Esmeraldas:** Vic. Lita, Lita-San Lorenzo rd., *Croat 81258* (MO); vic. Lita, 6.4 km W of old Río Lita bridge (prior to 1999), at Río Piguambi, 685 m, *L. P. Hannon 97-052* (MO), *L. P. Hannon 97-340* (MO). **Los Ríos:** Río Palenque Science Center, 1977, *Madison 4187* (SEL), from type clone, *Dodson 5911*.

4. *Chlorospatha bayae* Croat & L. P. Hannon, sp. nov. TYPE: Colombia. Valle: along old Calí-Buenaventura rd., 50.5 km N of Agua Clara, 31.2 km S of jct. with main Calí-Buenaventura Hwy., ca. 1100–1200 m, 3°31'N, 76°45'W, 6 July 1993, *Croat & D. Bay 75600* (holotype, MO-04570991-92!; isotype, CUVCI). Figures 6D, 7A–C.

Herba usque ad 1 m; internodia 1–3 cm longa, usque ad 3 cm lata; cataphylla 10–21 cm longa. Petiolus 62–72 cm longus, vaginatus per 37–41 cm; lamina foliaris sagittata, 24.5–35 × 11.5–19 cm, lobis posterioribus 8–12 × 4.8–8 cm, nervis basalibus utroque 6 vel 7, nervis primariis lateralibus utroque 8 ad 10. Inflorescentiae erectae, 2 ad 4 in quaque axilla; pedunculus 30–41 cm × ca. 2 mm; spatha 12.5–14.5 cm longa, 5–7 mm diam., lamina alba, 6–7 cm × 6–8 mm; spadix 10.7–12 cm longus, sessilis.

Terrestrial herb, to ca. 1 m tall; stem with remnants of old cataphylls persisting intact at uppermost nodes, otherwise fibrous with fragments of epidermis at remaining nodes, the fibers pale; internodes 1–3 × to 3 cm, dark green to gray, drying weakly glossy, tan (all measurements made from dried material); cataphylls quickly collapsing, 10–21 cm long, apex not known, drying weakly glossy to semiglossy, medium-dark to dark brown. LEAVES 2, erect-spreading; **petioles** 62–70 cm long, moderately firm, glabrous, medium yellow-green, drying weakly glossy, medium-dark to dark reddish brown, sheathed 37–41 cm, more than 1/2 of total length (less than 2/3); sheath decurrent at apex; free portion 4–6 mm diam. midway, terete; **blades** sagittate, 24.5–35 × 11.5–19 cm, 1.8 to 2.1 times longer than wide, acuminate at apex, broadest at base, 1.1 to 1.2 times wider at base than across anterior lobe (measured tip

to tip across posterior lobes), subcoriaceous, moderately bicolorous, weakly or not at all constricted in area of petiole attachment, drying subcoriaceous; upper surface ± flat (not quilted), semiglossy, dark green, drying matte to weakly glossy, dark olive-green; lower surface semiglossy, drying matte to weakly glossy, occasionally in part semiglossy, greenish yellow-brown; anterior lobe 18–26 × 10.3–16 cm, 1.6 to 1.7 times longer than wide, 2.2 to 2.3 times longer than posterior lobes, broadest below middle, ± symmetrical; posterior lobes directed toward base, 8–12 × 4.8–8 cm, 1.5 to 1.7 times longer than wide, narrowly rounded or bluntly acute at apex, broadest at base, weakly to moderately inequilateral, the inner side narrower, ± rounded toward base, decurrent onto petiole (possibly terminating at petiole apex); outer side 1.1 to 2 times wider than inner side midway, ± straight toward base, occasionally weakly concave; major and secondary venation drying ± wrinkled on lower surface; midrib sunken on upper surface and concolorous, convex on lower surface, paler than surface, drying raised, weakly paler to weakly darker than surface; **basal veins** 6 to 7 pairs, coalesced into prominent posterior rib; primary lateral veins 8 to 10 pairs, arising at 55°–70°, weakly to moderately arcuate, narrowly sunken on upper surface, convex on lower surface, drying raised, weakly paler to weakly darker than surface; secondary veins in part obtusely sunken on upper surface, raised on lower surface, drying raised, ± concolorous; tertiary veins darker than lower surface, drying prominulous, ± concolorous; reticulate veins drying obscure; collective veins 3, the innermost arising from one of the lowermost lateral veins on the inner side of the posterior lobe, loop-connected with all preceding lateral veins, ± parallel to and 2–6 mm from margin. INFLORESCENCES erect, 2 to 4 per axil; peduncle held within the sheath, 30–41 cm × ca. 2 mm, drying weakly glossy, medium-dark reddish brown; **spathe** weakly cucullate, 12.5–14.5 cm long, ± acute at apex, obtusely ribbed abaxially; spathe tube green along rib on outer surface, otherwise dark purple on both surfaces, 6.2–7.5 cm × 5–7 mm, drying matte to weakly glossy, dark blackish brown on outer surface, weakly to moderately paler on inner surface; spathe blade white, 6–7 cm × 6–8 mm, drying matte to weakly glossy, brownish cream to medium-dark tan on both surfaces, marcescent, erect after anthesis; **spadix** erect, 10.7–12 cm long, sessile, adnate to spathe 5–6 cm at base, the entire length of pistillate portion; pistillate portion creamy white, 5–6 cm × ca. 2.5 mm, drying medium-dark reddish brown; fertile staminate portion pale yellow-brown, 3.5–4.2 cm × 2–4 mm, bluntly acute



Figure 6. A–C. *Chlorospatha besseae* Madison. A, B photographed from MO cultivar, *Croat & L. P. Hannon 81474* (= *Hannon 97-386*). —A. Fertile habit. —B. Plant with inflorescence at anthesis. —C. Close-up of inflorescences (one cut open to expose pistillate portion of spadix), *Croat et al. 82131* (MO). —D. *Chlorospatha bayae* *Croat & L. P. Hannon, Croat & Bay 75600* (MO holotype, sheet 1 of 2).



Figure 7. A–C. *Chlorospatha bayae* Croat & L. P. Hannon from the original collection and holotype. —A. Leaf blade adaxial surfaces. —B. Fertile habit. —C. Close-up of petioles and inflorescences. —D. *Chlorospatha bogneri* Croat & L. P. Hannon, Croat 69556 (MO paratype).

at apex, ellipsoid, drying medium-dark reddish brown; sterile staminate portion 1.2–1.6 cm \times 2–3 mm, broadest at apex, drying dark blackish brown; pistils \pm laxly arranged, 1 to 3 across the axis (viewed from above), 1.5–2 mm long; ovaries subglobose, ca. 1 \times 1.8–2.2 mm, drying medium brown with darker veins; style Type 9 (Fig. 1), 0.5–0.8 \times 1.5–2 mm, the margins not coherent with those of adjacent styles; **stigma** golden tan, ca. 0.3 mm diam., elevated on and weakly broader than narrowed portion of style, drying dark reddish brown; synandria ca. 1 \times 1.5–2 mm, occasionally \pm elongated in direction of axis, coherent, truncate to obtusely truncate, 3- to 4(5)-lobed, 3- to 4(5)-androus (mostly 4); sterile flowers 0.8–1 \times 0.5–2 mm, elongated in direction of axis, laxly arranged in 7 whorls (axis naked between whorls), 1- to 6-branched, the branches \pm clavate. INFRUCTESCENCE 9.5 cm \times 8 mm, drying weakly glossy to semiglossy, dark reddish brown on outer surface, semiglossy and moderately paler on inner surface; berries 3–4.5 \times 2–5 mm, drying dark tan.

Phenology. Flowering is only known to occur in *Chlorospatha bayae* during the month of July.

Etymology. *Chlorospatha bayae* is named for Dorothy Bay (Missouri Southern College), one of the collectors of the type and an expert on the Flora of Bajo Calima in Valle Department of Colombia.

Discussion. *Chlorospatha bayae* is known only from the type collection from the western slopes of the Cordillera Occidental, in premontane wet forest or possibly premontane moist forest. The species is a member of *Chlorospatha* sect. *Occidentales* and distinguished by its sagittate, subcoriaceous, semiglossy, dark green leaf blades, medium green petioles, and large inflorescence (12.5–14.5 cm long), with most of the spathe tube dark purple on both surfaces. The blades have numerous primary lateral veins (eight to 10 pairs) and dry unusually thick, with the major and secondary venation prominently wrinkled on the lower surface.

Chlorospatha bayae could possibly be confused with *C. jaramilloi* and *C. sagittata*, known only from the western slopes of the Andes in Ecuador, in Pichincha and Imbabura provinces, respectively, the leaf blades being similar in shape and drying color and the spathe tubes purple or purplish. In the latter two species, the leaf blades dry thin, the lower surface more or less glossy, and the major venation flattened and smooth (not wrinkled), differing from those of *C. bayae*, which are subcoriaceous and dry unusually thick, mainly matte to weakly glossy on the

lower surface, with the major and secondary venation prominently raised and conspicuously wrinkled. The velvety living blades of *C. sagittata* further differ from the semiglossy blades of *C. bayae*, which have eight to 10 pairs of primary lateral veins versus six or seven pairs in *C. jaramilloi* and *C. sagittata*. The petiole in *C. bayae* and *C. jaramilloi* is sheathed one half of its length, with the sheath decurrent at the apex, differing from that of *C. sagittata*, which is sheathed more than three fourths of its length, with the sheath free-ending. The inflorescence of *C. bayae* is larger than those of the other two species (12.5–14.5 cm long vs. less than 12 cm long). The peduncles of *C. sagittata* are significantly longer than those found in either *C. bayae* or *C. jaramilloi*, 88 cm long and more than three fourths as long as the petiole versus one half as long as the petiole in the other two species, with the peduncle 30–41 cm long in *C. bayae* and only 18–20 cm long in *C. jaramilloi*. The spadix in *C. bayae* and *C. jaramilloi* is adnate to the spathe the entire length of the pistillate portion versus one half of the length in *C. sagittata*. In *C. bayae*, the pistillate portion of the spadix is significantly longer than the fertile staminate portion (ca. 2 cm longer), whereas in the other two species, it is shorter than that portion. The style is long-attenuated in *C. jaramilloi* (Type 5, Fig. 1), comprising one half of the length of the pistil, and briefly attenuated in *C. bayae* (Type 9, Fig. 1), comprising one third of the length of the pistil. The style is significantly different in *C. sagittata* (Type 4, Fig. 1), comprising less than one fourth of the length of the pistil, with the stigma apparently sessile. The synandria of *C. sagittata* are 4- to 6-androus versus 3- to 4-androus in the other two species. The sterile flowers are branched in both *C. bayae* and *C. jaramilloi*, but are densely arranged in the latter species and laxly arranged in *C. bayae*. These are subprismatic and laxly arranged in *C. sagittata*.

Chlorospatha bayae could not be easily confused with any species, but it could possibly be confused with *C. yatacuensis*, which occurs in the same general area, but with *C. bayae* occurring at higher elevations along the old Cali–Buenaventura road, 50.5 km north of Agua Clara, on the western slopes of the Cordillera Occidental in Valle Department, Colombia, at 1100–1200 m elevation. Both species are similar in size, with leaf blades of similar shape; however, the blades of *C. bayae* have eight to 10 pairs of primary lateral veins and dry subcoriaceous, with the major and secondary venation prominently raised and wrinkled. The blades of *C. yatacuensis* have four pairs of primary lateral veins and dry thin, with only the midrib and secondary veins weakly raised and none of the venation wrinkled. The petiole of *C. bayae* is

sheathed more than one half of its length and the peduncle is long (30–41 cm long), as is the inflorescence (12.5–14.5 cm long) in which the spathe tube is dark purple on both surfaces. *Chlorospatha yatacuensis* differs in having the petiole sheathed one third of its length, the peduncle less than 22 cm long, the inflorescence markedly small (4.2–5.5 cm long), and the spathe entirely cream-colored. The spadix of the latter species is adnate to the spathe one half of the length of the pistillate portion and the sterile flowers are prismatic. The spadix of *C. bayae* is adnate the entire length of the pistillate portion and the sterile flowers are 1- to 6-branched.

5. *Chlorospatha besseae* Madison, Selbyana 5(3–4): 352. 1981. TYPE: Ecuador. Esmeraldas: environs of Lita, on Ibarra–San Lorenzo RR, 550–650 m, 10 June 1978, *M. Madison, T. Plowman, H. Kennedy & L. Besse 5144* (holotype, SEL; isotypes, F!, K!, MO!, QCA!). Figure 6A–C.

Terrestrial herb, to 80 cm tall, in small colonies; stems decumbent, to 50 cm long, erect to 30 cm, occasionally with remnants of old leaf bases and cataphylls persisting \pm intact at upper nodes; internodes 1–4 \times 1.3–3 cm, weakly glossy to semiglossy, pale, medium or dark green (rarely purplish), becoming grayish green or brown with age, drying matte, dark reddish brown; cataphylls 7–11 cm long, apex not known, pale to medium green, drying matte, dark brown. LEAVES 2 to 5, erect-spreading; **petioles** 17–33.5 cm long, moderately firm, glabrous, matte, medium to dark green, drying matte to weakly glossy, medium-dark to dark reddish brown, sheathed 10–18 cm, ca. 1/2 to slightly more than 2/3 of total length; sheath decurrent at apex; free portion 2–4 mm diam. midway, terete, entirely weakly and narrowly sulcate or in part sharply V-sulcate toward apex and otherwise smooth; **blades** held \pm horizontally to erect-spreading, ovate-sagittate, cordate at base, 12.5–23(–28) \times 7–14(–16) cm, 1.5 to 1.8(to 2.1) times longer than wide, weakly to moderately or occasionally abruptly acuminate at apex, broadest across anterior lobe, 1.4 to 1.9 times wider across anterior lobe than at base (measured tip to tip across posterior lobes), thin, conspicuously bicolorous; upper surface \pm quilted, matte-subvelvety or velvety, dark to medium green, drying weakly glossy, dark green to olive-green or blackish brown; lower surface reticulate, narrowly matte and minutely colliculate along all orders of venation, otherwise semiglossy, drying weakly glossy to semiglossy, moderately to prominently paler; anterior lobe 10–18 \times 7–14(–16) cm, 1.1 to 1.4 times longer than

wide, 2.3 to 3.3 times longer than posterior lobes, broadest at or below middle, \pm symmetrical to weakly inequilateral, with one side to 1 cm wider than opposite side; posterior lobes directed toward the base, (2–)3–7.5 \times 2.8–5.6 cm, 1 to 1.2(to 1.4) times longer than wide, narrowly rounded to bluntly rounded at apex, broadest at base, moderately to markedly inequilateral, the inner side narrower, \pm rounded toward base, briefly attenuate and decurrent onto petiole; outer side 1.7 to 5 times wider than inner side midway, \pm convex to weakly constricted toward base; all orders of venation matte on lower surface; midrib narrowly sunken on upper surface, concolorous to weakly paler than surface, round-raised on lower surface, drying raised, moderately darker than surface; **basal veins** 3 to 4 pairs, coalesced into a prominent posterior rib; primary lateral veins 4 to 5(6) pairs, arising at 30°–65°, most acutely toward apex, weakly to moderately arcuate, narrowly sunken on upper surface, concolorous to occasionally in part weakly paler than surface toward the base, round-raised or narrowly raised on lower surface, drying raised to weakly flattened, moderately darker than surface; secondary veins in part obtusely sunken on upper surface, raised on lower surface, drying weakly raised, concolorous to weakly darker than surface; tertiary veins prominulous on lower surface, drying in part weakly prominulous, otherwise visible and distinct, concolorous to weakly darker than surface; reticulate veins prominulous on lower surface, drying visible, distinct, flat, concolorous to weakly darker than surface; collective veins 3, the innermost arising from one of the lateral veins on inner side of posterior lobe, rarely from apex of posterior rib, loop-connected with all preceding lateral veins, weakly scalloped, 3–8 mm from margin. INFLORESCENCES erect, 1 to 3 per axil, emitting a sweet fragrance at anthesis; peduncle held within the sheath, 10–19.5 cm \times 1–4 mm, obtusely D-shaped in apical 1/2, wider than thick toward apex (to 4 mm wide), narrowing toward base, matte, pale green, drying matte to weakly glossy, dark brown or greenish brown to dark green; **spathe** erect, 5–7 cm long, ovate-elliptic, cuspidate at apex, obtusely 1-ribbed abaxially in apical 1 cm; spathe tube semiglossy, pale green to yellow-green cream on outer surface, glossy on inner surface, 2.2–3.5 cm \times 4–7 mm, drying matte to weakly glossy, medium to dark brown, weakly paler on inner surface; spathe blade matte, cream or yellow-green cream, weakly paler than tube on both surfaces, 2.3–4 cm \times 5–9 mm, opening broadly at anthesis and broadly funnel-shaped, the margins directed \pm outward, drying matte to weakly glossy on outer surface, weakly paler on inner surface,

marcescent, erect after anthesis; **spadix** erect, held weakly forward at anthesis, (3.5–)4–5.8 cm long, sessile, adnate to spathe 1.5–2.3 cm at base, most or all of the length of pistillate portion; pistillate portion rose-colored (rarely cream), 2–2.5 cm × ca. 4 mm, wider than thick, weakly broadest midway, drying dark reddish brown; fertile staminate portion matte, bright orange, turning deep red when cut, 2.1–2.6 cm × ca. 4 mm, ± cylindrical to weakly tapering, narrowly rounded at apex, drying orange to dark orangish brown; sterile staminate portion cream to yellowish cream toward base, pale to medium yellow-orange at apex, 3.4–4 × 3–4 mm, ± cylindrical, drying medium orange at apex, weakly lavender-tinged gray toward base; pistils weakly coherent, 3 to 4 across the axis (viewed from above), 1.3–1.7 mm long; ovaries ± cylindrical, cream to greenish cream or creamy white (drying whitish), 0.8–1.2 × ca. 1.5 mm, 2-locular, with axile or subaxile placentation; ovules 6 to 10 per locule, hemianatropous, biseriate; funicle as long as ovule; style Type 9 (Fig. 1), rose-colored, densely darker rose-speckled, 0.5–0.7 × ca. 1.5 mm, the margins weakly coherent with those of adjacent styles; **stigma** whitish, ca. 0.5 mm diam., disklike, weakly elevated on style; synandria 1–1.5 × 1.5–2 mm, coherent, truncate, 3- to 5-lobed, 3- to 5-androus (mostly 4); sterile flowers 0.5–1 mm long, 1–1.3 × 1 mm diam. and weakly elongated in direction of axis, coherent, truncate, irregularly subprismatic to prismatic, in 2 to 4 whorls. **INFRUCTESCENCE** drying 5.6 cm × 6 mm, matte, dark brown; berries white, drying 2.5–3.5 mm diam., pale tan.

Phenology. Flowering is reported in *Chlorospatha besseae* for the months of June, October, November, and December. In cultivation, the species flowers periodically throughout the year but not continuously. Inflorescences emerge in slow progression, with several days between anthesis of one inflorescence and emergence of the next inflorescence at the apex of the petiole sheath. Fruiting is recorded only for the month of December.

Discussion. *Chlorospatha besseae* is known only from premontane wet forest and lower montane wet forest on the western slopes of the Andes in Carchi and Esmeraldas provinces in northwestern Ecuador at 550–814 m elevation and would be expected to occur to the north, along the border in southern Colombia. The species is a member of *Chlorospatha* sect. *Occidentales* and occurs in small colonies, the latter a condition that distinguishes it from most species of *Chlorospatha*, particularly those from the western slopes. The species is also distinguished by its velvety, ovate-sagittate leaf blades that are cordate

at the base, with the posterior lobes short and rounded at the apex, and its small inflorescence with bright orange synandria and rose-colored styles. It is one of only three species from the western slopes or Magdalena River drainage that have the leaf blade narrowly, minutely colliculate along all abaxial venation. This condition is also easily observed in dried material and is rarely encountered in species from the western slopes.

Chlorospatha besseae would be most easily confused with *C. bogneri* from La Planada Reserve in Nariño Department in southern Colombia, at 1700–2050 m elevation. The leaf blades of *C. bogneri* are subcordate to nearly truncate at the base, with the posterior lobes usually acute to bluntly acute at the apex and only occasionally narrowly rounded. The upper surface of the blade of *C. bogneri* is minutely rugose and all orders of venation are prominently raised, granular-puberulent to minutely puberulent on the lower surface and darker than the surface. The lower surface in *C. bogneri* lacks the characteristic colliculate border that occurs along the veins in *C. besseae*. *Chlorospatha bogneri* differs in having the petiole entirely or partially minutely many-ribbed, frequently entirely or partially minutely puberulent to granular-puberulent and occasionally purple-tinged. The most obvious difference lies in its sheathing, which, unlike that of *C. besseae*, is three fourths as long to nearly as long as the petiole, with the sheath prominently free-ending at the apex, such extensive sheathing being uncommon in *Chlorospatha*. As would be expected, the peduncles of *C. bogneri* are proportionally much longer than those of *C. besseae*, being equal in length to or longer than the petioles.

The inflorescences of *Chlorospatha besseae* and *C. bogneri* are small and the synandria bright orange, but the spadix of the latter species is weakly stipitate and adnate to the spathe one half of the length of the pistillate portion. In both species, the style is Type 9 (Fig. 1), but is deeply rose-colored in *C. besseae* and green in *C. bogneri*, in which this portion of the spadix is more than twice as long, with the sterile flowers more laxly arranged in six whorls. The two species are possibly closely related. Only five species have bright orange synandria and all occur in the frontier region along the border between Colombia and Ecuador, on the western slopes of the Andes: *C. besseae*, *C. bogneri*, *C. dodsonii*, *C. litensis*, and *C. mansellii*. Only *C. dodsonii* is widespread (in Ecuador).

Chlorospatha besseae might be confused with *C. mansellii*. The species are sympatric in the Lita–San Lorenzo region of Esmeraldas Province, Ecuador. *Chlorospatha mansellii* is a somewhat larger plant

with hastate-drying blades, with the posterior lobes acute at the apex and both longer and narrower (ca. 2 times longer than wide and two thirds as long as the anterior lobe) than those of *C. besseae*. The inflorescences are similar, but that of *C. mansellii* is consistently and significantly larger, with the fertile staminate portion tapering, acute to bluntly acute at the apex and longer than the pistillate portion. Both species have Type 9 styles (Fig. 1), but those of *C. mansellii* are pink-tinged orange. It is possible that *C. mansellii* is a hybrid taxon with *C. besseae* as one of the hybrid parents.

Chlorospatha besseae could be confused with *Chlorospatha* sp. indet. 1 from Nariño Department in southern Colombia. No fertile material of this species was examined, but the label notes report the spathe tube as medium green and dark purple at the apex. The species have similar blade shapes and petiole sheathing. *Chlorospatha* sp. indet. 1 either terminates at the petiole apex or is possibly weakly confluent with that of the opposite lobe. The major veins on the lower surface of the blade dry flattened in *Chlorospatha* sp. indet. 1 but raised in *C. besseae*. *Chlorospatha* sp. indet. 1 has only three pairs (rarely four) of primary lateral veins. The petiole of Species 1 is soft, semiglossy, and green with darker transverse markings and dries weakly glossy, with the epidermis partially separated intact from the petiole.

Additional specimens examined. ECUADOR. **Carchi:** El Pailón, 45 km below Maldonado, along footpath to Tobar Donoso, *Madison & Besse 7072* (SEL), 7279 (K, QCA, SEL, US). **Esmeraldas:** Lita–San Lorenzo rd., 3.7 km W of old Río Lita bridge below Lita (prior to 1999), 647 m, *Croat et al. 82131* (HUA, K, MO, QCA, QCNE, UB, US); Lita–San Lorenzo rd., 13 km W of Río Lita bridge (new rd., after 1998), 814 m, *Croat et al. 83223* (MO, QCNE, USM).

Cultivated specimens examined. ECUADOR. **Esmeraldas:** Lita–San Lorenzo rd., 3.4 km W of old Río Lita bridge below Lita (prior to 1999), *Croat & L. P. Hannon 81474* (MO, cult. from *L. P. Hannon 97-386*); vic. Lita, 600 m, *Madison 6740* (SEL, cultivated from type *Madison et al. 5144*; Selby live acc. 78-1086).

6. *Chlorospatha betancurii* Croat & L. P. Hannon, *Aroidiana* 27: 9–11. 2004. TYPE: Colombia. Antioquia: Cordillera Central, Mpio. Amalfi, 8–15 km from Amalfi on Amalfi–Rumazón rd., sites Salazar & La Playa, 1550 m, 06°56'N, 75°04'W, 28 Sep. 1988, *J. Betancur, F. Roldán & O. Escobar 782* (holotype, HUA!). Figure 5D.

Terrestrial herb, ca. 1 m tall; stem with remnants of old cataphylls persisting in part as short fibers at upper nodes, the fibers pale to dark brown (all measurements made from dried material); internodes (of juvenile plants) 9–10 × 8–11 mm, drying weakly

glossy, dark greenish brown; cataphylls ca. 37 cm long, acuminate at apex, drying semiglossy, medium tan or brown. LEAVES 1; **petiole** 77 cm long, drying glabrous, weakly glossy to semiglossy, dark reddish brown, with epidermis much paler, in part separated ± intact and semi-transparent, sheathed ca. 38 cm, ca. 1/2 of total length; sheath decurrent at apex; free portion 5–7 mm diam. midway; **blade** deeply 3-lobed, 30 × 29 cm, about as long as wide, drying thin, weakly bicolorous; upper surface green, sparsely, irregularly whitish maculate, drying weakly glossy, dark green, the maculations pale-medium green; lower surface drying semiglossy to glossy, the maculations pale yellow-green; **medial lobe** 28 × 10 cm, 2.7 times longer than wide, acuminate at apex, broadest below middle, weakly shorter than to weakly longer than lateral lobes, briefly attenuate toward base, broadly attached, ca. 3.5 cm wide at point of attachment, weakly inequilateral; **lateral lobes** directed toward the apex, 26.5–28.5 × 8–8.5 cm, 3.4 to 3.6 times longer than wide, gradually acuminate to long-acuminate at apex, broadest near base, markedly inequilateral, the inner side always narrower, long attenuate toward base and moderately confluent with medial lobe, the confluent portion ca. 1.5 cm wide; outer side ca. 2.2 times wider than inner side midway, ± rounded or oblique at base; midrib round-raised on lower surface, drying ± flattened, darker than surface; posterior rib naked 1.3–1.5 cm per side; primary lateral veins (of medial lobe) 6 pairs, arising at 30°–45°, straight to weakly arcuate, round-raised on lower surface, drying raised at base, otherwise ± flattened, darker than surface; primary lateral veins (of lateral lobes) 7 to 8 pairs, the basal pair briefly fused toward base, straight to weakly arcuate; secondary veins drying weakly raised on lower surface, weakly darker than surface; tertiary veins drying in part weakly prominulous, otherwise flat, mostly concolorous on lower surface, in part weakly darker than surface; reticulate veins drying obscure; collective veins 3, the innermost arising from lowermost lateral vein at base, loop-connected with all preceding lateral veins, moderately scalloped, 3–10 mm from margin. INFLORESCENCES erect, to 5 per axil; peduncle held within the sheath, 37–44 cm × ca. 2 mm, drying matte to weakly glossy, dark brown; **spathe** erect, total length not known; spathe tube green, 2.5–3 cm × 3.5 mm, drying matte to weakly glossy, dark reddish brown on outer surface, weakly glossy on inner surface and densely pale tan, punctiform (speckles regularly rounded, appearing as subepidermal cellular inclusions); spathe blade white, length not known; **spadix** erect, 6 cm long, sessile, adnate to spathe ca. 1 cm at base,

ca. 1/2 of the length of pistillate portion; pistillate portion ca. 2.2 cm × ca. 2 mm, drying brown; fertile staminate portion brown, ca. 2.8 cm × 1.5–3 mm, clavate, bluntly rounded at apex, drying dark reddish brown; sterile staminate portion ca. 1 cm × 1–1.5 mm, broadest at base, drying medium yellow-brown; pistils weakly coherent (laxly arranged in basal whorls), 2 to 4 across the axis (viewed from above), ca. 1 mm long; ovaries subglobose, ca. 0.8 × 1–1.5 mm, drying medium brown; style Type 3 (Fig. 1), 0.8–1 mm diam., the margins not coherent with those of adjacent styles; **stigma** 0.2–0.3 mm diam., sessile; synandria ca. 1 × ca. 1 mm, coherent, truncate, deeply (2)3- to 4-lobed, 3- to 4-androus (mostly 3); sterile flowers ca. 0.5 mm long, 1.7–2 × 1 mm diam. and ± elongated in direction of axis, ± coherent, truncate, irregularly subprismatic, in 6 whorls. **INFRUCTESCENCE** 4–6.3 × 0.9–1.4 cm, drying matte to weakly glossy, dark reddish brown; berries 3–4 mm diam., drying dark brown; seeds not known.

Phenology. Flowering and fruiting are only known to occur in *Chlorospatha betancurii* during the month of September.

Discussion. *Chlorospatha betancurii* is known only from tropical wet forest on the eastern slopes of the Cordillera Central in Antióquia Department, Colombia, at 1550–1850 m elevation, a region of significant endemism in *Chlorospatha*. The species is a member of *Chlorospatha* sect. *Chlorospatha* and is distinguished by its deeply 3-lobed, whitish maculate, green leaf blades that dry green on both surfaces, with the lateral lobes long-acuminate at the apex, narrower than and nearly as long as the medial lobe. The petiole dries semiglossy, with the epidermis partially separated intact from the main body and semi-transparent. The spadix is relatively small (6 cm long), with the fertile staminate portion brown.

Chlorospatha betancurii is one of only three trilobed species that occur in the region east of the Cordillera Occidental, and it could be confused with only one of these, *C. callejasii*, also from Antióquia Department, near Yarumal. The leaf blades of the latter species are not maculate and dry rich, reddish brown on both surfaces, with the upper surface matte-subvelvety and the major and secondary venation almost black on the lower surface. All segments are acute at the apex, with nine to 11 pairs of primary lateral veins on the lateral segments. The blades of *C. betancurii* are maculate and dry green on both surfaces, weakly glossy on the upper surface, with the abaxial venation only moderately darker than the surface, all segments long-acuminate at the apex and

seven or eight of the primary lateral veins on the lateral segments. The fertile staminate spadix of *C. callejasii* is white, whereas that of *C. betancurii* is brown.

Chlorospatha betancurii might also be confused with *C. cogolloi*, but the latter species occurs only on the western slopes of the Cordillera Occidental. *Chlorospatha cogolloi* differs in usually having the petiole sheathed three fourths or more of its length, with the epidermis not separating (on drying); the petiole is sheathed about half of its length in *C. betancurii*, with the epidermis partially separated (on drying), semi-transparent, and semiglossy. The blades of *C. cogolloi* are usually entirely purple on the lower surface, rarely green with the major veins purple; in *C. betancurii*, the lower blade surface is green. In *C. cogolloi*, there are more pairs of primary lateral veins on all segments (in mature specimens), with 10 pairs on the medial lobe, eight to 10 pairs on the lateral lobes versus six pairs on the medial lobe, and seven or eight pairs on the lateral lobes in *C. betancurii*. The spadix of *C. cogolloi* is also longer than that of *C. betancurii*, in specimens of comparable size, with the fertile staminate portion white, whereas that of *C. betancurii* is brown.

Chlorospatha betancurii bears a superficial resemblance to *C. mirabilis*, both having deeply 3-lobed blades; however, the latter species occurs only on the western slopes of the Cordillera Occidental and in Panama, and the lower surface of the blade is entirely purple or purplish, thus differing from that of *C. betancurii*, which is green. The sterile staminate portion of the spadix comprises only one fifth of the total length in the latter species, with the sterile flowers densely arranged, and one third of the total length in *C. mirabilis*, with the sterile flowers laxly arranged.

The second collection cited, *L. Escobar et al. 7961*, is a very small, sterile specimen from the same general area as the type and, therefore, is included here.

Additional specimen examined. COLOMBIA. **Antioquia:** Mpio. Gautapé, Santa Rosa trail, Finca Montepinar, *L. Escobar et al. 7961* (paratype, MO).

7. *Chlorospatha bogneri* Croat & L. P. Hannon, *Aroideana* 33: 78–81. 2010. TYPE: Colombia. Nariño: La Planada Reserve, on trails La Vieja and La Piña, NW of Science Center, 1850–2050 m, 1°09'40''N, 77°58'78''W, 8 June 1996, *J. Bittner 2493* (holotype, MO-05053495!; isotype, PSO!). Figures 7D, 8A, B.

Terrestrial herb, to 1.2 m tall (all measurements made from dried material); stem decumbent, to 34 cm

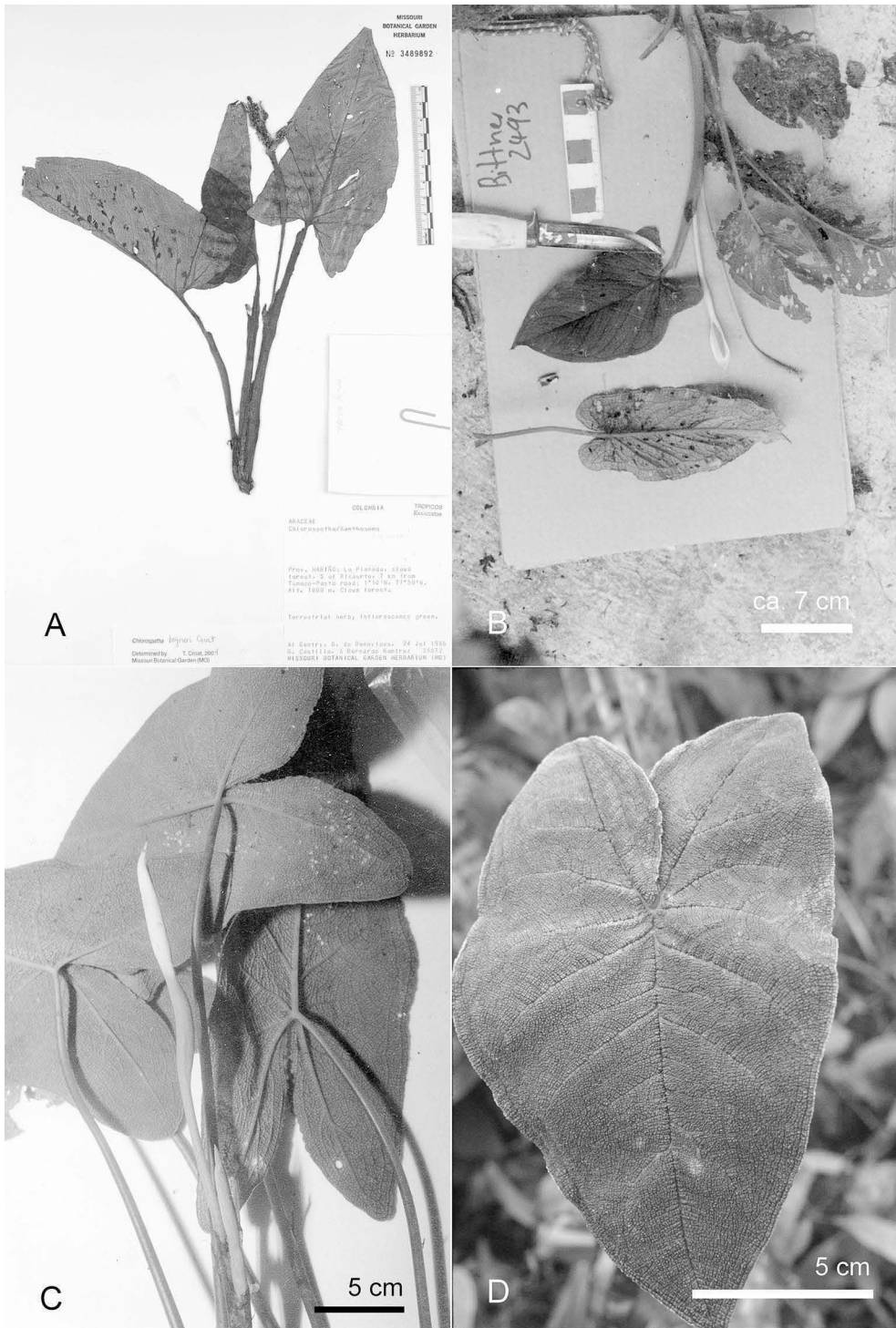


Figure 8. A, B. *Chlorospatha bogneri* Croat & L. P. Hannon. —A. Gentry *et al.* 55072 (MO paratype). —B. Live type collection on ground, Bittner 2493. —C. *Chlorospatha* sp. indet. 3, flowering plant, pre-anthesis, Croat & Gaskin 79662 (MO). —D. *Chlorospatha bullata* Croat & L. P. Hannon, leaf blade adaxial surface, Croat 50130 (MO).

long; sap milky; internodes 1.5–3 cm × 3–9 mm, weakly glossy, dark green, occasionally violet-tinged, drying matte, dark brown to blackish brown; cataphylls quickly deciduous, 6–16 cm long, obtuse with acumens at apex, dark green, drying matte, dark brown to blackish brown. LEAVES 2 to 7, erect-spreading; **petioles** 10–23 cm long, frequently minutely many-ribbed near apex, rarely entirely ± minutely crispy-puberulent or in part only near apex and otherwise granular-puberulent or minutely puberulent, matte, dark green, occasionally violet-tinged, drying matte, dark blackish brown, sheathed 8–22.5 cm, more than 3/4 of to almost entire length; sheath free-ending at apex, frequently prominently so, the margins in-rolled; free portion 2–3.5 mm diam. midway, terete, sharply V-sulcate; **blades** erect-spreading, ovate or narrowly ovate-sagittate, subcordate or subtruncate at base, 10–18 × 5–9.2 cm, 4.5–7.3 cm wide at base, (1.3 to)1.7 to 2.2 times longer than wide, weakly to moderately acuminate at apex, usually weakly broader across anterior lobe than at base, 1 to 1.4 times wider (measured tip to tip across posterior lobes), occasionally with one or both margins weakly to moderately constricted in area of petiole attachment, moderately thin, moderately to prominently bicolorous; upper surface minutely rugose, matte, markedly dark green, drying matte, dark blackish brown, rarely weakly greenish; lower surface reticulate, matte, drying weakly glossy, occasionally semiglossy, weakly to moderately paler; anterior lobe 9–16 × 4.5–9.2 cm, 1.6 to 1.8(to 3.5) times longer than wide, (3.3 to)3.6 to 4 times longer than posterior lobes, broadest at or below middle, ± symmetrical to weakly inequilateral; posterior lobes directed toward the base, 2.5–4.5 × 2.5–3.8 cm, 1 to 1.2 times longer than wide, usually as wide as long, acute to bluntly acute at apex, occasionally narrowly rounded, broadest at base, markedly inequilateral, the inner side narrower, weakly rounded to acute toward base, briefly attenuate and decurrent onto petiole; outer side (2.1 to)3.2 to 4.4 times wider than inner side midway; all orders of venation narrowly sunken on upper surface, prominently raised on lower surface, granular-puberulent to minutely puberulent, rarely crispy-puberulent, darker than surface, drying ± raised, concolorous to weakly paler than surface; midrib round-raised and obtusely minutely many-ribbed on lower surface; **basal veins** 1 to 2 pairs, coalesced into a prominent posterior rib or loosely coalesced, with 4 to 5 branching off, 3 acroscopic, 1 to 2 basiscopic, the first free to the base, 3 to 4 fused into a short posterior rib 1–2 cm long; primary lateral veins 4 to 6 pairs, arising at 30°–60°, most acutely toward apex, weakly to moderately arcuate, occasion-

ally straight, round-raised on lower surface; collective veins 3, the innermost arising from one of the lowermost lateral veins on inner side of posterior lobe, loop-connected with all preceding lateral veins, moderately scalloped, 3–14 mm from margin, frequently markedly remote from margin (relative to blade size). INFLORESCENCES erect, 1 to 2 per axile; peduncle held within the sheath, 21–25 cm × 2–3 mm, as long as or longer than petiole, narrowing toward base, pale green, drying matte to weakly glossy, dark brown; **spathe** erect, ca. 8 cm long, cuspidate at apex, broadly funnel-shaped at anthesis; spathe tube pale green on outer surface, ca. 4 cm × ca. 6 mm, drying matte, medium-dark brown on outer surface, weakly glossy and weakly paler on inner surface, densely pale, punctiform; spathe blade white, ca. 4 cm × ca. 6 mm, opening broadly (to 1.3 cm wide) at anthesis, drying matte, medium-dark brown on outer surface, weakly glossy, weakly paler on inner surface, weakly and densely pale, punctiform; **spadix** erect, stipitate 1–1.5 mm, ca. 6.8 cm long, adnate to spathe ca. 1.9 cm at base, along stipe and to slightly more than 1/2 of the length of pistillate portion; pistillate portion green, 3.1 cm × 3 mm, weakly wider than thick, broadest above middle, drying pale to medium-dark tan; fertile staminate portion bright orange, 2.6 cm × 4 mm, bluntly acute at apex, broadest near base, weakly tapering, drying medium-dark orangish brown; sterile staminate portion ca. 1.1 cm × 2.5–3.5 mm, broadest at apex, drying medium orangish brown; pistils weakly coherent, ca. 3 across the axis (viewed from above), ca. 1.5 mm long; ovaries ± cylindrical (possibly subglobose), 0.8–1 × 2–2.5 mm, drying medium-dark brown; style Type 9 (Fig. 1), ca. 0.5 × 1.5–2 mm, comprising 1/3 or slightly less of the length of pistil, most margins weakly coherent with those of adjacent styles; **stigma** 0.5–0.7 mm diam., weakly elevated on and weakly broader than narrowed portion of style (on drying); synandria 1–1.2 × 2–2.2 mm, coherent, truncate, 3- to 4-lobed, 3- to 4-androus; sterile flowers 0.5–0.7 × 1–1.5 mm, weakly coherent, truncate, subprismatic, in 6 whorls. INFRUCTESCENCE medium green, ca. 5 cm × ca. 7 mm, drying matte, medium-dark brown on outer surface, moderately paler on inner surface; berries 2–3.5 mm diam., drying tan.

Phenology. Flowering in *Chlorospatha bogneri* is reported only for the months of June, July, and November. Inflorescences apparently emerge in slow progression, with several days between anthesis of one inflorescence and emergence of the next inflorescence at the apex of the petiole sheath. The

label notes for *Bittner 2493* state that black beetles pollinate this species.

Discussion. *Chlorospatha bogneri* is known only from La Planada Reserve in Nariño Department, in premontane wet forest on the Pacific slope in southern Colombia, at 1700–2050 m elevation and possibly occurs in northern Ecuador, along the border. *Chlorospatha bogneri*, a member of *Chlorospatha* sect. *Occidentales*, is a striking plant with markedly dark green, minutely rugose leaf blades with all orders of venation prominently raised, minutely puberulent to granular-puberulent on the lower surface and darker than the surface. The species is also distinguished by the petiole sheath, which occupies three fourths of to nearly the entire length of the petiole and is free-ending at the apex, conspicuously so when in flower. Commensurate with such extensive sheathing is the long peduncle that is as long as or longer than the petiole, a condition infrequently encountered in *Chlorospatha*. The bright orange synandria are known in only four other species in the genus, all of which occur in the frontier region along the border between Colombia and Ecuador, on the western slopes of the Andes: *C. besseae*, *C. dodsonii*, *C. litensis*, and *C. mansellii*.

Chlorospatha bogneri might be confused with only one species, *C. besseae*, also from the frontier region along the border between Colombia and Ecuador on the Pacific slope, but the latter is known only from Ecuador, at 550–814 m, well below the known elevation of *C. bogneri* (see discussion under *C. besseae*). The two species are possibly closely related.

Additional specimens examined. COLOMBIA. Nariño: La Planada, 7 km above Chucunés on Túquerres–Ricaurte rd., trail above La Posada bldg., 1780 m, 1°05'N, 78°01'W, 26 July 1988, *Croat 69556* (MO); La Planada, S of Ricaurte, 7 km from Tumaco–Pasto rd., 1800 m, 1°10'N, 77°58'W, 24 July 1986, A. Gentry, O. Benavides, G. Castillo & B. Ramirez 55072 (MO); Mpio. Ricaurte, Reserva La Planada, 1800 m, Borde Marcos, 15 Nov. 1993, *C. Restrepo 743* (MO).

8. *Chlorospatha boosii* Croat & L. P. Hannon, sp. nov. TYPE: Ecuador. Morona-Santiago: Limón–El Triunfo rd., 915 m, 3°01'15"S, 78°23'05"W, Mar. 1996, *Croat & L. P. Hannon 81478* (holotype, MO-04901597!; isotypes, AAU!, B!, BR!, CAS!, COL!, CUVCI!, F!, GB!, GH!, HUA!, INB!, K!, M!, MEXU!, NY!, P!, PMA!, QCA!, QCNE!, RSA!, UB!). Figure 9A–D.

Herba 30–50 cm; internodia 0.5–1.5(–2) × 1.7–3.5 cm; cataphylla 12–17 cm longa. Petiolus 24–46.5 cm longus; lamina foliaris ovata, (16–)19–27.5 × (7–)13–19.5 cm, lobis posterioribus (4.5–)6.5–11 × (3.5–)6.5–10 cm, nervis basalibus utroque 1 ad 3, nervis primariis lateralibus

utroque 3 vel 4. Inflorescentiae erectae, 4 ad 7 in quaque axilla; pedunculus 6–12 cm longus; spatha 8–14 cm longa, tubo 0.8–2.5 cm × 3–7 mm; spadix 5.6–6.9 cm longus.

Terrestrial herb, 30–50 cm tall; stem decumbent, erect to 15 cm, remnants of old leaf bases persisting as few short fibers at upper nodes, with bulbils produced randomly along its length; bulbils in rosette clusters of (1–)2–6, 2–5 × 2–4 mm, covered with brownish fibers; sap milky; internodes 0.5–1.5(–2) × 1.7–3.5 cm, weakly glossy to semiglossy, medium to dark green, becoming weakly scurfy and greenish tan with age, with nodes raised and scurfy, drying matte, medium greenish brown to brown; cataphylls quickly deciduous, 12–17 cm long, erect-spreading and loosely arranged, obtuse with acumen (acumen to 1 cm long) or cuspidate at apex, obtusely 1- to 2-ribbed abaxially, weakly glossy, pale green, occasionally irregularly weakly darker green-mottled in narrow transverse bands. LEAVES 8 to 12, erect, erect-spreading, spreading and reflexed-spreading; **petioles** 24–46.5 cm long, glabrous, matte to weakly glossy, medium to dark green, drying matte to weakly glossy, medium to dark green or greenish brown, sheathed 13–30 cm, (1/3 to) 1/2 to 2/3 of total length; sheath decurrent at apex, the sides 5–10 mm wide and spreading to 90° from petiole axis midway, appearing winged; free portion 4–6 mm diam. midway (drying 2–4.5 mm diam.), obtusely D-shaped, with margins becoming bluntly acute in apical 1/4, narrowly, acutely sulcate or bluntly sulcate; **blades** ± erect-spreading to drooping, ovate (occasionally subsagittate in juvenile plants), frequently subhastate on drying, cordate-subcordate at base, subcordate on drying, (16–)19–27.5 × (7–)13–19.5 cm, 1.3 to 1.9 times longer than wide, weakly acuminate or apiculate at apex, broadest at base, (1)1.1 to 1.2 times wider at base than across anterior lobe (measured tip to tip across posterior lobes), occasionally widest midway in juvenile plants, frequently weakly to moderately constricted on one side, occasionally on both sides, thin, moderately to prominently bicolorous; upper surface broadly quilted, velvety (matte-subvelvety), medium to dark green, drying matte to velvety-matte, dark green, frequently narrowly weakly paler along major veins; lower surface reticulate, narrowly minutely colliculate and matte along all venation, otherwise weakly glossy, drying weakly glossy to semiglossy, moderately to conspicuously paler, frequently narrowly and weakly paler along major veins; anterior lobe (14–)17–23.5 × (7–)11.5–17.5 cm, 1.3 to 1.5 times longer than wide, 2.1 to 2.6 times longer than posterior lobes, broadest at or near base, ± symmetrical; posterior lobes directed toward the base or somewhat outward, (4.5–)



Figure 9. A–C. *Chlorospatha boosii* Croat & L. P. Hannon from the type collection Croat & L. P. Hannon 81478 (MO). —A. Potted type plant showing habit. —B. Leaf blade, adaxial surfaces. —C. Close-up of inflorescence showing hooded, recurved spathe. —D. Close-up of inflorescence showing front view of inflorescence with slightly hooded spathe, from Croat & L. P. Hannon 81476 (MO paratype).

6.5–11 × (3.5–)6.5–10 cm, 1 to 1.3 times longer than wide, broadest and occasionally weakly constricted at base, bluntly to narrowly rounded at apex, markedly inequilateral, the inner side always narrower, ± rounded toward base and briefly attenuate onto posterior rib or decurrent onto petiole; outer side 2.5 to 3.5 times wider than inner side midway, ± straight toward base; midrib deeply sunken and concolorous on upper surface, round-raised on lower surface, matte, weakly paler to weakly darker than surface, drying raised, weakly to moderately darker than surface; **basal veins** 1 to 3 pairs, coalesced into a prominent posterior rib or weakly coalesced, with 4 to 8 branching off, 2 to 3 acroscopic, 3 to 4 basiscopic, the first free to the base (or not) and fused 1–5 mm to second and/or third, posterior rib naked 3–9 mm per side, rarely not at all, drying ± flattened, weakly darker than surface; primary lateral veins 3 to 4 pairs, arising at 25°–55°, most acutely toward apex, moderately arcuate, quilted-sunken and concolorous on upper surface, frequently drying weakly glossy, narrowly raised or round-raised and obtusely angular on lower surface, matte, concolorous to weakly paler or weakly darker than surface, drying ± flattened, concolorous to weakly darker than surface; secondary veins in part weakly sunken on upper surface, weakly raised and concolorous on lower surface, drying in part weakly raised, concolorous or weakly paler than surface; tertiary veins in part weakly raised, otherwise prominulous on lower surface, weakly darker than surface, drying mostly flat, distinct, and visible, weakly darker than surface; reticulate veins visible, distinct on lower surface, weakly darker than surface, drying visible, distinct, weakly darker than surface; collective veins 3, the innermost arising from apex of posterior rib, occasionally from uppermost lateral vein on inner side of posterior lobe, loop-connected with all preceding lateral veins, moderately scalloped, 5–10 mm from margin. **INFLORESCENCES** erect, 4 to 7 per axil, emitting a sweet fragrance at anthesis; sympodium held within a sympodial cataphyll; sympodial cataphyll 10–15 × 1–2.5 cm, acuminate at apex, 1- to 2-ribbed abaxially, medium green; inflorescence cataphyll 1- to 2-ribbed abaxially; peduncle 6–12 cm long, cylindroid, 3–5 mm thick, 2 mm wide, or ca. 5 mm diam. and obtusely D-shaped, acutely so near apex, matte to weakly glossy, pale-medium to medium green or yellow-green, drying 1–1.5 mm diam., matte to weakly glossy, medium to dark brown; **spathe** cucullate, frequently prominently so, medium yellow-green to dark green, 8–14 cm long, 2–4(–6) cm longer than spadix, lanceolate, gradually to abruptly acuminate at apex, opening narrowly most of its length at anthesis;

spathe tube matte on outer surface, semiglossy on inner surface, 0.8–2.5 cm × 3–7 mm, thicker than broad, drying 2–4 mm diam., matte (rarely weakly glossy), dark brown or greenish brown; spathe blade matte to weakly glossy, with veins prominulous on outer surface, semiglossy to glossy on inner surface, with veins sunken and weakly darker than surface, 5.5–8.2 cm × 5–7 mm, 2–2.3 cm wide (flattened), drying matte to weakly glossy, medium to medium-dark yellowish green to greenish tan on both surfaces, paler than tube, marcescent, erect after anthesis; **spadix** erect, 5.6–6.9 cm long, sessile, adnate to spathe 3–7 mm at base, 1/4 to ca. 1/2 of the length of pistillate portion; pistillate portion pale yellow to pale yellow-green, 1–1.5 cm × 3–3.5 mm, weakly broadest midway, drying tan; fertile staminate portion matte, whitish to cream, 3.4–4.5 cm × 3.5–4 mm, bluntly acute at apex, broadest near base, weakly tapering, drying brownish cream; sterile staminate portion matte, white to creamy white, 5–9 × 2.5–3 mm, broadest apically, drying brownish; pistils weakly coherent, 2 to 3 across the axis (viewed from above), ca. 1 mm long; ovaries ± cylindrical to obtusely obconical, broadly concave medially, greenish white to pale yellowish green, 1–1.5 mm diam., usually 2-locular with axile or subaxile placentation and 6 to 10 ovules per locule, rarely unilocular with subaxile placentation and 8 ovules, the axis intact; ovules hemianatropous, biseriolate; funicles shorter than ovules; style Type 1 (Fig. 1), ca. 1 mm diam., thin, weakly narrower than ovary, the margins distinct and visible; **stigma** white, cream or greenish, 0.3–0.4 mm diam., sessile, coronate, weakly broadest at apex; synandria ca. 1 mm long, 2–2.2 × 1–1.2 mm diam. and ± elongated in direction of axis, occasionally subrounded, occasionally highly bilaterally symmetrical, prominently and deeply (2)3- or 4-lobed (occasionally almost to the middle), coherent, broadly concave medially with lobes thickened, the margins sinuate-undulate and interlocking with margins of adjacent flowers, 3- to 4-androus, the thecae each with a terminal pore; pollen creamy white; sterile flowers ca. 1 mm long, 2–2.2 × 1.3–1.5 mm diam. and ± elongated in direction of axis, subprismatic to irregularly prismatic, densely arranged in 3 to 5 whorls, more laxly in basal whorl. Berries not known.

Phenology. Flowering occurs in *Chlorospatha boosii* only during the months of May through September. Sterile collections were made in March and later flowered in cultivation only during those months. Inflorescences are fragrant and emerge in quick succession, with each reaching anthesis approximately one to three days after anthesis of the preceding inflorescence.

Etymology. *Chlorospatha boosii* is named for Julius Boos (1946–2010), noted Trinidadian naturalist and expert on Araceae, whose unsolicited gift to the second author, of Madison's paper (1981), including his treatment of *Chlorospatha*, ultimately led to the preparation of this revision.

Discussion. *Chlorospatha boosii* is known from tropical moist forest and possibly either premontane moist forest or lower montane moist forest on the eastern slopes of the Andes, to the north and south of Limón in Morona-Santiago Province, Ecuador, at 500–944 m elevation. It is noteworthy that two collections were made on the eastern slopes of the Cordillera de Cutucú, near the border with Peru, suggesting the possibility that *C. boosii* is sympatric with *C. longipoda* and *C. pubescens* in that area. The species would be expected to occur elsewhere in Morona-Santiago and eastward into Peru, also to the south, in Zamora-Chinchipec Province.

Chlorospatha boosii, a member of *Chlorospatha* sect. *Orientalis*, is found in small colonies and is distinguished by its broadly quilted, velvety, medium to dark green, broadly ovate leaf blades that are cordate-subcordate at the base, with the posterior lobes broad, more or less rounded at the apex and approximately half as long as the anterior lobe. Although it is a robust plant with stems to 3.5 cm in diameter, it is no more than 50 cm tall and has numerous leaves (eight to 12) that are held erect, erect-spreading, spreading, and reflexed-spreading. The petiole is sheathed (one third to) one half to two thirds of its length, with the sheath distinctive in having sides 5–10 mm wide and broadly flaring (to 90°), thus appearing winged. The species is also distinguished by the absence of cataphylls when not in flower. The peduncles are moderately long (6–12 cm long) and the inflorescence the largest recorded for a species from the eastern slopes, 8–14 cm long. The spathe of *C. boosii* is entirely medium to dark green or yellow-green and moderately to occasionally prominently cucullate, in the latter instance seeming almost deformed, with the apical half of the blade doubled over the spadix and the apex directed downward. The staminate portion of the spadix is matte and cream-colored and the styles, pale yellow to pale yellow-green.

Chlorospatha boosii is probably most closely allied and most easily confused with *C. hannoniae*, with which it is sympatric in Morona-Santiago Province. The two species are similar in several respects, both being relatively short, but somewhat robust, plants with numerous leaves, similar leaf blades, and the same unusual petiole sheathing. The stems of *C. boosii* can be 1 cm wider, with bulbils usually in

clusters of two to six, differing from the usually solitary bulbils observed in *C. hannoniae*. In *C. boosii*, the upper surface of the leaf blade is broadly quilted and velvety, medium to dark green, differing from that of *C. hannoniae*, which is sub-bullate and weakly glossy, dark blackish green. The posterior rib is not naked in the latter species but is usually naked 3–9 mm on each side in *C. boosii*. The peduncle of *C. boosii* is entirely green and usually longer than that of *C. hannoniae*, which is purple-tinged green. The spathe and spadix of *C. boosii* are consistently and significantly longer than those of *C. hannoniae*. The spathe of *C. boosii* is entirely green and 8–14 cm long, with the spadix 5.6–6.9 cm long and adnate to the spathe one fourth to one half of the length of the pistillate portion. *Chlorospatha hannoniae* differs in having the spathe 4.5–6 cm long, the tube purple-tinged green, the blade dark maroon, and the spadix 3.8–5 cm long and adnate only narrowly at the base. The synandria and sterile flowers are matte in *C. boosii* and glossy in *C. hannoniae*. The ovaries in the latter species are white, with the style white and densely dark purple-speckled. The ovaries of *C. boosii* are greenish white to pale yellow-green, with the style pale yellow to pale yellow-green.

Chlorospatha boosii could possibly be confused with *C. longipoda*, which is widespread on the eastern slopes of the Andes in Ecuador, at 470–1700 m elevation, and is probably sympatric with this species in Morona-Santiago Province. *Chlorospatha boosii* is a more robust plant when mature, with stems to 3.5 cm diameter versus 1.3 cm diameter in mature specimens of *C. longipoda*, which retain the remnants of old cataphylls and petiole bases more or less intact, thus differing from *C. boosii* in which these are, for the most part, deciduous. *Chlorospatha longipoda* has three to five erect to erect-spreading leaves, differing from *C. boosii*, which has eight to 12 leaves, the newest erect to erect-spreading, eventually becoming reflexed-spreading as newer growth is made. The mature blades of the latter species are larger as well as wider, with the posterior lobes longer, the anterior lobe being ca. 2.1 to 2.6 times longer than the posterior lobes versus usually ca. 3.5 to 10 times longer in *C. longipoda*. *Chlorospatha boosii* has three or four pairs of primary lateral veins versus four to six pairs in *C. longipoda*. The petiole sheathing is distinctive in *C. boosii*, with the sides broad and flaring, appearing winged. In *C. longipoda*, the sides are narrow and in-rolled or erect with the margins in-rolled. Flowering has been reported in *C. longipoda* during various months and probably occurs throughout the year. Flowering is seasonal in *C. boosii*, occurring only from May through September. It is noteworthy that *C. boosii* usually produces cataphylls

only during the flowering cycle, thus differing from *C. longipoda*, which produces cataphylls with each new vegetative and sympodial growth.

Paratypes. ECUADOR. **Morona-Santiago:** Limón-Méndez rd., 938 m, *Croat & L. P. Hannon 81476* (MO); along Puerto Morona-Santiago rd., at Río Morona, near summit of hills, Km. 18 from Río Morona, 500 m, *Croat 87417* (MO, QCNE); along Santiago-Morona rd. at Río Morona, 23.4 km E of Santiago, 500 m, *Croat 87454* (MO, QCNE); along rd. betw. Santiago & Río Morona, 33.7 km E of Santiago, 523 m, *Croat, L. P. Hannon, G. Walther & K. Tuniak 90681* (MO, QCNE); Patuca-Santiago rd., Cordillera de Cutucú, 11.4 km E of Patuca turn-off on Macas-Limón rd., 5.1 km E of Patuca, 944 m, *Croat, L. P. Hannon, G. Walther & K. Tuniak 90610* (MO, QCNE).

9. *Chlorospatha bullata* Croat & L. P. Hannon, sp. nov. TYPE: Colombia. Valle: Finca Zigara, Elvira distr., Km. 18 on Cali-Buenaventura hwy., Km. 4 via Dapa, 1900 m, 3°30'N, 76°34'W, 2-3 Apr. 1994, *J. Giraldo & C. Espinosa 255* (holotype, MO-05071721!); isotypes, CUVIC not seen, TULV not seen). Figure 8C, D.

Herba usque ad 40 cm; internodia (1-)1.5-4 × 0.8-2.5 cm; cataphylla 6-13.5 cm longa. Petiolus (13-)16-34 cm longus; lamina foliaris sagittata, anguste ovato-sagittata vel ovato-sagittata vel anguste triangularis, 16.5-28 × (5.5-)7-13 cm, lobis posterioribus (5-)7-10.5 × (2.5-)2.8-6 cm, nervis basalibus utroque 2 ad 4, nervis primariis lateralibus utroque 3 ad 5. Inflorescentiae erectae, 2 in quaque axilla; pedunculus 8-12 cm longus; spatha erecta, 5.2-8 cm longa; spadix 4.5-6.2 cm longus.

Terrestrial herb, to 40 cm tall; stem decumbent, to 1.5 m long, erect at apex, remnants of old leaf bases and cataphylls persisting intact to semi-intact along its length, rarely weakly fibrous; sap translucent white; internodes (1-)1.5-4 × 0.8-2.5 cm, semiglossy, medium green, drying weakly glossy to semiglossy, medium to dark brown or grayish brown (all measurements made from dried material); cataphylls 6-13.5 cm long, obtuse with acumen at apex (acumen to 3 mm long), drying semiglossy to glossy, rarely weakly glossy, medium-dark reddish brown, weakly fibrous. LEAVES 2 to 4, erect-spreading; **petioles** (13-)16-34 cm long, moderately spongy, glabrous, dark green, ± purple-tinged, drying weakly glossy to semiglossy, dark brown, occasionally almost black, sheathed 8-13 cm, ca. 1/3 of total length (ca. 1/4 of length on foliage leaves); sheath decurrent at apex, rarely free-ending; free portion 2-4 mm diam. midway, terete; **blades** sagittate, narrowly ovate-sagittate or ovate-sagittate or narrowly triangular, somewhat elliptical in larger specimens, 16.5-28 × (5.5-)7-13 cm, 1.5 to 2.5 (to 3) times longer than wide, narrowly acuminate at apex, usually broadest midway, occasionally broadest at

base, weakly or not at all constricted in area of petiole attachment, thin, moderately bicolorous; upper surface minutely bullate, matte, dark green, drying minutely bullate, matte (rarely weakly glossy), dark green to brownish green; lower surface prominently reticulate, with areoles deeply sunken, rarely purplish, drying densely reticulate, weakly glossy to semiglossy (rarely matte), weakly to moderately paler, occasionally weakly gray-tinged, rarely weakly purplish; anterior lobe 11-17.4 × 5.5-13 cm, 1.5 to 2 (to 2.2) times longer than wide, 1.5 to 2 (to 2.5) times longer than posterior lobes, broadest at or near base, occasionally midway, ± symmetrical; posterior lobes directed somewhat outward, (5-)7-10.5 × (2.5-)2.8-6 cm, 1.6 to 2.5 times longer than wide, narrowly rounded to occasionally bluntly rounded at apex, usually broadest at base, moderately to markedly inequilateral, the inner side narrower, frequently overlapping with that of opposite lobe, ± rounded toward base, briefly to gradually attenuate and decurrent onto petiole, possibly weakly confluent with opposite lobe, the confluent portion obscuring apex of petiole; outer side 1.7 to 3.8 times wider than inner side midway, ± straight or weakly concave to convex toward base; all orders of venation narrowly sunken on upper surface, usually drying weakly glossy and weakly paler than surface (creating a fine, netlike pattern), prominently raised and granular-puberulent on lower surface; midrib round-raised on lower surface, paler than surface, drying raised to weakly flattened, concolorous to weakly paler than surface, rarely weakly darker; **basal veins** 2 to 4 pairs, coalesced into a prominent posterior rib; primary lateral veins 3 to 5 pairs, arising at 30°-85°(-90°), frequently markedly arcuate, occasionally weakly arcuate or irregularly ascending (rarely straight), round-raised to convex on lower surface, paler than surface, drying raised to weakly flattened, concolorous to weakly paler than surface, rarely weakly darker; minor venation drying raised on lower surface, concolorous to weakly paler than surface; collective veins 3 to 4, the innermost arising from one of the basal veins on outer side of posterior lobe (usually the uppermost) or from apex of posterior rib, loop-connected with all preceding lateral veins, rarely with the 2 primary lateral veins toward the apex (of anterior lobe) disconnected and markedly arcuate to the margin at the apex or onto the midrib, ± scalloped, occasionally markedly scalloped, 0.3-1.7 cm from margin. INFLORESCENCES erect, 2 per axil; peduncle held within the sheath, 8-12 cm × 1 mm, glabrous, medium green, weakly irregularly darker-mottled in narrow transverse bands, drying weakly glossy, medium to dark brown; **spathe** erect,

5.2–8 cm long, acuminate at apex, the margins in-rolled in apical 3 mm; spathe tube medium green on outer surface, 2.5–4 cm \times 2–5 mm, drying matte to weakly glossy, dark brown on outer surface, weakly glossy and weakly paler on inner surface; spathe blade white, 2.7–4 cm long, 1.5 cm wide (flattened), drying weakly glossy, medium to medium-dark reddish brown on both surfaces, weakly paler than tube, marcescent, erect after anthesis; **spadix** erect, 4.5–6.2 cm long, sessile, adnate to spathe 2.2–2.4 cm at base, the entire length of pistillate portion and to 2 mm of sterile staminate portion; pistillate portion purplish, 2–2.2 cm \times 2–3 mm; fertile staminate portion creamy white, 1.9–3 cm \times 2.5–4.5 mm, narrowly rounded to bluntly acute at apex, \pm cylindrical or tapering, drying dark brown; sterile staminate portion 0.6–1.2 cm \times ca. 1.7 mm, \pm cylindrical, drying medium to dark brown; pistils weakly coherent, ca. 3 across the axis (viewed from above), ca. 1.2–1.75 mm long; ovaries subglobose, 1–1.2 \times 1.5–2 mm, drying medium to dark tan; style Type 9 (Fig. 1), ca. 0.6 \times ca. 1–2 mm, comprising ca. 1/3 of the length of pistil, most margins weakly coherent with those of adjacent styles; **stigma** weakly elevated on style, drying tan; synandria 1–1.2 \times 1–1.5 mm, coherent, truncate, deeply 3- to 4-lobed, 3- to 4-androus (mostly 4); sterile flowers less than 1 mm long, 1.2–2 \times 1 mm diam. and \pm elongated in direction of axis, irregularly lobed (margins narrowly sinuate), laxly arranged to weakly coherent, in 3 to 5 whorls. Berries not known.

Phenology. Flowering is only known to occur in *Chlorospatha bullata* during the months of April and July.

Etymology. The epithet of the new species is taken from the Latin “bullatus,” meaning “bullate,” “blistered,” or “puckered.”

Discussion. *Chlorospatha bullata* is known only from premontane rainforest, premontane moist forest, and possibly either premontane wet forest or lower montane wet forest on the eastern and western slopes of the Cordillera Occidental in Valle Department, Colombia, at 1020–2000 m elevation.

Chlorospatha bullata is a member of *Chlorospatha* sect. *Occidentales* and is distinguished by its moderately long internodes, purple-tinged petioles, and thin, sagittate, narrowly ovate-sagittate, or triangular leaf blades that are matte and minutely bullate on the upper surface and densely reticulate, with deeply sunken areoles on the lower surface, which is usually green but can rarely be purplish. The blades dry green, with all venation paler than the

upper surface and the surface itself rough to the touch, a condition not observed in any other species. It is also distinguished by its short peduncle and small inflorescence with purplish styles.

Chlorospatha bullata could not be easily confused with any species, but could possibly be confused with *C. congensis* from Cauca Department in southern Colombia (see discussion under *C. congensis*).

Paratypes. COLOMBIA. **Valle:** along Calí–Buenaventura hwy. at Km. 20.5, just beyond summit of rd. W of Diez y Ocho, 1930–2000 m, *Croat 38533A* (MO); near Queremal, Estación Microndas Tokio, along old rd. to Buenaventura, *Croat 50130* (MO), *50189* (MO); vic. Dapa, NW of Calí, along Continental Divide, 2000 m, *Croat 61421* (MO); along gravel rd. from Km. 18 on Calí–Buenaventura hwy. to Dapa, 1020 m, *Croat & J. Watt 70520* (CUVC, MO); Calí–Buenaventura Hwy., Km. 29, 1 km E of turnoff to Queremal, 1900 m, 3°30'50"N, 76°36'30"W, 10 July 1997, *Croat & J. Gaskin 79637* (CUVC, MO); La Cumbre, W Cordillera, 1700–2100 m, 9, 11 & 18 Sep. 1922, *T. Hazen & E. Killip 11153* (GH, NY, US).

10. *Chlorospatha caldasensis* Croat & L. P. Hannon, sp. nov. TYPE: Colombia. Caldas: Manizales, Monte León, Cordillera Central, 2250 m, 12 May 1984, *M. de Fraume & A. Gallego 215* (holotype, MO-3400353!; isotype, FAUC not seen). Figure 10A.

Herba 1.8–2 m; internodia 1.5–2 \times 1.5–1.8 cm. Petiolus ultra 40 cm longus; lamina foliaris profunde 5-loba, ca. 42 \times 42 cm, lobo medio ca. 30 \times 17 cm, confluenta cum lobis lateralibus, nervis primariis lateralibus utroque ca. 5. Inflorescentiae erectae, 1 in quaque axilla; pedunculus ca. 28 cm \times ca. 2 mm; spathae tubo ca. 6.5 cm \times 7 mm.

Terrestrial herb, 1.8–2 m tall; stem with remnants of old cataphylls persisting as numerous linear fibers at upper nodes; internodes 1.5–2 \times 1.5–1.8 cm, drying matte, dark brown (all measurements made from dried material); cataphylls (total length and apex not known) more than 25 cm long, drying semi-intact, moderately fibrous, semiglossy, medium reddish brown. LEAVES 2; **petioles** (total length not known) more than 40 cm long, brown, glabrous, drying weakly glossy to semiglossy, medium to dark reddish brown, weakly fibrous (fibers paler), sheathed ca. 30 cm; sheath apex not known; free portion 2–3 mm diam. midway; **blades** deeply 5-lobed, ca. 42 \times ca. 42 cm, as long as wide, drying thinly coriaceous, moderately bicolorous; upper surface brown, white maculate, drying weakly glossy to semiglossy, dark brown, the maculations not visible (on drying); lower surface drying semiglossy; **medial lobe** in part known, ca. 30 \times 17 cm, 1.8 times longer than wide, about same length as innermost lateral lobes, apex not known, weakly broadest above middle, promi-

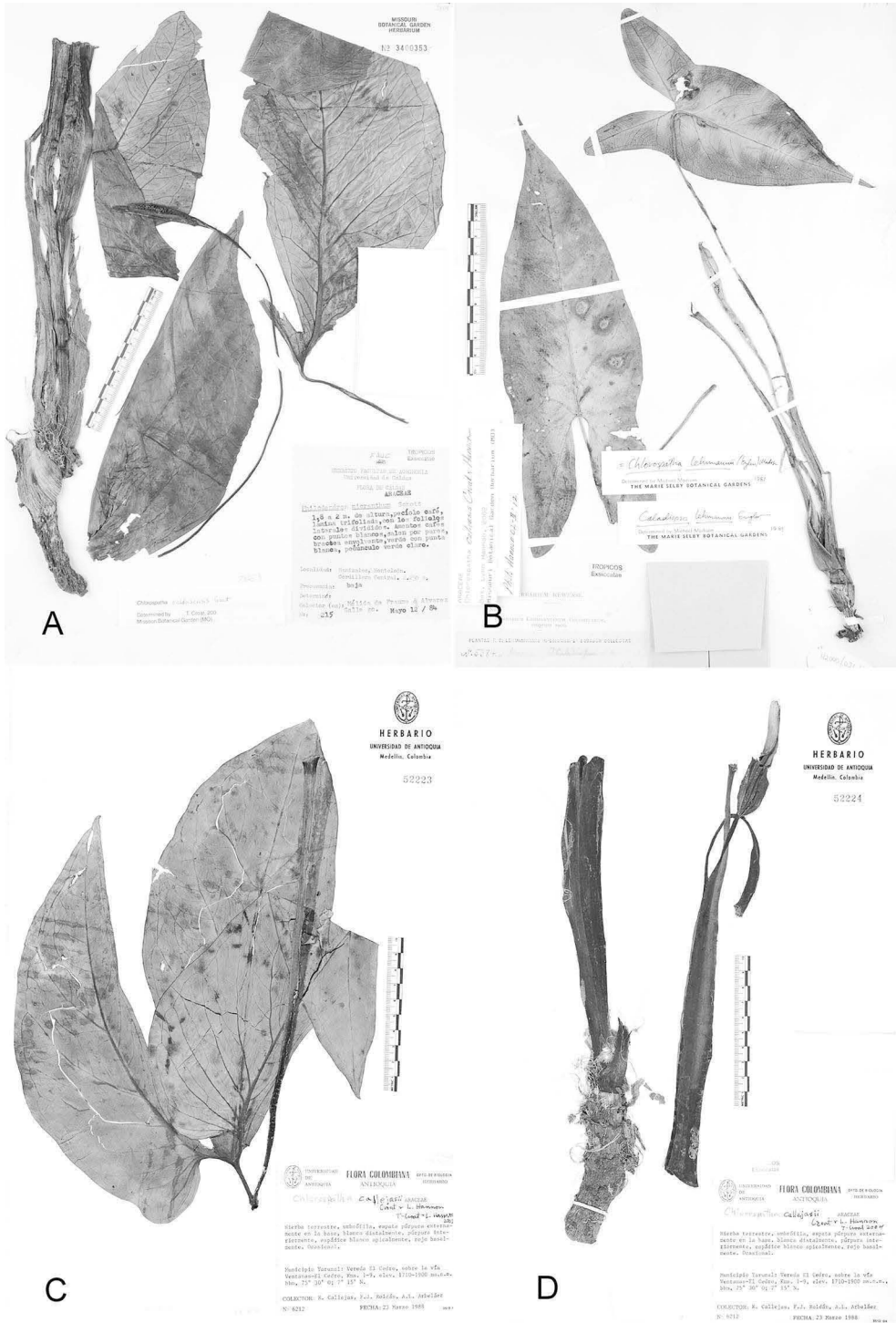


Figure 10. —A. *Chlorospatha caldasensis* Croat & L. P. Hannon, Fraume & Gallego 215 (MO holotype). —B. *Chlorospatha caliensiensis* Croat & L. P. Hannon, Lehmann 5384 (K holotype). C, D. *Chlorospatha callejasii* Croat & L. P. Hannon, Callejas et al. 6212 (HUA holotype, two sheets). —C. Leaf blade. —D. Stem with petiole and inflorescence.

nently attenuate toward and narrowly attached at base, ca. 2 cm wide at point of attachment; **lateral lobes** confluent with all adjacent lobes, the confluent portion 1.5–2.5 cm wide; innermost segment ca. $30 \times$ ca. 14 cm, apex not known, 2.1 times longer than wide, broadest midway, narrowly attached at base, ca. 2.5 cm wide at point of attachment, moderately inequilateral, the inner side narrower, \pm straight toward base; outer side to 1.5 times wider than inner side midway, \pm acute toward base; outermost segment ca. 20×10 cm, ca. 2 times longer than wide, bluntly acute at apex, broadest below middle, narrowly attached at base, ca. 2 cm wide at point of attachment, inequilateral, the inner side narrower, weakly attenuate toward base; outer side to 2 times wider than inner side midway, \pm acute toward base, narrowly attenuate onto posterior rib; all venation (except reticulate) drying glabrous or in part weakly granular-puberulent on lower surface; midrib and major veins round-raised on lower surface, drying \pm flattened, much darker than surface, almost black; posterior rib naked 2–3 cm per side; primary lateral veins (on medial lobe) ca. 5 pairs, arising at 30° – 40° , \pm straight; primary lateral veins (on lateral lobes) 7 to 8 pairs on innermost segment, arising at 40° – 50° , \pm straight, 5 pairs on outermost segment, arising at 20° – 40° , \pm straight; secondary veins drying raised on lower surface, moderately darker than surface; tertiary veins drying in part prominulous on lower surface, otherwise flat, moderately darker than surface; reticulate veins drying in part visible on lower surface, weakly darker than surface; collective veins 3, the innermost arising from lowermost lateral vein at the base, loop-connected with all preceding lateral veins, markedly scalloped on all segments, 0.8–2 cm from margin. INFLORESCENCE erect, 1 per axil; peduncle held within the sheath, 28 cm \times ca. 2 mm, pale green, drying weakly glossy, dark blackish brown; **spathe** (total length not known); spathe tube green, 6.5 cm \times ca. 7 mm, drying matte, blackish brown on outer surface, weakly glossy on inner surface, paler and densely tan, punctiform (speckles regularly rounded, appearing as subepidermal cellular inclusions); spathe blade white, otherwise not known; **spadix** erect, total length not known, sessile, adnate to spathe ca. 3 cm at base, ca. 1/2 of the length of pistillate portion; pistillate portion 5.5 cm \times ca. 5 mm, broadest midway, drying dark reddish brown; fertile staminate portion not known; sterile staminate portion in part known, ca. 2.5 mm diam. at base, drying orangish tan; pistils weakly coherent, 3 to 5 across the axis (viewed from above), 1.5–2 mm long; ovaries \pm cylindrical to obtusely conical, 1.5–2 mm diam., drying medium brown with

darker veins; style Type 3 (Fig. 1), 1–1.5 mm diam.; **stigma** sessile, ca. 3 mm diam.; synandria not known; sterile flowers in part known, ca. 1 mm long, 2×1 mm diam. and elongated in direction of axis, coherent, truncate, irregularly subprismatic. Berries not known.

Phenology. Flowering in *Chlorospatha caldasensis* is known from a single collection that flowered in the month of May.

Etymology. *Chlorospatha caldasensis* is named for Caldas Department, Colombia, in which the type of the new species was collected.

Discussion. *Chlorospatha caldasensis* is known only from the type collection made in lower montane wet forest on the western slopes of the Cordillera Central in Caldas Department, Colombia, at 2250 m elevation. *Chlorospatha caldasensis* is a member of *Chlorospatha* sect. *Chlorospatha* and is unique in the genus in having brown and functional leaves on the living plant. The species is distinguished by its deeply 5-lobed, white maculate leaf blades that are broadly confluent between all segments and dry semiglossy on the lower surface, with the major venation almost black. The species is also distinguished by its relatively long pistillate spadix, 5.5 cm long.

Chlorospatha caldasensis could be confused with *C. luteynii*, which occurs at similar elevations to the north, in the Cordillera Central in Antioquia Department, Colombia (see discussion under *C. luteynii*). *Chlorospatha caldasensis* is a larger plant, 1.8–2 m tall, compared to *C. luteynii*, which is about 1 m tall. The leaves of the latter species are green, with pale yellowish green maculate and dark green blades, differing from those of *C. caldasensis*, which are brown with white maculae. There are four or five pairs of primary lateral veins on the innermost lateral segments of *C. luteynii* versus seven or eight pairs in *C. caldasensis*. The petiole of the latter species dries intact, weakly fibrous, and medium-dark brown, whereas that of *C. luteynii* dries almost black, with the epidermis partially separated, semi-transparent, and semiglossy. The spathe of the latter species is entirely pale green, differing from that of *C. caldasensis*, which has a green tube and white blade.

Grayum (1986) predicted that *Chlorospatha croatiana* subsp. *croatiana*, known only from Central America, at 200–1173(–1400) m elevation, would ultimately be found in Colombia, and although that species and *C. caldasensis* have 5-lobed leaf blades, *C. caldasensis* should be considered distinct (see discussion under *C. croatiana* subsp. *croatiana*). It

differs from *C. croatianana* subsp. *croatianana* in having brown leaves with white maculae in living material. A sterile collection of what is presumably *C. croatianana* subsp. *croatianana*, made in Costa Rica, is the only collection of this taxon known to have maculate blades and only one blade is weakly pale yellow maculate, the other blades being entirely green. However, maculations are not a consistent character in some species of *Chlorospatha* and occasionally are not visible on drying. Numerous specimens of the latter species were examined in the course of this treatment and the spadices were consistently comparatively short, 3.9–8 cm long. The longer pistillate spadix of *C. caldasensis* would suggest total spathe and spadix lengths are significantly greater than those found in *C. croatianana* subsp. *croatianana*. This holds true also for *C. croatianana* var. *enneaphylla*, a 5- to 9-lobed taxon that occasionally has maculate leaf blades; however, none of the Colombian collections of variety *enneaphylla* are less than 7- to 9-lobed (see discussion under *C. croatianana* var. *enneaphylla*).

11. *Chlorospatha caliensis* Croat & L. P. Hannon, sp. nov. TYPE: Colombia. Valle: W Andes of Cali, 1800–2200 m, s.d., *C. Lehmann 5384* (holotype, K!). Figure 10B.

Herba minus quam 50 cm; internodia 0.9–1.7 cm × 5–8 mm; cataphylla ca. 10–13 cm longa. Petiolus 29.5–33.3 cm longus; lamina foliaris triangulo-sagittata vel sagittata, 18–26.3 × 7.5–9.5 cm, lobis posterioribus (6–)6.8–9 × 2.5–3.5 cm. Inflorescentiae erectae, 2 in quaque axilla; pedunculus 9–13.5 cm × ca. 1.5 mm; spatha erecta, ca. 7.3 cm longa, tubo ca. 3.6 cm × 4.5 mm, lamina ca. 3.7 cm × 6 mm; spadix erectus, ca. 6.5 cm longus.

Terrestrial herb, less than 50 cm tall; stem with remnants of old cataphylls persisting ± intact at upper nodes; internodes 0.9–1.7 cm × 5–8 mm, drying wrinkled, weakly glossy, pale tan (all measurements made from dried material); cataphylls ca. 10–13 cm long (apex not known), drying semi-glossy, medium reddish brown. LEAVES 2 to 3, erect-spreading; **petioles** 29.5–33.3 cm long, drying glabrous, weakly glossy, medium reddish brown, sheathed ca. 12 cm, less than 1/2 of total length; sheath decurrent at apex; free portion ca. 2 mm diam. midway, possibly flattened adaxially, with medial rib; **blades** triangular-sagittate to sagittate, 18–26.3 × 7.5–9.5 cm, 1.9 to 3.5 times longer than wide, long-acuminate at apex, broadest at base, 1 to 1.3 times wider at base than across anterior lobe (measured tip to tip across posterior lobes), weakly or not at all constricted in area of petiole attachment, drying thin, weakly bicolorous; upper surface drying matte, discolorous, weakly medium pinkish tan along major

veins, otherwise darker medium brown; lower surface drying weakly glossy, discolorous, pinkish tan along major veins, otherwise darker, weakly pink-tinged brown; anterior lobe 12.7–18.5 × 6.6–8.2 cm, 1.9 to 2.3 times longer than wide, 2 to 2.2 times longer than posterior lobes, broadest near base; posterior lobes directed toward the base or weakly outward, (6–)6.8–9 × 2.5–3.5 cm, 2.3 to 2.7 times longer than wide, narrowly rounded to bluntly rounded at apex, broadest at or near base, moderately inequilateral, the inner side narrower, ± rounded toward base and briefly attenuate onto posterior rib; outer side 1.5 to 2 times wider than inner side midway; midrib and major venation drying raised on lower surface, weakly darker than surface; midrib round-raised on lower surface; **basal veins** 3 pairs, coalesced into a prominent posterior rib; posterior rib naked 6–7 mm per side; primary lateral veins 4 to 6 pairs, arising at 35°–45°, most acutely toward apex, moderately arcuate; secondary veins drying raised on lower surface, weakly darker than surface; tertiary veins drying in part raised, otherwise prominulous on lower surface, weakly darker than surface; reticulate veins drying in part prominulous on lower surface, otherwise visible, flat, weakly darker than surface; collective veins 4, the innermost arising from one of the lateral veins on inner side of posterior lobe, ± scalloped, 4–8 mm from margin. INFLORESCENCES erect, to 2 per axil; peduncle held within the sheath, 9–13.5 cm × 1.5 mm, drying pale tan; **spathe** erect, 7.3 cm long, cuspidate at apex; spathe tube 3.6 cm × 4.5 mm, drying matte, pale tan on outer surface; spathe blade 3.7 cm × ca. 6 mm, drying matte, pale tan on both surfaces, marcescent, erect after anthesis; **spadix** erect, 6.5 cm long, sessile, adnate to spathe ca. 3 cm at base, the entire length of pistillate portion and narrowly onto sterile staminate portion; pistillate portion 2.8 cm × ca. 2 mm, drying medium brownish; fertile staminate portion 2.2 cm × ca. 2 mm, abruptly acute at apex, ± cylindrical, drying dark reddish brown, weakly paler at apex; sterile staminate portion ca. 8 × 1.5–2 mm, broadest apically, with axis naked 1 mm at base, drying dark reddish brown; pistils weakly coherent, 2 to 3 across the axis (viewed from above), 2.2–3 mm long; ovaries subglobose, obtusely truncate at apex, 1–1.2 × ca. 2 mm, drying cream-colored, with numerous brown veins; style Type 7 (Fig. 1), 2 × ca. 1–1.3 mm, comprising 1/2 to 2/3 of the length of pistil, the margins probably ± coherent with those of adjacent styles; **stigma** ± capitate, markedly elevated on style; **synandria** ca. 1 × 1–1.2 mm, coherent, truncate, deeply (2)3- to 4-lobed, (2)3- to 4-androus; sterile flowers 1–1.5 × ca. 1 mm, weakly coherent and irregularly branched in apical 2

whorls, laxly arranged and fungiform (like toadstools) in basal whorls, in 4 to 5 whorls. Berries not known.

Phenology. Flowering is only known to occur in *Chlorospatha caliensis* sometime between July and March.

Etymology. *Chlorospatha caliensis* is named for the city of Cali, Colombia, mentioned on the label notes of the single collection of the new species.

Discussion. *Chlorospatha caliensis* is known only from the type, a single specimen collected by Lehmann, in what is probably either premontane wet forest or lower montane wet forest on the western slopes of the Cordillera Occidental in Valle Department, Colombia, at 1800–2200 m elevation. Although no date is indicated for the collection, Lehmann died in 1903; therefore, the collection was made in or prior to 1903.

Chlorospatha caliensis is a member of *Chlorospatha* sect. *Occidentales* and is distinguished by its triangular-sagittate to sagittate leaf blades that dry thin and discolorous pinkish tan along the major veins on both surfaces, with the posterior lobes more or less rounded at the apex. All venation dries either raised or prominulous on the lower surface, with most reticulate venation prominulous but with some veins flattened. The species is also distinguished by its short peduncle (9–13.5 cm long), small inflorescence with the spathe less than 8 cm long, and its prominently attenuated style that comprises one half to two thirds of the length of the pistil.

Chlorospatha caliensis could possibly be confused with *C. lehmannii*, which also occurs on the western slopes in Colombia but to the south in Cauca Department. *Chlorospatha lehmannii* differs in having a free-ending petiole sheath and coriaceous, subhastate leaf blades that dry matte on both surfaces, with all venation except the midrib flattened on the lower surface, and the posterior lobes longer (3 or 4 times longer than wide) and acute at the apex. In *C. caliensis*, the sheath is decurrent and the blades sagittate, drying thin and weakly glossy on the lower surface, with most venation raised or prominulous and the posterior lobes less than 3 times longer than wide and more or less rounded at the apex. The blades of *C. caliensis* dry discolorous pinkish tan along the major veins on both surfaces, otherwise medium brown, whereas those of *C. lehmannii* dry dark brown on the upper surface, moderately paler on the lower surface, and not at all discolorous on either surface. The peduncle of *C. lehmannii* is 20–27 cm long and the spathe, 10.5–11 cm long, whereas in *C. caliensis*, the peduncle is less than 14 cm long and

the spathe, less than 8 cm long. The fertile staminate portion of the spadix is cylindrical and only 2.2 cm long in *C. caliensis* and the pistillate portion is also short, 2.8 cm long, with weakly coherent pistils. In *C. lehmannii*, the fertile staminate portion is clavate and more than 3 cm long and the pistillate portion is more than 3 cm long, usually about 5 cm long, with laxly arranged pistils. The synandria of *C. caliensis* are 2- to 4-androus and dry dark, purplish brown, differing from those of *C. lehmannii*, which are 3- to 5-androus and dry medium grayish brown.

Chlorospatha caliensis might be confused with *C. congensis* from Cauca Department, Colombia, which has similarly shaped leaf blades and short peduncles but differs in having blades that dry subcoriaceous and weakly bullate on the upper surface, not at all discolorous on either surface and posterior lobes that are decurrent onto the petiole. In *C. caliensis*, the blades dry thin and smooth on the upper surface and discolorous on both surfaces, with the posterior rib naked. *Chlorospatha congensis* differs also in having the midrib and major and secondary veins wrinkled and more prominently raised on the lower blade surface. The venation is not wrinkled in *C. caliensis*. The style of *C. caliensis* (Type 7, Fig. 1) comprises one half to two thirds of the length of the pistil, differing from that of *C. congensis* (Type 10, Fig. 1), which comprises only one third of the length. The sterile flowers of the latter species are subprismatic, differing from the somewhat fungiform to irregularly branched flowers found in *C. caliensis*.

12. *Chlorospatha callejasii* Croat & L. P. Hannon, *Aroideana* 27: 11. 2004. TYPE: Colombia. Antióquia: Mpio. Yarumal, vic. El Cedro, betw. Ventanas & El Cedro, Km. 1–9, 1710–1900 m, 7°15'N, 75°30'W, 23 Mar. 1988, R. Callejas, F. Roldán & A. Arbeláez 6212 (holotype, HUA sheet 1: HUA-52223 and sheet 2: HUA-52224!). Figures 10C, D, 11A.

Terrestrial herb, ca. 1 m tall; stem with remnants of old cataphylls persisting in part semi-intact at upper nodes, otherwise as pale, reddish brown, linear fibers (all measurements made from dried material); internodes 1.5–2.5 × 1.5–2.5 cm, drying weakly glossy, medium-dark brown; cataphylls not known. LEAVES 2, probably erect-spreading; **petiole** 82.5 cm long, drying glabrous, weakly glossy, dark reddish brown, almost black, sheathed 45 cm, slightly more than 1/2 of total length; sheath decurrent at apex; free portion ca. 5 mm diam. midway; **blade** deeply 3-lobed, nearly trisect, ca. 33 × ca. 30 cm, 1.1 times longer than wide, drying thinly coriaceous, weakly bicolorous; upper surface green, drying matte-

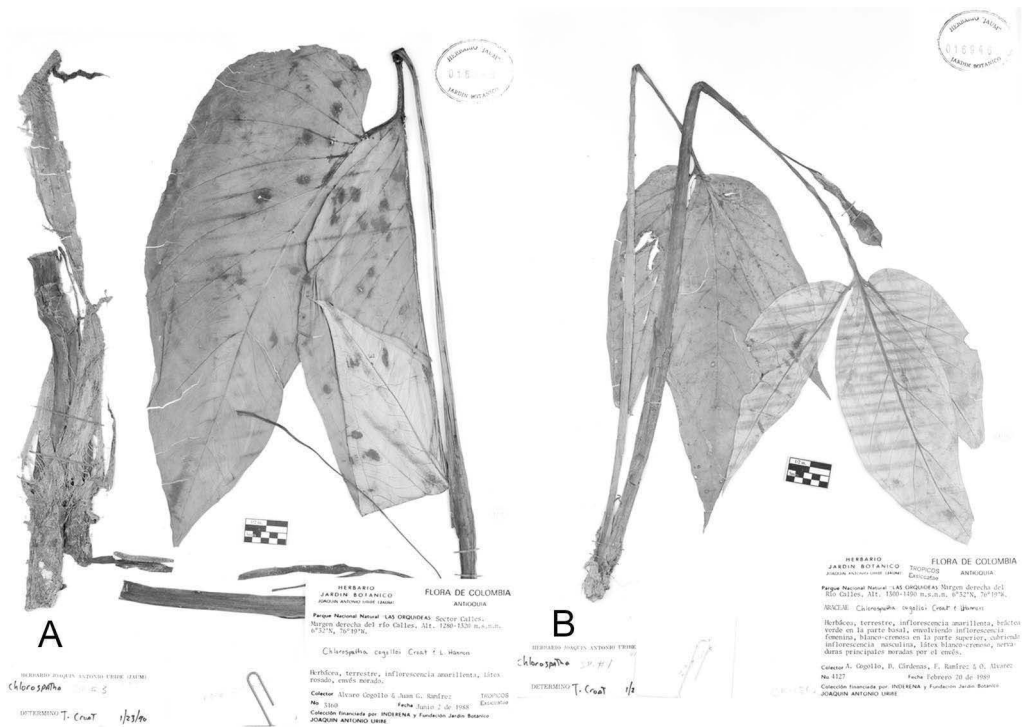


Figure 11. —A. *Chlorospatha cogolloi* Croat & L. P. Hannon, the paratype *Cogollo & Ramírez 3160* (JAUM-16943). —B. *Chlorospatha cogolloi*, the paratype *Cogollo et al. 4127* (JAUM-16946).

subvelvety, weakly green-tinged, dark reddish brown; lower surface drying semiglossy; **medial lobe** 29.5 × 12 cm, 2.5 times longer than wide, acute at apex, broadest at or above middle, 1.1 to 1.2 times longer than lateral lobes, cuneate and broadly attached at base, ca. 3 cm. wide at point of attachment, weakly inequilateral; **lateral lobes** weakly falcate, directed toward apex, 24.5–28 × 8.5–9.2 cm, 3 times longer than wide, acute at apex, broadest below middle, markedly inequilateral, the inner side always narrower, weakly attenuate to long-attenuate toward base, narrowly confluent with medial lobe, the confluent portion ca. 4 mm wide; outer side 3.2 to 4.8 times wider than inner side midway, moderately to narrowly rounded at base, briefly attenuate onto posterior rib; midrib and major venation convex on lower surface, drying ± flattened, much darker than surface, almost black; posterior rib naked 1–1.5 cm per side; primary lateral veins (on medial lobe) 5 pairs, arising at 35°–45°, weakly arcuate; primary lateral veins (on lateral lobes) 9 to 11 pairs, arising at 40°–120°, weakly arcuate, aggregated toward the base, the basal 3 fused near base; secondary veins drying in part weakly raised, otherwise prominulous on lower surface, much darker than surface; tertiary and reticulate veins drying weakly prominulous on

lower surface, weakly darker than surface; collective veins 3, the innermost arising from one of the lowermost lateral veins at the base, loop-connected with all preceding lateral veins, moderately scalloped, 5–10 mm from margin. INFLORESCENCES erect, to 2 per axil; peduncle held within the sheath, 46 cm × 2–3 mm, drying weakly glossy, blackish brown; **spathe** erect, ca. 9 cm long, apex not known; spathe tube dark purple on both surfaces, 4.2 cm × 7 mm, drying weakly glossy, weakly purple-tinged dark brown on both surfaces; spathe blade white, ca. 4.5 cm × 8 mm, drying matte, pale tan, marcescent, erect after anthesis; **spadix** erect, 8.2 cm long, sessile, adnate to spathe ca. 1.5 cm at base, ca. 1/2 of the length of pistillate portion; pistillate portion red, 3.6 cm × 3–4 mm, broadest below middle; fertile staminate portion white, 3.2 cm × 3.5–6 mm, broadest near base, weakly tapering, narrowly rounded at apex, drying medium yellowish brown; sterile staminate portion 1.4 cm × ca. 3 mm, ± cylindrical, drying medium-dark reddish brown, weakly darker than fertile staminate portion; pistils ± densely arranged, 4 across the axis (viewed from above), ca. 1 mm long; ovaries cylindrical, 1–1.5 × 1–1.5 mm, drying dark tan with darker veins; style Type 3 (Fig. 1), 1–1.5 mm diam., the margins not

coherent with those of adjacent styles; **stigma** sessile, ca. 0.2 mm diam., \pm capitate; synandria ca. $1 \times$ ca. 1.5 mm, coherent, truncate, deeply 3- to 4-lobed, 3- to 4-androus; sterile flowers ca. 0.5 mm long, $2-3 \times 1$ mm diam. and markedly elongated in direction of axis, coherent, truncate, irregularly prismatic to subprismatic, in 5 whorls. INFRUCTESCENCE (immature) 5.5 cm \times 8 mm, drying matte, blackish brown; berries not known.

Phenology. Flowering is only known to occur in *Chlorospatha callejasii* in the month of March.

Discussion. *Chlorospatha callejasii* is known only from the type collection made in premontane wet forest near Yarumal in Antióquia Department, Colombia, at 1710–1900 m elevation in the region of the Magdalena River drainage at the northern end of the Cordillera Central. The species is a member of *Chlorospatha* sect. *Chlorospatha* and is distinguished by its entirely green, nearly trisect leaf blades that dry matte-subvelvety, dark reddish brown on the upper surface and glossy below, with the major and secondary venation almost black, and all segments acute at the apex. It is also distinguished by its dark purple spathe tube and red styles.

Chlorospatha callejasii is one of only three trilobed species occurring in the region east of the Cordillera Occidental in Colombia, and it might be confused with only one of these, *C. betancurii* (see discussion under *C. betancurii*).

It could be argued that *Chlorospatha callejasii* is possibly conspecific with *C. mirabilis*, since in one specimen of the latter species (*Hort. Veitch s.n.*) from an undetermined locality, the inner surface of the spathe tube is purple. However, all known Colombian collections of *C. mirabilis* are from the western slopes of the Andes at lower elevations. These, including the specimen of undetermined origin for *C. mirabilis*, differ from *C. callejasii* in having the upper blade surface drying somewhat glossy and the lower blade surface and petiole purple or purplish green. *Chlorospatha callejasii* is entirely green, with the upper blade surface drying matte-subvelvety. There are fewer pairs of primary lateral veins on the lateral segments in *C. mirabilis*, three to six versus nine to 11 in *C. callejasii*. The sterile staminate portion of the spadix comprises about one third of the total length in *C. mirabilis*, with the flowers laxly arranged in seven to nine (to 11) whorls, but comprises only one fifth of the total length in *C. callejasii*, with the flowers densely arranged in five whorls.

13. *Chlorospatha carchiensis* Croat & L. P. Hannon, sp. nov. TYPE: Ecuador. Carchi: vic. Maldona-

do, 1800 m, 15 Apr. 1977, *M. Madison 3988* (holotype, US!; isotype, SEL!). Figure 12A.

Herba ca. 1.5 m; internodia 1.7–3 \times 1.5–2 cm; cataphylla 22–31 cm longa. Petiolus 36.5–75.5 cm longus, vaginatus per 19–44 cm; lamina foliaris sagittata, 21–36.5 \times 12–20 cm, lobis posterioribus 7.5–17 \times 3.5–8 cm, nervis basalibus utroque 5 vel 6, nervis primariis lateralibus utroque 4 vel 5. Inflorescentiae 1 ad 3 in quaque axilla; pedunculus 27–33 cm \times 2–4 mm; spathe erecta, 10.7–11.5 cm longa, tubo 4–6 cm \times ca. 5 mm, lamina ca. 5.5 cm \times 5 mm; spadix 9.5–10.8 cm longus.

Terrestrial herb, ca. 1.5 m tall; stem decumbent, erect to 60 cm, with remnants of old leaf bases and cataphylls persisting \pm intact at upper nodes; internodes 1.7–3 \times 1.5–2 cm, drying matte to weakly glossy, dark brown or green (all measurements made from dried material); cataphylls 22–31 cm long, obtuse with acumen at apex, drying semiglossy, dark reddish brown. LEAVES 1 to 2, erect-spreading; **petioles** 36.5–75.5 cm long, glabrous, drying matte to weakly glossy, dark reddish brown, sheathed 19–44 cm, 1/2 to slightly more of total length; sheath free-ending at apex; free portion 2–5 mm diam. midway; **blades** sagittate, occasionally \pm triangular, 21–36.5 \times 12–20 cm, 1.8 to 2.8 times longer than wide, abruptly to gradually acuminate at apex, broadest at base, 1.1 to 1.2 times wider at base than across anterior lobe (measured tip to tip across posterior lobes), thin, moderately bicolorous, weakly to moderately constricted on one side in area of petiole attachment, markedly constricted on opposite side, 1–3 cm narrower at point of constriction; upper surface drying matte to weakly glossy, medium-dark to dark green or brownish green; lower surface drying (weakly glossy) semiglossy, weakly to moderately paler; anterior lobe 14.5–22.5 \times 6–14.5 cm, 1.5 to 2.2 times longer than wide, 1.3 to 1.8 times longer than posterior lobes, broadest near base, weakly to moderately inequilateral, with one side 1–2.5 cm wider than opposite side midway; posterior lobes directed toward the base or somewhat outward, 7.5–17 \times 3.5–8 cm, 2 to 2.5 times longer than wide, weakly acuminate to bluntly acute at apex, broadest midway, rarely weakly broadest at base, \pm symmetrical, the inner side broadly rounded toward base, attenuate onto posterior rib; outer side \pm straight to weakly convex toward base; midrib and major venation round-raised on lower surface, drying raised, concolorous to weakly paler than surface, occasionally weakly darker; **basal veins** 5 to 6 pairs, coalesced into a prominent posterior rib; posterior rib naked 1–1.5 cm per side; primary lateral veins 4 to 5 pairs, arising at 45°–55°(–65°), weakly to moderately arcuate; secondary veins raised on lower surface, drying raised, con-

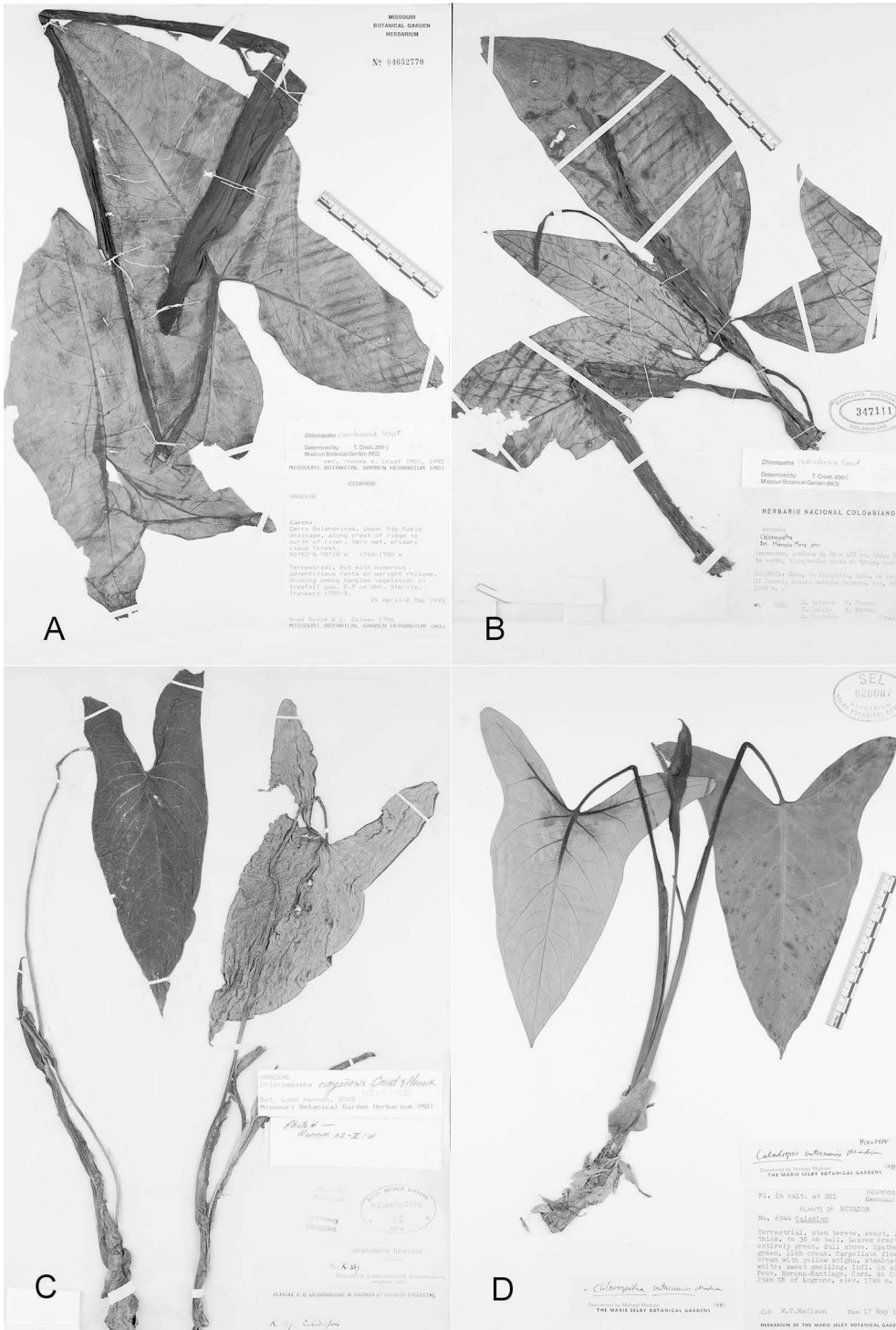


Figure 12. —A. *Chlorospatha carchiensis* Croat & L. P. Hannon, Boyle & Dalmau 1756 (MO paratype). —B. *Chlorospatha cedralensis* Croat & L. P. Hannon, the holotype Galeano et al. 2004 (COL-347111). —C. *Chlorospatha congenisa* Croat & L. P. Hannon, Lehmann 389 (K holotype). —D. *Chlorospatha cutucensis* Madison, Madison 6944 (SEL holotype).

colourous to weakly paler or weakly darker than surface; tertiary veins drying weakly to moderately prominulous on lower surface, weakly paler to weakly darker than surface; reticulate veins usually drying flat on lower surface, visible and distinct, otherwise prominulous, weakly darker than surface; collective veins 3 to 4, the innermost arising from one of the lateral veins on inner side of posterior lobe, loop-connected with all preceding lateral veins, \pm parallel to and 3–7 mm from margin. INFLORESCENCES erect, 1 to 3 per axil; peduncle held within the sheath, 27–33 cm \times 2–4 mm, drying matte to weakly glossy, dark brown to blackish brown; **spathe** erect, 10.7–11.5 cm long, cuspidate at apex; spathe tube green, 4–6 cm \times ca. 5 mm, drying weakly glossy, dark brown on outer surface; spathe blade white, ca. 5.5 cm \times ca. 5 mm, drying weakly glossy, medium yellowish tan on outer surface, marcescent, erect after anthesis; **spadix** erect, 9.5–10.8 cm long, sessile, adnate to spathe 3.6–4.4 cm at base, 3/4 of the length of pistillate portion; pistillate portion pale green, 3.7–4.5 cm \times 2.5–4 mm, broadest at apex, drying medium to dark reddish brown; fertile staminate portion white, 4.5–4.8 cm \times 4–5 mm, narrowly rounded at apex, broadest near base, weakly tapering, drying dark reddish brown or weakly glossy, medium orangish brown; sterile staminate portion 4–8 \times ca. 4 mm, \pm cylindrical, drying markedly dark reddish brown; pistils weakly coherent, more laxly arranged near base (of spadix), 3 to 4 across the axis (viewed from above), 1.5–1.8 mm long; ovaries \pm cylindrical, obtusely truncate at apex, drying tan, 1–1.2 \times 1.8–2 mm; style Type 9 (Fig. 1), 0.5–0.75 \times 1.8–2 mm, comprising ca. 1/3 or slightly more of the length of pistil, the margins usually \pm coherent with those of adjacent styles; **stigma** prominent, ca. 0.8 mm diam., elevated on and wider than narrowed portion of style, drying pale yellow-orange or tan; synandria ca. 1 \times 1.5–2.2 mm, coherent, \pm truncate, 3- to 4(5)-lobed, 3- to 4(5)-androus; sterile flowers 0.5–0.8 \times 0.5–2 mm, in 4 whorls, weakly coherent, occasionally deeply irregularly lobed in apical 2 whorls, otherwise 2- to 5-branched in basal 2 whorls or all whorls, the branches truncate at apex, abruptly narrowed below, a few flowers extending into apical whorl of pistils. INFRUCTESCENCE (immature) 6.5 cm \times 7 mm, drying matte, dark brown; berries not known.

Phenology. Flowering and fruiting are only known to occur in *Chlorospatha carchiensis* during the month of April.

Etymology. *Chlorospatha carchiensis* is named for Carchi Province, Ecuador, where the new species is endemic.

Discussion. *Chlorospatha carchiensis* is known only from lower montane wet forest in the vicinity of Maldonado in Carchi Province, Ecuador, on the western slopes of the Andes at 1740–1800 m elevation, and would be expected to occur in Esmeraldas Province and northward into Nariño Department, Colombia. The species is a member of *Chlorospatha* sect. *Occidentales* and is distinguished by its sagittate leaf blades that are prominently constricted on one side in the area of petiole attachment and dry matte to weakly glossy green on the upper surface and semiglossy on the lower surface, with the midrib, major, and secondary venation raised and usually concolorous to weakly paler than the surface. The posterior lobes are moderately narrow, more than 2 times longer than wide and usually broadest midway, with one lobe prominently constricted at the base. The lobes are also long, relative to the length of the anterior lobe, which is less than twice as long as the posterior lobes. *Chlorospatha carchiensis* is also distinguished by its relatively large inflorescence with a green spathe tube, white spathe blade, and green styles.

Chlorospatha carchiensis could possibly be confused with *C. narinoensis* from the western slopes of the Andes in or near the Reserva Natural Río Nambí in Nariño Department, Colombia, at 1100–1325 m elevation. The species could ultimately prove to be sympatric, the type localities being in close proximity. *Chlorospatha carchiensis* has the petiole sheathed one half or slightly more of its length, with the sheath free-ending at the apex, and the leaf blades sagittate, with the posterior lobes significantly broader than those of *C. narinoensis*. The petiole of *C. narinoensis* is sheathed one third of its length, with the sheath decurrent at the apex, and the blades are hastate. The upper surface of the blade in *C. carchiensis* lacks the pale raphid cells observed on the blades of *C. narinoensis*, and the peduncle is significantly longer, 27–33 cm, as is the spathe, 10.7–11.5 cm. In *C. narinoensis*, the peduncle is only 12–14.5 cm long and the spathe less than 8 cm long. The spadix of the latter species is adnate to the spathe most or all of the length of the pistillate portion versus three fourths of the length in *C. carchiensis*. The style (Type 9, Fig. 1) of *C. carchiensis* comprises about one third of the length of the pistil, thus differing from that of *C. narinoensis* (Type 5, Fig. 1), which comprises about one half of the length. The sterile flowers are also different, all or most being branched in *C. carchiensis* versus subprismatic in *C. narinoensis*.

Paratype. ECUADOR. **Carchi:** vic. Maldonado, upper Río Pablo drainage, along crest of ridge to N of river,

Transect 1750-3, 1740-1780 m, 0°53'N, 78°10'W, 24 Apr.-2 May 1993, B. Boyle & L. Dalmau 1756 (CM, MO).

14. *Chlorospatha castula* (Madison) Madison, Selbyana 5(3-4): 356. 1981. Basionym: *Caladiopsis castula* Madison, Contr. Gray Herb. 208: 98. 1978. TYPE: Ecuador. Pichincha: vic. Chiriboga, 1200 m, 1975, M. Madison 4151 [non 4141, sic, Madison, 1981: 356] (holotype, SEL!; isotypes, K!, QCA!). Figure 13A-D.

Terrestrial herb, less than 1 m tall; stem possibly erect, erect 8-30 cm at apex, producing bulbils randomly along its length; bulbils ca. 1 cm long, shape of bulbils unknown; internodes short, 2-4 cm diam.; cataphylls triangular, 8-11 cm long, apex not known. LEAVES 2 to 3, erect-spreading; **petioles** 35-50 cm long, granular-puberulent at apex, entirely green toward apex, otherwise green with dark purple mottling, drying matte to weakly glossy, medium-dark to dark brown, sheathed 22.5-33.5 cm, 1/2 to 2/3 of total length; sheath decurrent at apex; free portion 3-4 mm diam. midway; **blades** sagittate-subhastate, 33-43 × 21-25.5 cm, 1.6 to 1.7 times longer than wide, acuminate at apex, broadest at base, (1.4 to)3.3 to 3.6 times wider at base than across anterior lobe (measured tip to tip across posterior lobes), frequently weakly to moderately constricted on one side in area of petiole attachment, thin, moderately bicolorous; upper surface quilted, velvety, dark green, occasionally medium green toward margins, drying matte, medium to dark greenish brown; lower surface purple-tinged medially or entirely green with midrib and major veins purplish, drying weakly glossy to semiglossy, weakly paler; anterior lobe 21-25 × 9-16 cm, 1.6 to 2.3 times longer than wide, 1.2 to 1.4 times longer than posterior lobes, broadest at or near base, ± symmetrical; posterior lobes directed somewhat outward, 16-20.5 × 4-8 cm, (2.3 to)3.4 to 4 times longer than wide, acute to weakly acuminate at apex, broadest below middle, ± symmetrical, the inner side straight to rounded toward base; midrib and major venation granular-puberulent on lower surface and ± purple-tinged, drying weakly raised and ± flattened, weakly to moderately darker than surface; midrib deeply sunken on upper surface, round-raised on lower surface; **basal veins** 6 to 8 pairs, coalesced into a prominent posterior rib; posterior rib naked 1.3-2.3 cm per side; primary lateral veins 4 to 7 pairs, arising at 40°-60°, weakly to moderately arcuate, rarely markedly arcuate, straight or irregularly ascending, quilted-sunken on upper surface, convex on lower surface; secondary veins raised on lower surface, drying ± raised, weakly to moderately darker than surface; tertiary veins raised on lower surface, drying

weakly raised, weakly to moderately darker than surface; reticulate veins drying obscure; collective veins 3, the innermost arising from one of the lowermost lateral veins on inner side of posterior lobe, loop-connected with all preceding lateral veins, parallel to and 3-4 mm from margin. INFLORESCENCES erect, 4 per axil; peduncle held within the sheath, terete, 25-37 cm × 1-2 mm, medium green, dark purple-mottled, drying matte, dark brown; **spathe** cucullate, 6.3-8.5 cm long, 2-4 cm longer than spadix, ± acute at apex, with margins in-rolled near apex; spathe tube entirely dark purple or pale green and in part narrowly dark purple at the base and along the outer margin, 3-4.3 cm × 5-7 mm, drying matte to weakly glossy, purple or purplish brown on outer surface, weakly glossy to semiglossy on inner surface and concolorous to weakly paler; spathe blade entirely cream-colored, rarely pale green at base and white at apex, 3.2-4.2 cm × 5-8 mm, drying matte, yellowish cream to pale tan, rarely cream and in part purple-tinged, with reticulate veins purplish on both surfaces, opening narrowly at anthesis, marcescent, erect after anthesis; **spadix** erect, 4.3-6.5 cm long, sessile, adnate to spathe 1.5-2.2 cm at base, most of the length of pistillate portion; pistillate portion white, 1.7-2.8 cm × 3-4 mm (dry), broadest midway, drying creamy white; fertile staminate portion cream to pale yellow-green, 1.6-2.2 cm × 3-4 mm (dry), narrowly rounded at apex, ± clavate, drying yellowish cream; sterile staminate portion purple to maroon, 1-1.6 cm × 2 mm (dry), ± cylindrical; pistils ± laxly arranged, ca. 3 across the axis (viewed from above), ca. 1.5 mm long; ovaries ± subglobose, ca. 2 mm diam., 3-carpellate, semi-unilocular, with basal placentation, drying brown; style Type 4 (Fig. 1), white, ca. 3 mm diam., thin, lacy, possibly obscurely attenuate medially, markedly broader than ovary apex, the margins ± coherent with those of adjacent styles; **stigma** yellow, ca. 0.5 mm diam. (dry), sessile, obtusely truncate, drying yellowish tan; synandria ca. 1 × 0.75-1 mm, coherent, truncate, deeply (2)3- to 4-lobed, 3- to 4- androus; sterile flowers cream-colored, with margins purple, ca. 1 mm long (or less), 2-2.5 × 1 mm diam. and ± elongated in direction of axis, weakly coherent to ± laxly arranged, fungiform, broadly and deeply concave medially, with margins irregular (probably sinuate-undulate), in ca. 5 whorls. Berries not known.

Phenology. Flowering times of *Chlorospatha castula* are not known.

Discussion. *Chlorospatha castula* is known from only two collections made in Pichincha Province, Ecuador, at 1200 m elevation on the western slopes of



Figure 13. *Chlorospatha castula* (Madison) Madison, the type collection *Madison 4151*. —A. Fertile habit in the type locality (Ecuador). —B. Leaf blade adaxial surface. —C. Close-up of petioles and inflorescences. —D. Close-up of inflorescence at anthesis. B–D, cultivated from the type at Munich Botanical Garden. A photograph by M. Madison. B–D photographs by J. Bogner.

the Andes, and would be expected to occur in the adjoining provinces. No coordinates were reported, but the species was probably collected in premontane wet forest.

Chlorospatha castula is a member of *Chlorospatha* sect. *Occidentales* and distinguished by its sagittate-subhastate leaf blades that are velvety, dark green on the upper surface and usually purple-tinged on the lower surface, and by its relatively small inflorescence with a dark purple spathe tube. Of particular note are the thin, broadly spreading style, 3 times broader than the ovary apex, and unusual concave-fungiform sterile flowers that are cream-colored medially with dark purple margins. The sterile staminate portion of the spadix comprises approximately one third of the total length, a character, which combined with the unusual sterile flowers, is found in only two other species, *C. atropurpurea* and *C. hastata*. *Chlorospatha hastata* is known only from Carchi and Esmeraldas provinces in Ecuador, and is not known to occur with *C. castula*.

Chlorospatha castula differs from *C. atropurpurea* and *C. hastata* in having the lower surface of the leaf blade only purple-tinged, whereas that of the other species is either entirely dark purple or sharply discolorous and dark purple along the major venation (see differences discussed under both species). *Chlorospatha castula* would be most easily confused with the sympatric species, *C. atropurpurea*, both of which occur in Pichincha Province, with no indication of hybridization. The ovaries of *C. castula* differ in having basal placentation, rare in *Chlorospatha*, those of *C. atropurpurea* having axile or pseudoaxile placentation and those of *C. hastata*, subaxile placentation.

Madison (1981) originally assigned *Madison et al.* 4596 to *C. castula*, but the collection better accords with *C. hastata* in all respects.

Additional specimen examined. ECUADOR. **Pichincha:** vic. Chiriboga, 1200 m, 1975, *Madison 2106* (SEL).

15. *Chlorospatha cedralensis* Croat & L. P. Hannon, sp. nov. TYPE: Colombia. Risaralda: Mpio. Pereira, El Cedral, old Salento rd., 2200–2300 m, 11 June 1989, *G. Galeano, N. Ladino, A. Castillo, P. Franco & F. Forero 2004* (holotype, COL-347111!). Figure 12B.

Herba ultra 1 m; cataphylla plus quam 26 cm longa. Petiolus 65–100 cm longus; lamina foliaris \pm 5-pedatisecta, ca. 32 \times 36 cm, debiliter confluens inter lobos, nervis primariis lateralibus utroque 6 (in lobis lateralibus). Inflorescentiae erectae, 1 in quaque axilla; pedunculus ca. 58 cm \times 1–2 mm; spathe erecta ca. 9 cm longa, tubo ca.

4.2 cm \times 6 mm, lamina ca. 4.7 cm \times 7 mm; spadix ca. 7.5 cm longus.

Terrestrial herb, more than 1 m tall; stem not known; internodes not known (all measurements made from dried material); cataphylls more than 26 cm long (total length and apex not known), drying semiglossy, dark orangish brown. LEAVES 1; **petioles** 65–100 cm long, glabrous, drying matte, dark brown, sheathed 49 cm, ca. 3/4 of total length; sheath decurrent at apex; free portion 4–5 mm diam. midway; **blades** \pm 5-pedatisect, ca. 32 \times ca. 36 cm, ca. 1.1 times wider than long, drying thin, moderately bicolorous; upper surface drying matte to weakly glossy, medium-dark greenish brown, with pale, punctiform raphid cells; lower surface drying matte to weakly glossy, brownish green, moderately paler, with raphid cells visible; **medial lobe** in part not known, drying \pm acute at base and narrowly attached, 7 mm wide at point of attachment; **lateral lobes** acute to weakly acuminate at apex, \pm acute at base, occasionally weakly alate between some segments; innermost segment 20–25 \times 8–10 cm, broadest at or below middle, 2.5 times longer than wide, moderately inequilateral, the inner side narrower; outer side 2 times wider than inner side midway; outermost segment 16–16.5 \times 5–5.5 cm, broadest midway, 3 to 3.2 times longer than wide, moderately inequilateral, the inner side narrower; outer side to 2 times wider than inner side near base; midrib and major venation round-raised on lower surface, drying round-raised, moderately darker than surface; posterior rib naked ca. 2 cm per side; primary lateral veins (on medial lobe) not known; primary lateral veins (on lateral lobes) 6 pairs, arising at 40°–45° on innermost segment, 17°–60° on outermost segment, most acutely toward base, irregularly ascending to weakly arcuate; minor veins drying darker than lower surface; secondary veins raised on lower surface, drying raised; tertiary veins drying prominulous on lower surface; reticulate veins drying weakly prominulous on lower surface; collective veins 3, the innermost arising from lowermost lateral vein at base, loop-connected with all preceding lateral veins, conspicuously scalloped on innermost segments, 0.6–1.8 cm from margin. INFLORESCENCE erect, 1 per axil; peduncle held within the sheath, ca. 58 cm \times 1–2 mm, drying matte, dark brown; **spathe** erect, ca. 9 cm long (estimated; total length and apex not known), drying weakly constricted above tube; spathe tube green, 4.2 cm \times 6 mm, drying matte, dark brown on outer surface, matte to weakly glossy and moderately paler on inner surface, densely cream, punctiform (speckles regularly rounded, appearing as subepidermal cellular inclusions); spathe blade whitish, ca. 4.7 cm \times 7 mm, drying matte, medium reddish brown,

marcescent, erect after anthesis; **spadix** erect, 7.5 cm long, sessile, adnate to spathe ca. 1.8 cm at base, ca. 1/2 of the length of pistillate portion; pistillate portion ca. 3.5 cm × 3.5 mm, drying dark tan; fertile staminate portion ca. 3 cm × 3 mm, narrowly rounded at apex, ± cylindrical, weakly narrower at base, drying dark brown; sterile staminate portion 1.1 cm × 2 mm, ± cylindrical, drying medium brown; pistils weakly coherent, 3 to 4 across the axis (viewed from above), ca. 1.3 mm long; ovaries subglobose, ca. 1.5 mm diam., drying dark tan with weakly darker veins; style Type 3 (Fig. 1), 0.75–1 mm diam., drying dark purplish brown; **stigma** ca. 0.3 mm diam., sessile, obtusely truncate at apex; synandria ca. 1 × 1–1.5 mm, coherent, truncate, deeply 3- to 4-lobed, 3- to 4- (mostly 4); sterile flowers ca. 0.5 mm long, 2–3 × 0.8 mm diam., and markedly elongated in direction of axis, ± coherent or only laterally, truncate, irregularly subprismatic, in 4 whorls. Berries not known.

Phenology. Flowering in *Chlorospatha cedralensis* is only known to occur in the month of June.

Etymology. *Chlorospatha cedralensis* is named for the town of El Cedral, near the type locality in Risaralda Department.

Discussion. *Chlorospatha cedralensis* is known only from the type collection made in lower montane wet forest on the western slopes of the Cordillera Central, in the vicinity of Pereira in Risaralda Department, Colombia, at 2200–2300 m elevation, and would be expected to occur in Caldas Department to the north and in Quibdó to the south. The species is a member of *Chlorospatha* sect. *Chlorospatha* and is distinguished by its 5-pedatisect leaf blades, petiole sheathed approximately three fourths of its length, peduncle nearly as long as the petiole, and relatively small inflorescence, ca. 9 cm long.

Chlorospatha cedralensis might be confused with two species that also occur above 2000 m elevation in the Cordillera Central: *C. caldasensis* from Caldas Department to the north and *C. luteynii* from the northern portion of the mountain range in Antioquia Department (see discussions under both species). These two species have maculate, 5-lobed leaf blades that are broadly confluent between segments (confluent portion 1.5–4 cm wide), the petiole sheathed about one half of its length and the peduncle about one half as long as the petiole. *Chlorospatha cedralensis* differs in having blades that lack maculations, with segments free to the base or weakly alate between segments and acute at the base, the petiole sheathed three fourths of its length and the peduncle nearly as long as the petiole. In *C.*

caldasensis and *C. luteynii*, the lower blade surface dries semiglossy to glossy, with the midrib and major venation flattened versus matte to weakly glossy, with the midrib and major venation round-raised in *C. cedralensis*. The upper surface of the blade of *C. cedralensis* contains densely dispersed, punctiform raphid cells that do not occur in the other two species. The leaf blades of *C. caldasensis* are brown and dry brown, differing from those of *C. cedralensis*, which are green and dry greenish.

Chlorospatha cedralensis is similar to *C. croatiana* var. *enneaphylla*, both having deeply lobed leaf blades with the segments acute at the base and either occasionally alate or weakly confluent between segments, depending on the taxon; however, all Colombian collections of the latter taxon have 7- to 9-lobed blades, the petiole sheathed one half to two thirds of its length and the peduncle half as long as the petiole. In Colombia, *C. croatiana* var. *enneaphylla* is known only from below 900 m elevation in Antioquia, Boyacá, and Chocó departments, whereas *C. cedralensis* occurs only in Risaralda, at above 2000 m.

16. *Chlorospatha chocoensis* Croat & L. P. Hannon, sp. nov. TYPE: Colombia. Chocó: near Río Iró, ca. 10 km S of Istmina, less than 50 m, 5°04'30"N, 76°41'W, 13 Mar. 1984, Croat 57402 (holotype, MO-3184311!; isotype, CHOCO!). Figure 14A, B.

Herba ca. 1 m; internodia brevia, usque ad 3 cm diam. Petiolus ca. 67.5 cm longus, vaginatus per ca. 25 cm; lamina foliaris profunde 3-loba, ca. 36 × 48 cm, lobo medio late ovato, ca. 26.5 × 20 cm, nervis primariis lateralibus utroque 5. Inflorescentiae 2 in quaque axilla; pedunculus 16–18 cm × 1–1.5 mm; spatha erecta, 7–7.5 cm longa, tubo 3.2–4 cm × ca. 6 mm, lamina 3.8–4.2 cm × ca. 5 mm; spadix 5–5.2 cm longus.

Terrestrial herb, ca. 1 m tall; stem possibly erect, to 30 cm long; internodes short, to 3 cm diam.; cataphylls (length and apex not known), drying weakly glossy, dark reddish brown, weakly fibrous. LEAVES 1, probably erect-spreading (all measurements made from dried material); **petiole** 67.5 cm long, glabrous, purple-tinged green, drying weakly glossy, dark reddish brown, sheathed ca. 25 cm, ca. 1/3 of its length; sheath free-ending at apex; free portion ca. 7 mm diam. midway, terete; **blade** deeply 3-lobed to trisect, ca. 36 × ca. 48 cm, wider than long, drying thinly coriaceous, moderately bicolorous; upper surface quilted, weakly glossy, dark green, sparsely paler maculate, drying weakly glossy to semiglossy, brownish green, with weakly paler maculations; lower surface purple-tinged, drying semiglossy to glossy, moderately paler; **medial lobe**

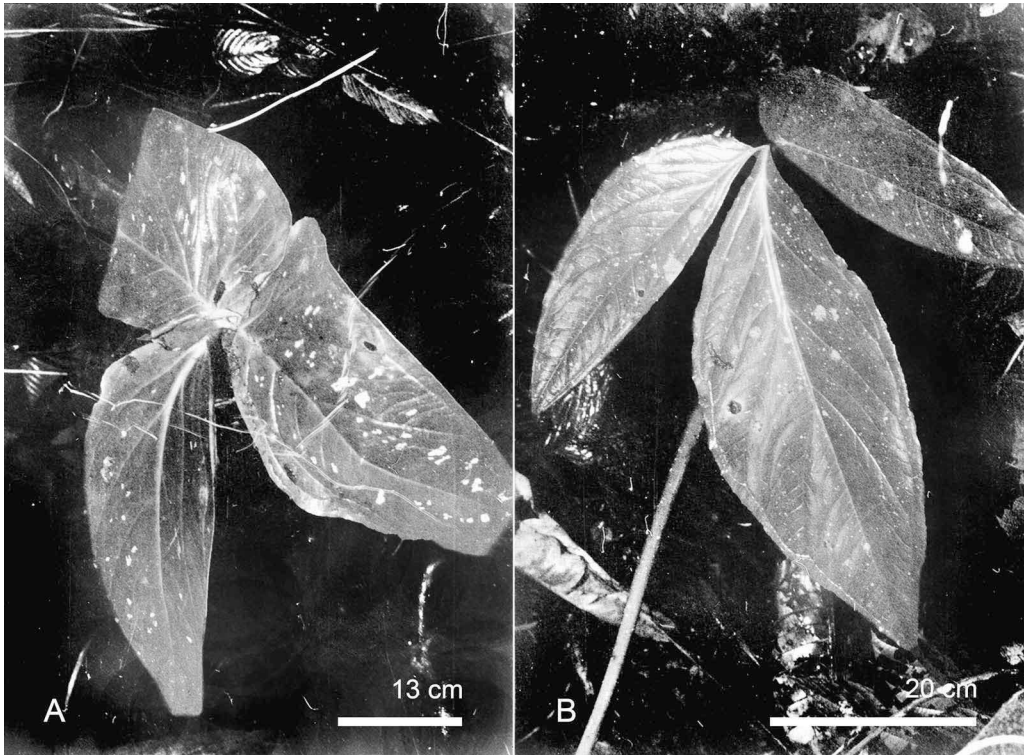


Figure 14. *Chlorospatha chocoensis* Croat & L. P. Hannon, from the type collection Croat 57402. A, B. Leaf blade adaxial surfaces.

broadly ovate, 26.5 × 20 cm, 1.3 times longer than wide, 1 to 1.4 times longer than lateral lobes, abruptly acuminate at apex, broadest below middle, broadly cuneate and broadly attached at base, ca. 7 cm wide at point of attachment, moderately inequilateral, one side 1.1 to 1.5 times wider than opposite side; **lateral lobes** oblique, 24–25.5 × 12–14 cm, 1.7 to 2 times longer than wide, broadly and weakly long-acuminate at apex, broadest midway, moderately inequilateral, the inner side narrower, ± straight toward base and broadly confluent with medial lobe, the confluent portion 3.5–4 cm wide; outer side 1.1 to 2.2 times wider than inner side midway, broadly rounded toward base and overlapping the base of opposite lobe, decurrent onto petiole; midrib and major veins quilted-sunken on upper surface, convex on lower surface, drying ± flattened, weakly to moderately darker than surface; posterior rib not naked; primary lateral veins (of medial lobe) 5 pairs, arising at ca. 45°, straight to weakly or moderately arcuate; primary lateral veins (of lateral lobes) 5 pairs, arising at 35°–90°, most acutely toward apex, weakly to moderately arcuate; secondary veins drying weakly raised on lower surface, ± concolorous; tertiary veins drying in part weakly prominulous and

otherwise obscure on lower surface, usually concolorous, in part weakly darker than surface; reticulate veins drying obscure; collective veins 3, the innermost arising from lowermost lateral vein at the base, loop-connected with all preceding lateral veins, prominently scalloped on lateral lobes, 0.3–2 cm from margin, weakly to moderately scalloped on medial lobe, 3–8 mm from margin. **INFLORESCENCES** erect, 2 per axil; peduncle held within the sheath, 16–18 cm × 1–1.5 mm, drying weakly glossy, medium to dark brown; **spathe** erect, 7–7.5 cm long, cuspidate at apex; spathe tube 3.2–4 cm × ca. 6 mm, drying matte, medium to dark brown and paler at the margins on outer surface, matte, moderately to prominently paler on inner surface; spathe blade subcoriaceous, 3.8–4.2 cm × ca. 5 mm, drying matte, medium to pale yellowish tan on outer surface, matte, much paler on inner surface, marcescent, erect after anthesis; **spadix** erect, 5–5.2 cm long, sessile, adnate to spathe ca. 1.6 cm at base, slightly more than 1/2 to 3/4 of the length of pistillate portion; pistillate portion 2.2–2.7 cm × 3–5 mm, broadest toward apex, drying pale yellowish tan; fertile staminate portion 1.5–1.7 cm × 2–2.8 mm, bluntly acute at apex, ± cylindrical, drying medium-dark reddish brown, creamy tan at

apex; sterile staminate portion 1–1.2 cm \times 1.8–2.5 mm, broadest at base, drying cream-colored to pale tan, with numerous red speckles; pistils weakly coherent to laxly arranged, ca. 3 to 4 across the axis (viewed from above), 1.5–2 mm long; ovaries 1.5–2 mm diam., \pm cylindrical (possibly obtusely conical or subcuboidal), drying creamy white, occasionally with weakly darker veins, 3-locular; style Type 3 (Fig. 1), 1.5–2 mm diam., weakly broader than ovary apex; **stigma** disklike, 0.5–0.75 mm diam., sessile, obtusely truncate, drying brownish, darker than style; synandria ca. 1 \times 1–1.5 mm, coherent, truncate, deeply (2)3- to 5-lobed, 3- to 5-androus (mostly 4), lacking microsporangia in apical 2 whorls; sterile flowers ca. 0.5–0.75 mm long, 1.2–2.2 mm \times 0.75–1 mm diam. and \pm elongated in direction of axis, \pm laxly arranged, fungiform, broadly concave medially, with deeply sinuate margins, conspicuously and abruptly narrowed below apex, in 6 to 8 whorls. Berries not known. JUVENILE plants with petioles 23 cm \times 4 mm midway, sheathed 7.5 cm; blades maculate; **medial lobe** 15 \times 10.5 cm, broadest below middle, acuminate apex, with 3 primary lateral veins; **lateral lobes** oblique, 11.5–12 \times 4.2–4.8 cm, broadest below middle, acute to weakly acuminate at apex, broadly confluent with medial lobe, confluent portion ca. 1 cm wide, with outer sides broadly rounded at base, decurrent onto petiole, with 2 pairs primary lateral veins.

Phenology. Flowering is only known to occur in *Chlorospatha chochoensis* during the month of March.

Etymology. *Chlorospatha chochoensis* is named for Chocó Department, Colombia, where the type was collected.

Discussion. *Chlorospatha chochoensis* is known only from the type collection made near Istmina in Chocó Department, Colombia, at less than 50 m elevation, in tropical rainforest on the western slopes of the Cordillera Occidental.

The species is a member of *Chlorospatha* sect. *Chlorospatha* and distinguished by its maculate, deeply 3-lobed to trisect blades that are purple-tinged on the lower surface, as is the petiole, and by its short peduncle and unusual sterile flowers. The lower blade surface dries an unusual jade-green. The posterior rib is not naked in fully mature leaf blades of *C. chochoensis*, distinguishing it from all other taxa with divided blades.

Chlorospatha chochoensis would be most easily confused with *C. mirabilis*, which also occurs at low elevations in Chocó Department and might eventually

prove to be conspecific with this species (see discussion under *C. mirabilis*).

Chlorospatha chochoensis might also be confused with another species that occurs in Chocó, *C. maculata* (see discussion under that species). The latter species differs in having entirely green leaves (except for paler maculations), a brittle petiole, and subcoriaceous blades that are matte and not at all quilted on the upper surface, with the segments broadly concave on the upper side (observed in photographs), a condition not previously observed in the genus, possibly resulting from the considerable thickness of the blade. In *C. chochoensis*, the blades are weakly glossy on the upper surface, purple-tinged below, with the blade segments convex and quilted, and the petiole is spongy and purple-tinged. The leaf blades of *C. chochoensis* are thinner and the petiole is sheathed only one third of its length versus one half to two thirds of its length in *C. maculata*. There are more primary lateral veins on all blade segments in *C. maculata* (mature specimens), with seven to 10 pairs on the lateral lobes and six to eight pairs on the medial lobe versus five pairs on both the lateral and medial lobes in *C. chochoensis*. The primary lateral veins are aggregated in the basal one third of the lateral lobes in *C. maculata* but evenly distributed in *C. chochoensis*.

17. *Chlorospatha cogolloi* Croat & L. P. Hannon, *Aroidiana* 27: 14–17. 2004. TYPE: Colombia. Antioquia: Parque Nac. Nat. Las Orquídeas, vic. Calles, on ridge to NW of La Cabaña Calles, Quebrada Honda, Parcel W, subparcels W8–W9, 1300 m, 6°29'N, 76°14'W, 11 Dec. 1992, J. Pipoly, A. Cogollo, D. Cadenas, M. Villa, O. Alvarez & L. Velez 16992 (holotype, MO-04925669!; isotype, JAUM!). Figure 11B.

Terrestrial or hemiepiphytic herb, ca. 1 m tall (all measurements made from dried material); stem with remnants of old cataphylls persisting semi-intact at upper nodes, mostly as linear fibers, with most fibers paler; sap pink or creamy white; internodes ca. 1.5 \times 0.7–2 cm, drying matte, dark brown; cataphylls 15–30 cm long, obtuse with acumen at apex (acumen ca. 7 mm long), drying \pm fibrous, matte to weakly glossy, medium to dark reddish brown. LEAVES 1 to 3, erect-spreading; **petioles** 35–73(–95) cm long, glabrous, drying matte to weakly glossy, dark brown, sheathed 34.5–70 cm, usually 3/4 or more of its length (in mature specimens); sheath decurrent at apex; free portion 2–4 mm diam. midway, minutely many-ribbed; **blades** trisect to deeply 3-lobed (entire or with conspicuously short, broadly confluent lateral lobes in juvenile plants), 23–43(–56) \times 22–55(–65)

cm, as wide as long or weakly wider than long, drying thin to thinly coriaceous, moderately to conspicuously bicolorous; upper surface green, occasionally sparsely paler maculate, drying weakly glossy to semiglossy, dark brown to dark green; lower surface usually entirely purple, rarely entirely green with major veins purple, drying weakly glossy to semiglossy, gray-tinged green to greenish brown; **medial lobe** elliptical to narrowly long-ovate, 22–36.5(–46) × 8–15(–18) cm, 2.4 to 2.7 times longer than wide, 1.2 to 1.4 times longer than lateral lobes, acuminate at apex, broadest below middle, occasionally midway, acute to cuneate toward the base and narrowly attached, 1–4 cm wide at point of attachment, weakly inequilateral to symmetrical; **lateral lobes** directed toward the apex, (22–)25–30.5(–40) × (6–)9–12(–15) cm, (2.2 to)2.5 to 3.6 times longer than wide, moderately acuminate to broadly or narrowly long-acuminate at apex, broadest at or below middle, moderately to markedly inequilateral, the inner side always narrower, weakly to moderately attenuate or rarely ± straight toward base, narrowly or not at all confluent with medial lobe, the confluent portion 1–3(–8) mm wide; outer side 1.5 to 4.7 times wider than inner side midway, moderately to broadly rounded at base, briefly attenuate onto posterior rib; midrib purple, round-raised and finely many-ribbed on lower surface, drying raised to weakly flattened, much darker than surface; posterior rib naked 1–2(–5) cm per side; primary lateral veins (on medial lobe) ca. 10 pairs (fewer in younger plants), arising at 30°–45°, straight to weakly arcuate, purple, minutely many-ribbed on lower surface, drying ± raised to weakly flattened, brown or green, moderately darker than surface; primary lateral veins (on lateral lobes) 8 to 10 pairs (fewer in younger plants), arising at 35°–80°, most acutely toward apex, straight to weakly arcuate, prominently aggregated toward the base; secondary veins drying raised on lower surface, weakly to moderately darker than surface; tertiary veins drying in part weakly raised or prominulous on lower surface, otherwise flat, in part weakly to moderately darker than surface, otherwise concolorous; reticulate veins occasionally drying in part prominulous on lower surface, otherwise ± obscure; collective veins 3, the innermost arising from one of the lowermost lateral veins at base, loop-connected with all preceding lateral veins, moderately scalloped, 2–13 mm from margin. INFLORESCENCES erect, to 4 per axil; peduncle held within the sheath, (37.5–)42.5–53 cm × 1–2 mm, glabrous, drying matte, dark brown to blackish brown; **spathe** erect, (7–)8.5–10.5 cm long, cuspidate at apex; spathe tube green, (2.7–)4.3–4.5 cm × 5–6 mm, drying matte, dark blackish brown

on outer surface, matte and concolorous to weakly paler on inner surface; spathe blade creamy white, rarely pale green, 4.2–6 cm × ca. 5 mm, drying matte, blackish brown on outer surface, weakly paler on inner surface, marcescent, erect after anthesis; **spadix** erect, (5.4–)7–8 cm long, sessile, adnate to spathe ca. 1.7 cm at base, slightly more than 1/2 of the length of pistillate portion; pistillate portion 2.3–3.3 cm × 3–4 mm, drying purplish brown; fertile staminate portion yellowish, ca. 3.5 cm × 2.5–4 mm, narrowly rounded at apex, ± cylindrical, drying medium-dark reddish to pinkish brown; sterile staminate portion 5–9 × 1.5–2.5 mm, weakly narrowest midway, drying dark tan to dark brown; pistils weakly coherent, ca. 4 across the axis (viewed from above), ca. 1–1.5 mm long; ovaries subglobose, 1–1.5 mm diam., drying tan; style Type 3 (Fig. 1), 1.2–1.5 mm diam., weakly broader than ovary apex, most margins ± coherent with those of adjacent styles; **stigma** 0.3–0.5 mm diam., sessile, obtusely truncate; synandria ca. 1–1.2 × 1–1.5 mm, or occasionally 2 × 0.75 mm diam. and elongated in direction of axis in basal 4 whorls, coherent, obtusely truncate, deeply (2)3- to 4-lobed, (2)3- to 4-androus (mostly 3); sterile flowers 0.5–1 mm long, 1.5–2.5 × 0.5–1.5 mm diam. and ± elongated in direction of axis, coherent, truncate, subprismatic, arranged in 4 to 5 whorls. Berries not known.

Phenology. Flowering is only known to occur in *Chlorospatha cogolloi* during the months of February, June, and December.

Discussion. *Chlorospatha cogolloi* is known only from the Parque Nacional Natural Las Orquídeas and the Nutibara–La Blanquita area near Frontino, in premontane rainforest, lower montane rainforest, or tropical wet forest on the western slopes of the Cordillera Occidental in Antioquia Department, Colombia, at 1250–1800 m elevation. The species is a member of *Chlorospatha* sect. *Chlorospatha* and is distinguished by its petiole, which is sheathed three fourths or more of its length (in mature specimens), trisect to nearly trisect leaf blades, with the lower surface usually purple but usually drying weakly gray-tinged green, and relatively small inflorescence, with the fertile staminate portion of the spadix yellowish.

Chlorospatha cogolloi would be most easily confused with *C. mirabilis*, especially juvenile or young flowering specimens, the leaf blades of both species having three to six pairs of primary lateral veins at this stage of development. However, fully mature specimens of *C. cogolloi* have eight to 10 pairs on all segments versus three to six pairs in *C.*

mirabilis. The major and secondary venation in *C. cogolloi* dries more or less raised on the lower blade surface, but flattened in *C. mirabilis*. The blades of *C. cogolloi* are thin, with the major and secondary venation drying raised on the lower surface, whereas those of *C. mirabilis* are thinly coriaceous to subcoriaceous, with the venation drying more or less flattened. The mature petiole is usually sheathed three fourths of its length in *C. cogolloi* versus one half to two thirds in *C. mirabilis*. In *C. cogolloi*, the spadix is shorter (in plants of comparable size), with the sterile staminate portion comprising only one tenth of the total length and the sterile flowers densely arranged in four or five whorls, whereas that portion comprises approximately one third of the total length in *C. mirabilis*, with the sterile flowers laxly arranged in seven to nine (to 11) whorls.

Chlorospatha cogolloi is also similar to *C. betancurii*. The latter species differs in having entirely green leaf blades with fewer primary lateral veins and the petiole sheathed about one half of its length. Its spadix is longer than seen in *C. betancurii*, with the fertile staminate portion white (see discussion under *C. betancurii*). *Luteyn 12060* (Mpio. Frontino, Nutibara district, Nutibara-La Blanquita rd., Murri region, Alto de Cuevas, 1700–1800 m, 6°45'N, 76°20'W [HUA]) is included with reservation and possibly represents another species. It is a small, fertile collection made at somewhat higher elevation, to the north of the type locality, in which the petiole is sheathed only one third of its length and the spathe is entirely pale green.

Additional specimens examined. COLOMBIA. **Antioquia:** Parque Nacional Nat. Las Orquídeas, Sector Calles, rt. bank of Río Calles, 1280–1320 m, 6°32'N, 76°19'W, 2 June 1988, *Cogollo & J. Ramírez 3160* (JAUM-016943, Fig. 11A), 1300–1490 m, 20 Feb. 1989, *Cogollo et al. 4127* (JAUM-016946, Fig. 11B); Parque Nacional Nat. Las Orquídeas, vic. Calles, right bank of Río Calles, 1350–1450 m, 6°32'N, 76°19'W, 6 Dec. 1993, *Pipoly et al. 17820* (JAUM, MO), 1250 m, 8 Dec. 1993, *Pipoly et al. 17952* (JAUM, MO).

18. *Chlorospatha congensis* Croat & L. P. Hannon, sp. nov. TYPE: Colombia. Cauca: La Conga, Popayán, along banks of Río Timbiquí, 1899, *C. Lehmann 389* (holotype, K!; isotype, K!). Figure 12C.

Herba ca. 50 cm; internodia 1–1.5 × 1–1.8 cm; cataphylla 13–16 cm longa. Petiolus 30–39 cm longus; lamina foliaris sagittata, 20–24.5 × 8–12 cm, lobis posterioribus 6–8.5 × 3–3.7 cm, nervis basalibus utroque 3, nervis primariis lateralibus utroque 5 ad 7. Inflorescentiae 3 vel 4 in quaque axilla; peduncula 11–14 cm × ca. 2 mm; spathe erecta, 5.5–8 cm longa, tubo 2–3.7 cm × 4–5

mm, lamina 3.2–3.5 cm × 4–5 mm; spadix 4.1–6.2 cm longus.

Terrestrial herb, ca. 50 cm tall; stem with remnants of old cataphylls persisting intact along its length (all measurements made from dried material); internodes 1–1.5 × 1–1.8 cm, drying matte, dark brown; cataphylls 13–16 cm long, obtuse with acumen and inequilateral at apex, 1- to 2-ribbed abaxially, drying weakly glossy to semiglossy, medium reddish brown. LEAVES 3 to 4, erect-spreading; **petioles** 30–39 cm long, drying glabrous, matte to weakly glossy, dark reddish brown, sheathed 13–18 cm, less than 1/2 of total length; sheath decurrent at apex; free portion 2–3 mm diam. midway; **blades** sagittate, 20–24.5 × 8–12 cm, 2.1 to 2.6 times longer than wide, gradually acuminate to narrowly acuminate at apex, broadest at base, 1.1 to 1.3 times broader at base than across anterior lobe (measured tip to tip across posterior lobes), weakly or not at all constricted in area of petiole attachment, drying subcoriaceous, moderately bicolorous; upper surface drying weakly bullate, matte-subvelvety, dark reddish brown, dark purplish brown, punctiform (speckles regularly rounded, appearing as subepidermal cellular inclusions), sometimes with interrupted, dark secretory canals; lower surface drying matte to weakly glossy, occasionally obscurely and minutely dark green-spotted (10× magnification); anterior lobe 14.5–17 × 6.5–9 cm, 1.9 to 2.2 (to 2.6) times longer than wide, 2 to 2.2 times longer than posterior lobes, broadest near base, ± symmetrical; posterior lobes directed toward the base, 6–8.5 × 3–3.7 cm, 2 to 2.5 times longer than wide, bluntly acute to narrowly rounded at apex, broadest at base, ± symmetrical to weakly inequilateral, the inner side occasionally weakly narrower, ± rounded toward the base and decurrent onto petiole; outer side ± straight toward the base, occasionally weakly concave; midrib and major veins drying narrowly etched-sunken on upper surface, moderately to weakly paler than surface, prominently round-raised on lower surface, ± wrinkled and granular-puberulent; midrib drying concolorous to weakly paler or occasionally weakly darker than surface; **basal veins** 3 pairs, coalesced into a prominent posterior rib; primary lateral veins 5 to 7 pairs, arising at 30°–70°, most acutely toward apex, moderately arcuate, drying concolorous to weakly paler than lower surface; secondary veins drying etched-sunken on upper surface, prominently raised on lower surface, ± wrinkled and granular-puberulent, concolorous to weakly paler than surface; tertiary veins drying weakly sunken on upper surface, ± raised or in part prominulous on lower surface, ± wrinkled and granular-puberulent, mostly concolo-

rous, in part weakly darker than surface; reticulate veins drying weakly sunken on upper surface, in part prominulous on lower surface, otherwise visible, flat, concolorous to weakly darker than surface; collective veins 3, the innermost arising from apex of posterior rib or from a lateral vein on inner side of posterior lobe, parallel to margin to weakly scalloped, 3–6 mm from margin. INFLORESCENCES erect, 3 to 4 per axil; peduncle held within the sheath, 11–14 cm \times ca. 2 mm, drying matte, medium reddish brown; **spathe** erect, 5.5–8 cm long, gradually acuminate to cuspidate at apex, occasionally drying densely or sparsely purplish brown-speckled on both surfaces; spathe tube 2–3.7 cm \times 4–5 mm, drying matte to weakly glossy, dark reddish brown on outer surface, weakly paler on inner surface; spathe blade 3.2–3.5 cm \times 4–5 mm, drying weakly glossy, pale to dark reddish brown, marcescent, erect after anthesis; **spadix** erect, 4.1–6.2 cm long, sessile, adnate to spathe 1.8–3.2 cm at the base, the entire length of pistillate portion and 3–4 mm of sterile staminate portion; pistillate portion 1.5–2.8 cm \times 1–3 mm, drying cream-colored to pale tan; fertile staminate portion 2–2.5 cm \times 2–3 mm, narrowly rounded at apex, weakly tapering, broadest at or near base, curved weakly forward below middle, then recurved with apical 1/3 erect, drying cream to medium brownish cream; sterile staminate portion 3–9 \times 1.5–3.5 mm, broadest at base, drying medium to dark brown; pistils weakly coherent, 3 to 4 across the axis (viewed from above), ca. 2 mm long; ovary obtusely conical to \pm cylindrical, ca. 1.5 \times 1–1.5 mm, drying brownish cream with dark brown veins; style Type 10 (Fig. 1), ca. 0.5 \times ca. 1.5 mm, comprising 1/3 of the length of pistil, the margins not coherent with those of adjacent styles; **stigma** ca. 0.3 mm diam., weakly elevated on and weakly broader than narrowed portion of style, broadest at apex, depressed medially, drying yellowish amber; synandria ca. 1 \times ca. 1 mm, coherent, truncate, deeply 3- to 4-lobed; sterile flowers ca. 1 \times 1–2.5 mm, \pm elongated in direction of axis in basal whorls, less so in apical 2 whorls, coherent, truncate, irregularly subprismatic, in (3)5 to 7 whorls. INFRUCTESCENCE (immature) 4.3 cm \times 5 mm, weakly glossy, dark brown; berries not known.

Phenology. Flowering months are not known for *Chlorospatha congensis*.

Etymology. This is named for La Conga, in Cauca Department, the type locality of the new species.

Discussion. *Chlorospatha congensis* is known from only two Lehmann collections made in 1899,

presumably from premontane rainforest on the western slopes of the Cordillera Occidental in Cauca Department in southern Colombia, at 1400–1800 m elevation. The label notes report the type locality as “La Conga, Popayán, along the banks of the Río Timbiquí.” La Conga cannot be located on any map, and it is possible that it no longer exists as a place name, many place names that are 100 years old or more having been completely abandoned. However, the Río Timbiquí notation would place it on the western slopes. The first author recently found the supposed area somewhat on the dry side, with no towns or farms, but with isolated pockets of suitable habitat that could still easily support *Chlorospatha*.

Chlorospatha congensis is a member of *Chlorospatha* sect. *Occidentales* and is distinguished by its sagittate, subcoriaceous leaf blades that dry weakly bullate and velvety-matte on the upper surface, with the major venation paler than the surface. It is likely that the living plant has bullate blades as well. On the lower surface, the midrib and major and secondary venation dry prominently raised, wrinkled and paler than the surface, with the tertiary veins prominently prominulous and paler than the surface. The posterior lobes are usually more or less rounded at the apex and decurrent onto the petiole at the base. The species is also distinguished by its short peduncles and small inflorescence (less than 8 cm long), with the spadix about 6 cm long and pistillate portion short, 1.5–2.8 cm long. The spadix is unique in the genus in curving forward and then recurving, with the apex erect.

Chlorospatha congensis would be most easily confused with *C. bullata*, known only from Valle Department, Colombia, to the north (see discussion under *C. bullata*). In the latter species, the petiole is sheathed about one third of its length, and the leaf blade is thin, with the upper surface matte, not purplish brown-speckled, and the lower surface densely reticulate, with deeply sunken areoles, both in living and dried material. *Chlorospatha congensis* differs in having the petiole sheathed slightly less than one half of its length and subcoriaceous leaf blades that are velvety on the upper surface and dry brown and densely dark purplish brown-speckled, with the lower surface lacking areoles and not densely reticulate. The blades of *C. bullata* dry green, with the midrib and major venation somewhat flattened on the lower surface, differing from *C. congensis* in which these dry prominently raised. In both species, the major venation dries paler than the upper blade surface, but in *C. bullata*, the minor venation is also paler, creating a conspicuous reticulate pattern that is lacking in *C. congensis*.

The sterile flowers are irregularly lobed in *C. bullata*, often deeply so, and subprismatic in *C. congensis*.

Chlorospatha congensis could possibly be confused with *C. huilensis*, known only from the Magdalena River drainage in Huila Department, and the eastern slopes of the Andes in Putumayo Department, Colombia. *Chlorospatha huilensis* differs in having longer internodes (1.5–3.5 cm vs. 1–1.5 cm long), the petiole sheath free-ending at the apex and the leaf blades semiglossy on the upper surface and drying thin. It can be assumed from the drying texture as subcoriaceous that the upper surface of the living blades in *C. congensis* is velvety-matte. Also, the upper blade surface is densely dark purplish brown, punctiform in *C. congensis*. In *C. huilensis*, the internodes are consistently longer (1.5–3.5 cm long) and the petiole sheaths are free-ending; the internodes in *C. congensis* are short (1–1.5 cm long), and the petiole sheaths decurrent. The midrib and major veins dry concolorous on the upper surface in *C. huilensis*, with the abaxial venation less prominently raised, not at all wrinkled, and usually weakly darker than the surface. The midrib and major veins dry paler than the upper surface in *C. congensis*, with the major and secondary venation prominently raised, wrinkled, and paler on the lower surface. The posterior lobes of *C. congensis* are rounded at the apex and decurrent onto the petiole at the base, whereas those of *C. huilensis* are bluntly acute at the apex and weakly confluent at the base, with the petiole apex obscured. In the latter species, the style comprises one half of the length of the pistil in *C. huilensis* (Style Type 5, Fig. 1) and is prominently broader than the ovary apex, thus differing from that of *C. congensis*, which comprises one third of the length of the pistil and is only as broad as the ovary apex (Style Type 10, Fig. 1).

Madison (1981) assigned both collections of *Chlorospatha congensis* to *C. lehmannii*, a species also from La Conga, the type locality of both species; however, *C. congensis* differs from the latter species in significant ways (see discussion under *C. lehmannii*).

Paratype. COLOMBIA. **Cauca**: La Conga, Popayán, 1400–1800 m, *C. Lehmann 388* (K).

19. *Chlorospatha corrugata* Bogner & Madison, *Aroideana* 8(2): 49. 1985. TYPE: Colombia. Antióquia: Vic. Sopetrán, 2 1/2 hrs. NW of Medellín, near Río Cauca & Río Aurra, [1970s], *E. Spear s.n.* (holotype, M!; isotypes, COL not seen, K!). Figure 15A–D.

Terrestrial herb, to 1 m tall; stem (possibly erect) 10 cm long or longer, with remnants of old cataphylls persisting \pm intact along its length, weakly fibrous,

the fibers pale; sap milky; internodes 1–2 \times 1.5–2.5 cm, brown, drying 1–2 cm diam., matte, dark brown; cataphylls (6–)10–23 cm long, green, drying weakly glossy to semiglossy, medium brown, with some pale, linear fibers. LEAVES 3 to 4, erect-spreading; **petioles** (13–)30–63 cm long, entirely weakly minutely puberulent to granular-puberulent or in part only toward apex, medium green, drying matte, dark brown to greenish brown, sheathed 6–18 cm, ca. (1/4 to)1/3 of total length; sheath decurrent at apex; free portion (0.25–)0.5–1 cm diam. midway; **blades** deeply 3-lobed or trisect (in some mature specimens), 26–35 \times 30–42 cm, 1.1 to 1.2 times wider than long, thinly coriaceous (dry), concolorous; upper surface prominently corrugate, weakly glossy, medium green, drying weakly glossy, medium to dark brown to brownish green or olive-green; lower surface reticulate, narrowly minutely colliculate along all veins, medium green, drying weakly glossy to semiglossy, weakly to moderately paler; **medial lobe** 16–23.5 \times 9–12 cm, \pm elliptical, broadest at or above middle, 1.7 to 2.2 times longer than wide, shorter and narrower than lateral lobes, abruptly acuminate at apex, cuneate to acute toward the base, narrowly attached, 1.4–1.8 cm wide at point of attachment (dry), weakly to moderately inequilateral, with one side to 1.8 times wider than opposite side midway; **lateral lobes** oblique or directed toward the apex, 15–30 \times (7–) 11–14.5 cm, 1.6 to 2.4 times longer than wide, abruptly acuminate to gradually acuminate at apex, broadest at or below middle, markedly inequilateral, the inner side always narrower, attenuate toward base, markedly narrowly or not at all confluent with medial lobe, the confluent portion 1–2 mm wide (moderately confluent in young plants); outer side to 7.3 times wider than inner side midway, usually broadly rounded at base and abruptly attenuate onto posterior rib or with a weakly to well-developed posterior lobe or auricle 5.5–11.5 \times 6–10 cm, narrowly rounded to rarely bluntly acute at apex, separated from lateral lobe by slender posterior rib 1.5–2.2 cm long, the inner side ca. 3–5.5 cm wide, abruptly attenuate at base, the outer side broadly rounded, weakly to prominently or not at all constricted in area of petiole attachment; all orders of venation \pm raised on lower surface, granular-puberulent to crispy-puberulent, drying \pm raised or prominently prominulous (reticulate veins), concolorous to weakly darker than surface; midrib deeply sunken on upper surface, weakly paler than surface, drying \pm concolorous, round-raised on lower surface; posterior rib naked 1.3–2 cm per side, round-raised on lower surface; posterior rib of posterior lobe (when present) naked 2–3 cm per side (including rachis), markedly curved, round-raised on

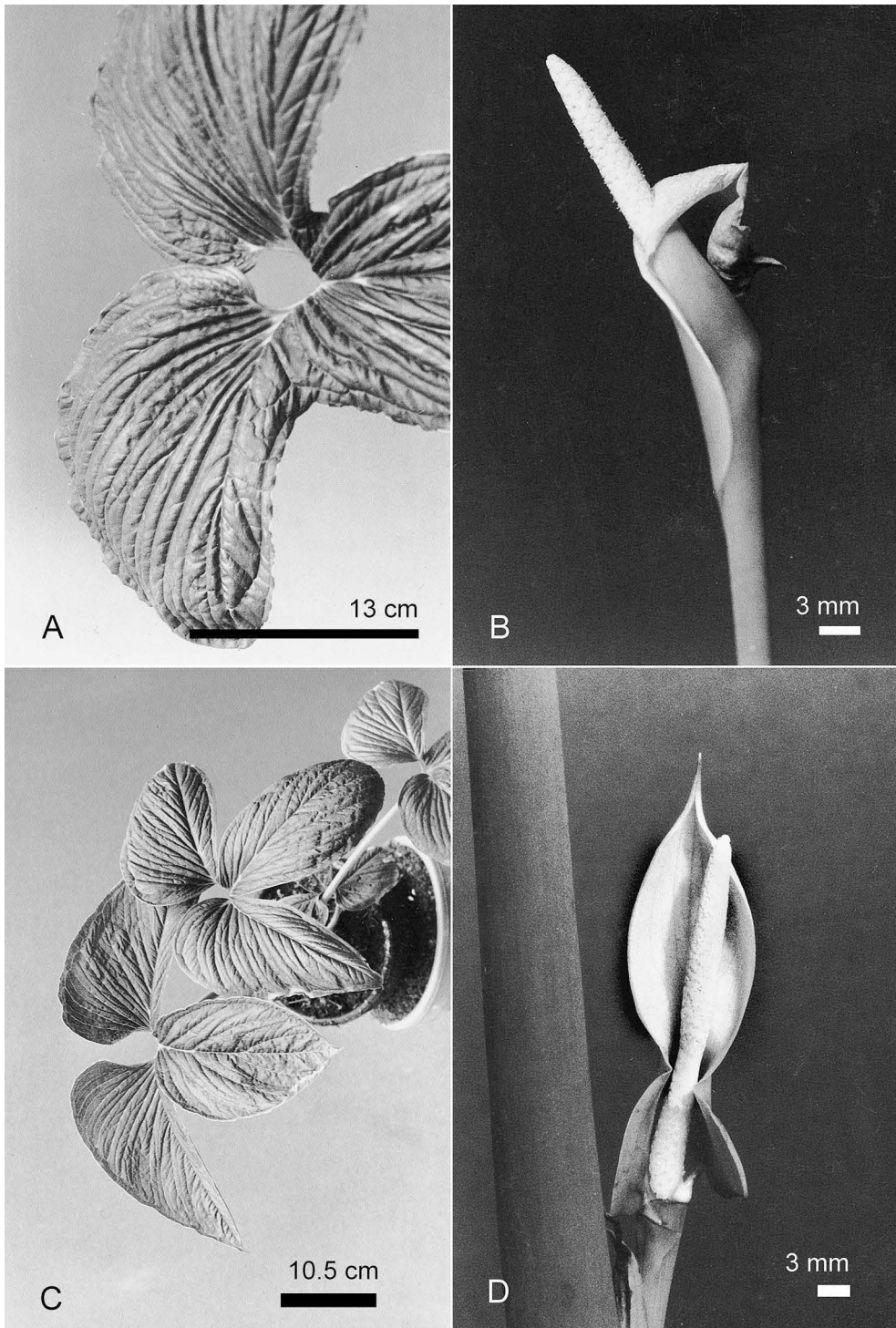


Figure 15. *Chlorospatha corrugata* Bogner & Madison, cultivar at the Munich Botanical Garden, from the type collection *Spear s.n.* —A. Close-up of the leaf blade adaxial surface. —B. Inflorescence in side view, with spathe spreading and coiled. —C. Habit of potted plant. —D. Inflorescence with spathe at anthesis (tube cut open to expose the lower pistillate portion). A–D photographs by J. Bogner.

lower surface, with 7 to 10 veins branching off, ca. 4 aicroscopic, 5 basisopic, quilted-sunken on upper surface, occasionally weakly paler than surface toward the base, drying concolorous; primary lateral veins (on medial lobe) 4 to 6 pairs, arising at 25°–35°, straight to weakly arcuate, quilted-sunken on upper surface, weakly paler than surface, round-raised on lower surface, drying concolorous; primary lateral veins (on lateral lobes) (7)8 to 10 on outer side, arising at 40°–45°, moderately arcuate, aggregated toward the base; secondary veins quilted-sunken on upper surface; tertiary veins in part sunken on upper surface; collective veins 3, the innermost arising from one of the lowermost lateral veins at base, loop-connected with all preceding lateral veins, weakly scalloped, 3–8 mm from margin. INFLORESCENCES erect, to 3 per axil; peduncle held within the sheath, (3–3.5)8–13 cm \times 2.5–3 mm, granular-puberulent, pale green, drying ca. 2 mm diam., matte, dark brown; **spathe** erect, 4.5–5.3 cm long, acuminate at apex, the margins in-rolled in apical 1–1.5 cm, broadly funnel-shaped at anthesis; spathe tube pale to medium green or white on both surfaces, granular-puberulent to weakly minutely puberulent on outer surface, ca. 2.3 cm long, drying 3.5–4.5 mm diam., matte to weakly glossy, dark brown to reddish brown on outer surface, weakly paler on inner surface and densely cream, punctiform (speckles regularly rounded, appearing as subepidermal cellular inclusions), most densely so toward base; spathe blade white, green, or yellowish, ca. 3 cm long, drying ca. 5 mm diam., paler than tube, opening broadly at anthesis, marcescent, reflexing after anthesis; **spadix** erect, 3.5–4.9 cm long, sessile, \pm cylindrical, adnate to spathe 6–9 mm at base, 1/2 to 2/3 of the length of pistillate portion; pistillate portion whitish, 1–1.3 cm long, drying 2.5–3 mm diam., orangish; fertile staminate portion yellowish or white, 2–2.5 cm \times 2–4 mm, bluntly acute at apex, \pm cylindrical to tapering, occasionally weakly narrowed at base, drying medium pinkish tan; sterile staminate portion creamy yellow, 0.5–1 cm \times ca. 2.5 mm, cylindrical, weakly narrower than pistillate and fertile staminate portions, drying yellowish; pistils weakly coherent, ca. 4 across the axis (viewed from above), 1–1.5 mm long; ovaries 1.5–1.9 mm diam., subglobose, with axile placentation, drying pale yellowish; ovules hemianatropous; style Type 4 (Fig. 1) (possibly Type 6, Fig. 1), whitish, 1–1.5 mm diam., moderately broader than ovary apex, the margins weakly coherent with those of adjacent styles; **stigma** disklike, lemon-yellow, 0.7–0.8 mm diam., sessile or apparently so, weakly depressed medially, drying medium reddish brown; synandria ca. 1.3 \times 1.8–2 mm, coherent, truncate, irregularly 3- to 4-lobed, 3- to 4-androus,

with a few at the apex lacking microsporangia; pollen in tetrahedral tetrads, ca. 42 microns diam., obscurely punctate; sterile flowers ca. 1 mm long, 1.5–3 \times 0.8–1.3 mm and \pm elongated in direction of axis, coherent, truncate, irregularly subprismatic, arranged in 3 to 6 whorls. INFRUCTESCENCE 3.5 \times 1 cm, drying dark brown, almost black, weakly minutely puberulent on outer surface; berries not known. CHROMOSOMES $2n = 26$ (Mayo et al., 1999).

Phenology. Flowering is only known to occur in *Chlorospatha corrugata* in March, April, and July, with fruiting recorded for the month of July.

Discussion. *Chlorospatha corrugata* is known only from Antióquia Department, Colombia, at 890–1350 m elevation, in premontane rainforest or possibly tropical wet forest, and is the only member of *Chlorospatha* sect. *Occidentales* with divided leaf blades. No other species occurs on the western slopes of both the Cordillera Central and Cordillera Occidental; however, the type locality in the vicinity of Sopetrán, near the Río Cauca in the Cordillera Central, is possibly in error. The type is the only collection from this area and the information regarding the collection was obtained only recently, by way of personal communication with Mrs. Elaine Spear, the collector of the type. However, it is unlikely that these apparently widely separated collections represent more than one species. They appear to accord in all respects except in the size of the leaf blades and the presence of a posterior lobe in one collection from the Cordillera Occidental (*Callejas et al. 6706*), which can be reasonably attributed to maturity or age, and in the color of the synandria, which are yellowish in the type and white in the other collections.

Chlorospatha corrugata is distinguished by its deeply 3-lobed to trisect, concolorous, corrugate, medium green leaf blades that are densely reticulate on the lower surface, with all orders of venation raised and puberulent to granular-puberulent. The lateral lobes are distinctive, being unusually long and broad, usually longer and wider than the medial lobe, and markedly inequilateral. The species is also distinguished by its short peduncle (to 13 cm long) and small inflorescence, less than 6 cm long, with the spathe blade reflexing after anthesis, a condition observed in only two other species of *Chlorospatha*.

Chlorospatha corrugata could not be easily confused with any other species. Only *C. risaraldensis* shares its unusual blade shape and will be considered under that species. *Chlorospatha risaraldensis* is a member of *Chlorospatha* sect. *Chlorospatha* and occurs only on the western slopes in Risaralda Department, Colombia, to the south (see discussion for *C. risaraldensis*).

Additional specimens examined. COLOMBIA. **Antioquia:** Mpio. Frontino, La Blanquita District, Region Murrí, betw. Nutibara & La Blanquita, 14.5 km W of Nutibara, 15–16 km from Alto de Cuevas–La Blanquita, 890–900 m, *Callejas et al. 6706* (MO, HUA); Mpio. Urrao, Parque Nac. Las Orquídeas, Sector Calles, Quebrada “La Agudelo,” 1300–1350 m, *J. Ramírez et al. 4102* (MO).

20. *Chlorospatha croatiana* Grayum, Ann. Missouri Bot. Gard. 73: 464. 1986. TYPE: Panama. Coclé: N slope & summit of Cerro Pilón, 900–1173 m, 13 Mar. 1973, *Croat 22932* (holotype, MO-3272450!; isotypes, B not seen, K!, PMA not seen, US!). Figures 16A–D, 17A–D.

Terrestrial herb, rarely hemiepiphytic, 0.5–2 m tall; stem decumbent or erect, in part subterranean, erect 5–50(–100) cm, occasionally producing bulbils randomly along its length, remnants of old cataphylls persisting as pale to medium brown fibers along its length; bulbils solitary, 0.5–2.2 cm \times 3–12 mm, covered in brown fibers; sap milky or transparent; internodes 0.3–2(–3.3) \times 0.8–4 cm, medium to dark brown, weakly scurfy, rarely with epidermis peeling and curling back at base of stem (*Croat 83606*), drying matte, dark brown; cataphylls lanceolate, becoming fibrous, 2 to 4 per leaf, 9–23(–25) cm long, acute or obtuse and inequilateral with acumen at apex (acumen to 1 cm long), obtusely 1-ribbed in apical 1/2 and longitudinal veins prominulous abaxially, weakly glossy, medium purplish, broadly dark purple along margins and abaxial rib, densely purple-mottled in narrow transverse bands, glossy and much paler on inner surface, drying matte to weakly glossy, dark reddish brown. LEAVES 1 to 4, erect to erect-spreading; **petioles** 31–78(–100) cm long, spongy or fleshy, glabrous, matte to semiglossy, green, purple, purplish or purplish brown, or green and purplish toward the base or entirely or in part purple-, purple-brown- or darker green-mottled, usually in narrow transverse bands, rarely gray-mottled, drying matte to weakly glossy, medium-dark to dark reddish brown, occasionally blackish, weakly fibrous, sheathed (14–) 18–50 cm, 1/4 to 2/3 of total length; sheath decurrent at apex; free portion 3–8 mm diam. midway, terete or obtusely flattened near apex adaxially, with margins weakly sharp, occasionally with obtuse medial rib; **blades** held horizontally to drooping, 3- to 5-lobed to \pm pedatisect and usually prominently auriculate, or 5- to 9-lobed with auricles lacking, (20–)24–44(–56) \times 20–60 cm, 1.1 to 1.5 times wider than long, occasionally as long as or weakly longer than wide, thin to thinly coriaceous, rarely subcoriaceous, conspicuously bicolorous, occasionally moderately so, the margins occasionally weakly broadly sinuate; upper surface \pm flat to broadly quilted, rarely weakly

corrugate, velvety, matte, weakly glossy or semiglossy, dark green, rarely gray-green, occasionally sparsely white or pale yellow maculate (maculations small), drying matte or weakly glossy to semiglossy, dark green to olive-green or brownish green, rarely greenish brown; lower surface matte to weakly glossy, drying weakly glossy to semiglossy, occasionally glossy, occasionally yellow-green, grayish, or with a silvery sheen, moderately to conspicuously paler; all segments \pm broadly to narrowly elliptical, ovate or obovate, rarely \pm lanceolate, weakly, gradually, or abruptly acuminate at apex, rarely acute, moderately to markedly narrowed toward and moderately to markedly narrowly attached at base, narrowly to moderately confluent between segments, the confluent portion (0.05–)0.1–2.5(–3) cm wide; **medial lobe** 19–36(–44) \times 7–21 cm, (0.3–)1–5(–7) cm wide at point of attachment, (1.5 to)1.9 to 3.6(to 4.8) times longer than wide, occasionally equal in length to or weakly shorter than innermost lateral segment, acute, attenuate or occasionally cuneate at base, weakly to moderately inequilateral, with one side 1.1 to 1.5(to 2) times wider than opposite side midway; **lateral lobes** 9–33 \times (1.5–) 2–15.5(–21) cm, (1.5 to)1.9 to 4(to 5) times longer than wide, progressively shorter and weakly to moderately narrower toward outermost segments, rarely with innermost segment weakly broader than medial segment, weakly progressively inequilateral toward outermost segments, rarely markedly so, the inner side always narrower, usually attenuate at base, occasionally acute; outer side (1.2 to)1.6 to 2.6(to 4) times wider than inner side midway; outermost segment rounded, acute or truncate at base on posterior side, with or without a weakly to well-developed auricle 7–12 \times 2–4.5 cm, acute to narrowly or bluntly rounded at apex, with weakly to well-developed midrib 2.5–8.5 cm long, with 3 to 10 veins branching off, 2 to 6 acroscopic, 1 to 4 basicopic, with inner side 0.5–2 cm wide midway, the outer side 1.5–2.5 cm wide midway and weakly to prominently constricted at base; all orders of venation glabrous on lower surface; midrib and major venation obtusely to moderately or deeply sunken on upper surface, concolorous to occasionally weakly darker than surface, convex or round-raised to acutely raised on lower surface, concolorous to moderately darker than surface, drying weakly to moderately raised, rarely \pm flattened, concolorous or weakly paler to conspicuously darker than surface; posterior rib naked 2.5–5.5(–8) cm per side, frequently markedly curved; primary lateral veins (on all segments) 2 to 7(8) pairs, arising at 15°–60°, most acutely toward apex, weakly to moderately arcuate, occasionally \pm straight; secondary veins flat or obtusely sunken on upper surface, rarely narrowly



Figure 16. *Chlorospatha croatianae* Grayum subsp. *croatiana*. —A. Habit. —B. Fertile plant. —C. Close-up of three inflorescences, one at anthesis. —D. Cluster of inflorescences. A, D from *Croat 74821* (MO). B, C from cultivated plants at MO from *Croat 67109*.

sunken, weakly to conspicuously raised on lower surface, concolorous to weakly darker than surface, drying weakly to moderately raised, prominulous or in part weakly raised and otherwise flat, concolorous to moderately darker than surface; tertiary veins flat or occasionally sunken on upper surface, entirely weakly to prominently raised, or flat and visibly distinct, or in part raised and otherwise visibly distinct on lower surface, concolorous to weakly darker than surface, drying weakly to moderately raised, prominulous, flat and visibly distinct or obscure, concolorous to moderately darker than surface; reticulate veins flat, rarely in part obtusely sunken on upper surface, flat and visibly distinct or obscure on lower surface, rarely weakly raised, drying obscure to occasionally visibly distinct or in part prominulous and otherwise flat, concolorous to weakly darker than surface, rarely in part moderately darker; collective veins 2 to 4, arising from lowermost lateral vein at the base, occasionally from the base or lateral vein near the base, loop-connected with all preceding lateral veins, markedly scalloped and remote from margin, 0.3–3 cm from margin, occasionally \pm parallel to margin. INFLORESCENCES erect, 3 to 8 per axil, emitting a sweet fragrance at anthesis; inflorescence cataphyll 2-ribbed abaxially; peduncle held within the sheath, 11–50 cm \times 2–5 mm (1–4 mm diam. dry), terete or obtusely cylindroid and thicker than broad, glabrous, entirely purple or matte, medium green to yellow-green and darker green- or purple-mottled in narrow transverse bands, most densely so toward base, drying matte to weakly glossy, medium to dark brown or blackish; **spathe** moderately to markedly cucullate, (4.6–)6–9.5(–10) \times ca. 0.5–1.2 cm (to 1.8 cm diam. at anthesis), cuspidate at apex, opening \pm broadly 1/2 to 3/4 of its length at anthesis, the margins directed forward; spathe tube matte to weakly glossy, white, cream, or pale to medium green or yellow-green on outer surface, glossy, green or purplish on inner surface, (1.8–)2.3–3.6 cm long, drying matte to weakly glossy, medium to dark greenish brown or brown on outer surface, matte to weakly glossy on inner surface, weakly to moderately paler; spathe blade weakly glossy to semiglossy, white, cream, pale green, or pale yellow-green, narrowly glossy and cream along margins on outer surface, matte on inner surface, (2.6–)3.5–6 cm long, occasionally obtusely 1-ribbed abaxially, drying matte, tan to medium brown on outer surface, matte on inner surface, rarely semiglossy, marcescent, erect after anthesis; **spadix** erect or curving weakly forward, 3.9–8 cm long, frequently markedly shorter than spathe (to 4 cm shorter), sessile or stipitate 2–6 mm, adnate to spathe 0.7–2(–3) cm at base, 1/5 to 3/5 of the length of pistillate portion, rarely to 3/4 or not at

all, the axis pale green; pistillate portion white or yellow, (1.2–)1.5–3.7 cm \times 3–6 mm, drying 2–5 mm diam., medium brown to dark purplish brown; fertile staminate portion white, cream, yellowish, or greenish cream, purple (*Hammel 2571*) or yellow (*Callejas et al. 4570*), (1.5–)1.7–3.7 cm \times 3–7 mm, narrowly rounded at apex, \pm cylindrical to weakly tapering, weakly broadest at base or toward middle, drying medium to dark purplish brown, occasionally yellowish tan; sterile staminate portion cream or pink (*Dressler 4884*), (0.1–)0.3–1.5(–1.7) cm \times 3–8 mm, \pm cylindrical or broadest at base, frequently with axis naked 1–4 mm at base, drying brownish cream, pale to medium tan or dark brown, with orange chromoplasts; pistils weakly coherent to \pm laxly arranged, 3 to 6 across the axis (viewed from above), 1.5–2 mm long; ovaries \pm conical, cylindrical or ovoid, occasionally subglobose on drying, white or lavender-tinged white, dark purple-tinged at base (*Croat 74799*), 1.5–2 mm diam., drying white, cream or pale tan, 2- to 3-locular (mostly 3), with axile or subaxile placentation; ovules 7 to 10 per locule, large, hemianatropous, biseriate or disorganized and uniseriate; funicle shorter or longer than ovule; style Type 3 (Fig. 1), 0.2–0.5 \times 1–2 mm, as broad as or weakly broader than ovary apex, the margins usually not coherent with those of adjacent styles; **stigma** white or pale green, 0.5–0.8 mm diam., sessile or apparently so, \pm cylindrical or weakly broadest at apex, coronate and concave medially; synandria 1–1.2 \times 1.5–2.2 mm, coherent, truncate, deeply (2)3- to 5-lobed, (2)3- to 5-androus (mostly 3 to 4); pollen (pictured in Grayum, 1984) in planar tetrads, inaperturate, coarsely foveolate or reticulate, the individual grains 24–31 μ m diam. (mean, 27 μ m), starchless, binucleate; sterile flowers in 1 to 6 whorls (rarely with none at all), 1–1.8 \times 1–2 mm, or 1 \times 1.5–2 mm diam. and \pm elongated in direction of axis, \pm coherent to laxly arranged, subprismatic, irregularly lobed or fungiform (like toadstools) and broadly concave medially, rarely 2- to 4-branched in basal 1 to 2 whorls, the branches \pm clavate and obtusely truncate at apex. INFRUCTESCENCES (4–)5.5–9 \times 1–1.5 cm; berries white, 3–5 mm diam.; seeds white, 13 to 25 per berry, 1–1.5 mm long, ovoid, longitudinally striate, minutely brown-strophiolate.

Discussion. *Chlorospatha croatiana* is widely distributed in Panama, with a few sterile collections having been made on the Atlantic slopes in Costa Rica, and occurs southward into northwestern Colombia.

Chlorospatha croatiana is distinguished by its frequently large size (1–2 m tall) with the stem erect, occasionally to as much as 1 m, and the internodes relatively short, rarely more than 2 cm long. The species

is also distinguished by its thin to thinly coriaceous, rarely subcoriaceous, 3- to 9-pedatifid leaf blades that are narrowly to moderately confluent between segments and usually conspicuously bicolorous, with the lower surface matte. The innermost collective vein is conspicuously scalloped and remote from the margin, occasionally to almost 3 cm from the margin. The spathe is short (relative to plant size), rarely as much as 10 cm long, and the spadix is cylindrical and frequently much shorter than the spathe (to 4 cm shorter), which is usually prominently cucullate.

Chlorospatha croatiana, as defined by Grayum (1986), consists of one subspecies and one variety, with the typical subspecies restricted to Panama and Costa Rica and variety *enneaphylla* restricted to the western slopes of the Cordillera Oriental and eastern slopes of the Cordillera Central in Colombia. The typical subspecies has leaf blades with three to five lobes, with the posterior side of the outermost lobes more or less rounded at the base or prominently, broadly auriculate. In contrast, variety *enneaphylla* typically has seven to nine lobes that are narrower, with the outermost lobes acute at the base and lacking prominent auricles. Recent studies in Panama have shown that variety *enneaphylla* occurs in the same localities as subspecies *croatiana*, precluding the possibility that it is a subspecies, not being separated geographically, elevationally, or ecologically. Two recent collections were made in Chocó Department, Colombia, on the Panamanian border, near Acañí. Therefore, the epithet *enneaphylla*, previously known as a subspecies, should now be considered only a variety of *C. croatiana*. Sterile collections of *Chlorospatha* var. *enneaphylla* (Grayum) Croat & L. P. Hannon with 7-lobed blades were made in Panama, in Coclé and Veraguas provinces. As well as having 7- to 9-lobed blades, variety *enneaphylla* may have as few as five lobes, with the segments acute, narrowly attached, and narrowly confluent between segments or nearly free at the base versus consistently broadly attached (not acute) and more broadly confluent at the base in the species. *Chlorospatha croatiana* var. *enneaphylla* has only two to four pairs of primary lateral veins arising at 15°–35° versus five to seven (eight) pairs arising at 35°–60° in the species. The distinction between the two subspecies is based less on the quantity of lobes on each blade and more on the nature of the lobes. Since the degree to which the blades of aroid taxa are compound or deeply lobed is highly variable, through both age and geographical distribution, it is not surprising that both of these subspecies are more variable in the number of lobes than was initially assumed. However, the nature of the lobes, especially the shape, venation, and degree to

which auricles develop on the outermost segments, is uniform and consistently different in the two subspecies of *C. croatiana*.

KEY TO THE SUBSPECIES AND VARIETIES OF *CHLOROSPATHA CROATIANA*

- 1a. Terrestrial, 1–2 m tall; internodes 3–10 mm long; leaf blade 3- to 5-lobed to ± pedatisect; segments broad, broadly attached at the base, the outermost rounded or prominently auriculate on the posterior side at the base; primary lateral veins 5 to 7(8) pairs, arising at 35°–60°; petiole sheathed 1/4 to 1/2 of its length; posterior rib naked 2.5–4(–5.5) cm per side; pistils weakly coherent, 5 to 6 across the axis (viewed from above); Costa Rica to Panama, 200–1173(–1400) m
..... *C. croatiana* Grayum subsp. *croatiana*
- 1b. Terrestrial or hemiepiphytic, ca. 1 m tall or less; internodes 0.8–3.3 cm long; leaf blade 5- to 9-lobed to ± pedatisect; segments narrow, narrowly attached and ± acute at the base, the outermost not prominently auriculate on the posterior side; primary lateral veins 2 to 4 pairs, arising at 15°–35°; petiole sheathed 1/2 to 2/3 of its length; posterior rib naked 4–8 cm per side; pistils ± laxly arranged, 3 to 4 across the axis (viewed from above); Colombia and Panama, 150–1000(–1135) m
..... *C. croatiana* var. *enneaphylla* (Grayum) Croat & L. P. Hannon

20a. *Chlorospatha croatiana* Grayum subsp. *croatiana*. Figure 16A–D.

Terrestrial herb, 1–2 m tall; sap milky; internodes 3–10 mm × to 4 cm, drying 0.6–2.5 mm diam.; **petioles** 31–100 cm long, sheathed 1/4 to 1/2 of total length; **blades** 3- to 5-lobed to ± pedatisect, usually prominently auriculate; upper surface rarely pale yellow maculate; all segments broadly elliptical, ovate or obovate, gradually or abruptly acuminate at apex, moderately confluent between segments, the confluent portion 1–2.5(–3) cm wide; outermost segment ± rounded or auriculate at the base on posterior side; posterior rib naked 2.5–4(–5.5) cm per side; primary lateral veins 5 to 7(8) pairs, arising at 35°–60°; tertiary veins drying weakly to moderately raised or prominent on lower surface; reticulate veins drying occasionally visibly distinct or in part prominent on lower surface. INFLORESCENCES 3 to 8 per axil; **spathe** (4.6–)6–9.5(–10) cm long; **spadix** 3.9–8 cm long, sessile or stipitate; fertile staminate portion white, cream, purple, or yellowish to greenish cream; sterile staminate portion 0.3–1.5(–1.7) cm long; pistils weakly coherent, 5 to 6 across the axis (viewed from above); sterile flowers subprismatic, irregularly lobed, fungiform or 2- to 4-branched.

Phenology. Flowering occurs in *Chlorospatha croatiana* subsp. *croatiana* in all months except January and November, with fruiting collections

having been made in February, March, April, May, June, August, and October. Inflorescences emerge from the petiole sheath in quick succession, each reaching anthesis approximately one to three days after anthesis of the preceding inflorescence. *Dressler 4884* reports the spathe as being full of small beetles.

Discussion. *Chlorospatha croatianana* subsp. *croatiana* is widespread in Panama, occurring on both sides of the Continental Divide and in all provinces except Chiriquí, Herrera, and Los Santos, at 200–1400 m elevation, usually at 700–1000 m, and is found on steep, wet slopes along creeks, rivers, roads, and trails, in premontane rainforest, lower montane rainforest, tropical wet forest, premontane wet forest, and lower montane wet forest. The dry conditions existing in the provinces of Herrera and Los Santos would not sustain subspecies *croatiana*, but it undoubtedly occurs in Chiriquí Province, as does variety *enneaphylla*, and would be expected to occur in Colombia, some collections from Darién and San Blas provinces having been made near that border. Four collections were made on the Atlantic slope in Costa Rica, at 200–750 m elevation, in tropical wet forest, premontane rainforest (Monteverde Reserve), and in transitional forest from tropical wet forest to premontane wet forest. These collections represent the northern limit of the species as well as the genus, although it is likely that the species extends into southeastern Nicaragua. Unfortunately, all Costa Rican collections are sterile, but these accord well with subspecies *croatiana*.

Chlorospatha croatianana subsp. *croatiana* is a member of *Chlorospatha* sect. *Chlorospatha* and is distinguished by its terrestrial habit, frequently large size (1–2 m tall, with the stem to 4 cm diam. and erect to 1 m), and short, brown internodes (3–10 mm long), with the cataphylls retained as pale to medium brown fibers. The leaf blade is 3- to 5-lobed and usually prominently auriculate. As Grayum (1986) noted, *C. croatianana* subsp. *croatiana* is variable, occasionally highly so in many respects, and is the most variable taxon in the genus. Most of the variation is observable within a small area around the sawmill near El Copé in Coclé Province, where numerous collections have been made. The petiole is consistently terete in the free portion, but can be entirely green, purple or purplish brown, or mottled with purple, green, purplish brown, or gray, and can be sheathed one fourth to one half of its length, with the peduncles accordingly long or short. The upper surface of the leaf blade can be flat or quilted, velvety to matte, or weakly glossy to semiglossy. *Croat 74821* from this area represents several extremes, having all segments almost as wide as long and corrugate on the

upper surface, with seven to eight pairs of primary lateral veins, all but the reticulate venation quilted-sunken on the upper surface and all venation raised on the lower surface. Considerable variation occurs also in the inflorescence. The color of the spathe is somewhat variable on the outer surface and the inner surface of the tube can be green or purple. Remarkable variation occurs in the sterile flowers, which can be coherent to laxly arranged, and, although subprismatic in the type and other collections, are frequently irregularly lobed and occasionally fungiform (like toadstools) or branched.

Chlorospatha croatianana subsp. *croatiana* would be most easily confused with *C. luteynii*, also with 5-lobed blades, known only from the northern portion of the Cordillera Central in Antióquia Department, Colombia, at 2440–2800 m elevation. *Chlorospatha luteynii* differs in having prominently maculate leaf blades. Weak maculations were observed on only one blade of a sterile collection from Costa Rica, of what is presumably *C. croatianana* subsp. *croatiana*, with the other blades (on the same plant) lacking maculations. The petiole of *C. luteynii* dries with the epidermis partially separated intact and semi-transparent, differing from that of *C. croatianana* subsp. *croatiana*, which usually dries somewhat fibrous, with the epidermis not separated. The spathe of *C. croatianana* subsp. *croatiana* is 6–9.5(–10) cm long versus 9–12 cm long in *C. luteynii*. The most noteworthy differences lie in the inflorescence, particularly the structure of the spadix. The spadix of *C. luteynii* is adnate to the spathe most of the length of the pistillate portion and is significantly longer, 8.5–9.5 cm long versus 3.9–8 cm long in *C. croatianana* subsp. *croatiana* in which the spadix is adnate one fifth to three fifths of the length of the pistillate portion (rarely to three fourths). The fertile staminate portion is cylindrical to weakly tapering in *C. croatianana* subsp. *croatiana*, narrowly rounded at the apex, and approximately as long as or shorter than the pistillate portion, differing from that of *C. luteynii*, which is prominently tapering, acute at the apex and more than 2 cm longer than the pistillate portion, occasionally almost twice as long. In *C. croatianana* subsp. *croatiana*, the sterile flowers are usually laxly arranged, not elongated in the direction of the axis and only occasionally subprismatic, differing from those of *C. luteynii*, which are densely arranged and consistently subprismatic and prominently elongated in the direction of the axis. The innermost collective vein is conspicuously scalloped and remote from the margin in *C. croatianana* subsp. *croatiana*, and only moderately scalloped and not markedly remote from the margin in *C. luteynii*.

Chlorospatha croatiana subsp. *croatiana* could possibly be confused with another large, 5-lobed species, *C. caldasensis*, known only from the western slopes of the Cordillera Central in Caldas Department, Colombia, at 2250 m elevation (see discussion under *C. caldasensis*).

Additional specimens examined. COSTA RICA. **Heredia:** Atlantic slope of Volcán Barva, forest betw. Río Peje & Río Sardinalito, 700–750 m, *Grayum 6657* (MO). **Limón:** Cordillera de Talamanca, ridge separating Quebrada Cañabral from Río Barbilla, slope down to latter, 200–400 m, *Grayum et al. 8742* (CR, MO); vic. Guápilles, 300–500 m, *Standley 37356* (US). **Puntarenas:** Monteverde Res., Atlantic slope, drainage of Río Peñas Blancas, 750 m, *Hammel et al. 15383* (INB, MO). PANAMA. **Bocas del Torro:** along Fortuna–Chiriquí Grande rd., 8.5 mi. N of bridge over Fortuna Lake, 4.3 mi. N of Continental Divide, 590 m, *Croat & Grayum 60208* (K, MO, NY, US); 1.1 mi. W of Fortuna–Chiriquí Grande rd., near Continental Divide, 8°44'N, 82°17'W, 11 Mar. 1985, *Croat & Grayum 60343* (MO); along rd. betw. Fortuna Dam & Chiriquí Grande, along gravel rd. departing main hwy. near Continental Divide, 4.5 mi. N of bridge over Fortuna Dam, 1170 m, *Croat 66627* (MO); Chiriquí Grande–Fortuna, above waterfall, 1.6 mi. N of Continental Divide, 770–790 m, *Croat & Zhu 76465* (MO). **Coclé:** vic. Alto Calvario, near sawmill above El Copé, 4.5 mi. N of El Copé, 2.5 mi. N of Escuela Barrigón, 580–740 m, *Croat 67528* (MO), 710–800 m, *68753* (MO), 680–770 m, *Croat 74821* (B, F, K, MEXU, MO, US); N of El Valle de Antón, forest betw. fork in rd. near Finca Mandarinas, along rd. to Finca Furlong, 785 m, *Croat 67109* (F, MO); El Valle de Antón region, at La Mesa, 3.2 mi. above El Valle, 0.1 km E of Finca Macarenita, 775 m, *Croat 74799* (M, MO, PMA), back side of Cerro Gaital, *Croat 83606* (MO); vic. Alto Calvario & near sawmill above El Copé, betw. La Junta & Limón, 5 hr. walk N of Alto Calvario, 800–1000 m, *Folsom 5870* (MO), La Pineda–El Copé rd., via Piedras Gordas, 914 m, *Hammel 2571, 3528* (MO), *Hammel & Kress 11329* (DUKE), 750–800 m, *Knapp & Dressler 3471* (MO), 793 m, *Kress et al. 83–1599* (DUKE); La Mesa area, along trail toward Los Llanos & border betw. Coclé & Panamá Prov., N of El Valle de Antón, 800–850 m, *Luteyn 3155* (DUKE); near sawmill, *Folsom 2663* (MO); **Colón:** headwaters of Río Piedras, ca. 11 km SW of Cerro Braja, 600–700 m, *Sytma et al. 4244* (MO). **Darién:** middle slopes on W side of Cerro Pirre, 800–1050 m, *Croat 68943* (M, MO); Cerro Pirre, around camp at summit of Pirre, near triangulation marker, 1400 m, *Folsom 4340* (MO); Cerro Sapó, ca. 5 km S of Garachiné, along ridge at N approach to hill, 800–1000 m, *Hammel et al. 14867* (MO). **Panamá:** Cerro Campana, W of Canal Zone, *Bartlett & Lasser 16938* (MICH, MO, UC), 800–1000 m, *Croat 17235* (MO), *Luteyn & Kennedy 1804* (DUKE), 1000 m, *Madison 775* (GH, HUH); Río Pequení, 10–15 mi. upstream from hydrographic station by motor, *Dressler 4884* (MO); betw. Tortí & Pilota del Toro, mtn. overlooking Tortí Arriba, *Folsom et al. 5058* (MO); El Llano–Cartí rd., ca. 8 km N of turn-off, 300 m, *Churchill 3804* (MO), 1000 ft., *Hammel & Kress 13401* (DUKE). **San Blás:** forest SE of Puerto Obaldía, *Croat 16818* (MO, SCZ); headwaters of Río Cangandí, trail from end of rd. past Los Altos de Pacora region of Cerro Jefé, 600–800 m, *Hammel & de Nevers 13593* (MO). **Veraguas:** valley of Río Dos Bocas, 11 km

from Escuela Agrícola Alto Piedra (above Santa Fé) on rd. to Calovébora, forest along river, 450 m, *Croat 27519* (MO).

20b. *Chlorospatha croatiana* var. *enneaphylla* (Grayum) Croat & L. P. Hannon, comb. & stat. nov. Basionym: *Chlorospatha croatiana* var. *enneaphylla* Grayum, Ann. Missouri Bot. Gard. 73: 466. 1986. TYPE: Colombia. Boyacá: El Humbo, 130 mi. N of Bogotá, 1933, *A. Lawrance 794* (holotype, K!). Figure 17A–D.

Terrestrial or rarely hemiepiphytic herb, ca. 1 m tall or less; sap milky or transparent; internodes 0.8–3.3 cm long, drying 1–1.3 cm diam.; **petioles** 47–74 cm long, sheathed 1/2 to 2/3 of total length; **blades** deeply 5- to 9-lobed to \pm pedatisect, almost pedatisect; upper surface occasionally white maculate; all segments \pm narrowly elliptical, ovate or obovate, rarely lanceolate, weakly acuminate to \pm acute at apex, markedly narrowly confluent between segments, the confluent portion 0.5–3 mm wide; outer segments \pm acute or truncate at base on posterior side; posterior rib naked 4–8 cm per side; primary lateral veins 2 to 4 pairs, arising at 15°–35°, \pm straight to weakly arcuate; tertiary veins drying flat and \pm obscure on lower surface; reticulate veins drying obscure on lower surface. INFLORESCENCES 4 to 6 per axil; **spathe** 6.5–8 cm long; **spadix** 5.5–6.5 cm long, sessile; fertile staminate portion white or yellow; sterile staminate portion 5–10 mm long; pistils \pm laxly arranged, 3 to 4 across the axis (as viewed from above); sterile flowers irregularly lobed.

Phenology. Flowering is only known to occur in *Chlorospatha croatiana* var. *enneaphylla* in May, July, and August, with fruiting collections having been made in May and July.

Discussion. *Chlorospatha croatiana* var. *enneaphylla* is known from northwestern Colombia, in Antioquia, Boyacá, and Chocó departments, at 150–820 m elevation, in premontane wet forest, premontane rainforest, and transitional forest from premontane wet forest to tropical moist forest, and from Panama, in Chiriquí, Coclé, Darién, Panamá, and Veraguas provinces, at 710–1135 m elevation, in premontane wet forest, premontane rainforest, and lower montane rainforest. The six Colombian collections were made in only three areas separated by considerable distances. The type locality in Colombia is on the western slopes of the Cordillera Oriental in Boyacá Department, in premontane wet forest. The taxon was reported as abundant in the transitional forest area near the border between Colombia and Panama and would be expected to occur in Santander, Cundinamarca, and possibly Córdoba

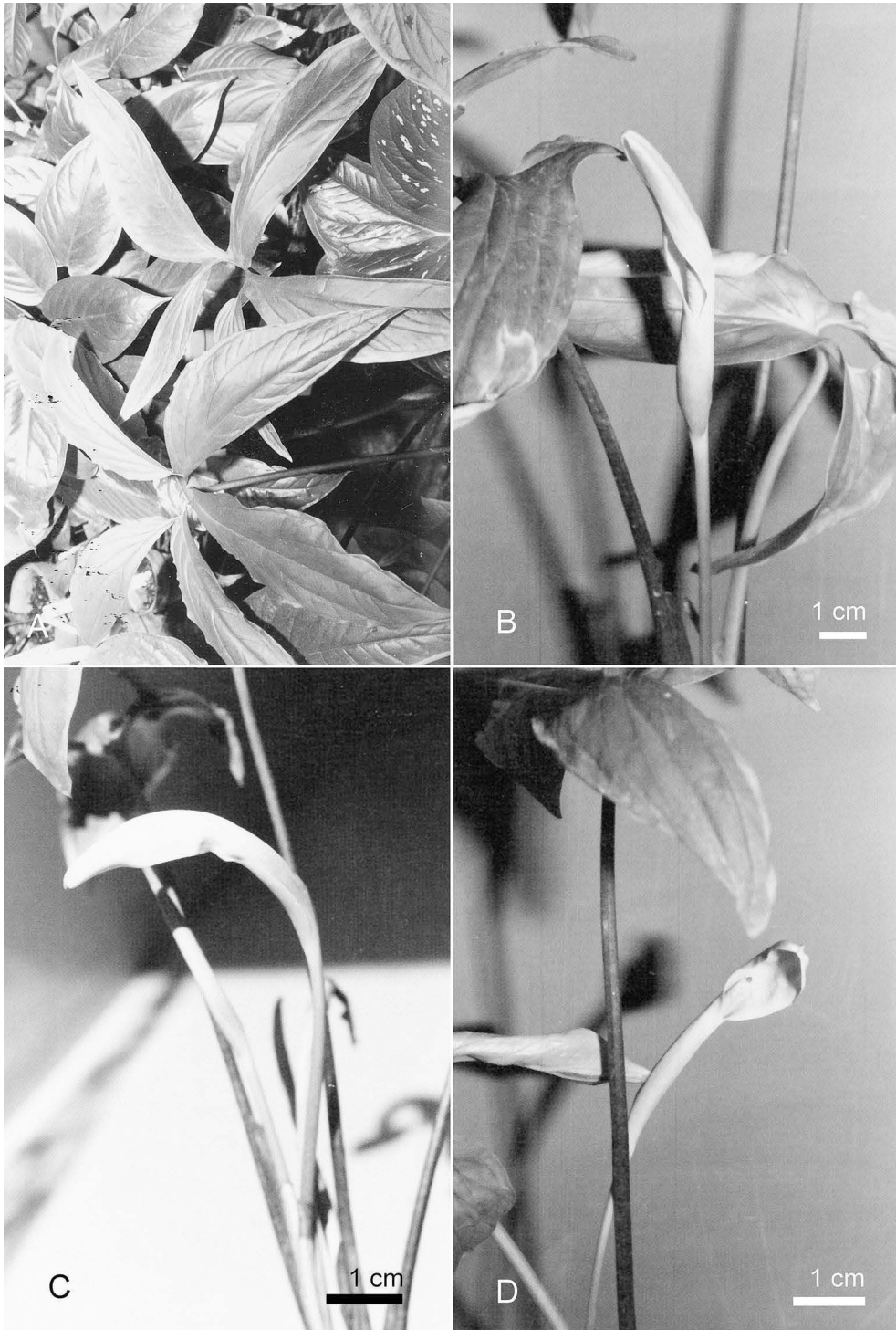


Figure 17. *Chlorospatha croatianae* var. *enneaphylla* Grayum. —A. Habit showing blade adaxial surfaces, from *Croat & Grayum 60078* (MO). —B. Inflorescence beginning to open. —C. Inflorescence in side view, post-anthesis. —D. Inflorescence in frontal view, post-anthesis. B–D from cultivated plant at MO from *Croat 22815* from Panama.

departments in Colombia. *Chlorospatha* has not been reported from any of these departments.

Chlorospatha croatianana var. *enneaphylla*, a member of *Chlorospatha* sect. *Chlorospatha*, is terrestrial or hemiepiphytic and distinguished by its deeply 5- to 9-lobed, almost pedatisect, leaf blades with the segments narrowly attached at the base (0.5–2 cm wide at point of attachment), narrowly confluent or alate between segments, the confluent portion 0.5–3 mm wide, and occasionally white maculate. The taxon has only two to four pairs of primary lateral veins arising at 15°–35°, and usually only the midrib, major, and occasionally the secondary venation dry-raised on the lower surface, with the tertiary and reticulate venation more or less obscure. The taxon is also distinguished by its relatively long internodes (1–3.3 cm long) and its petiole, which is sheathed one half to two thirds of its length. The pistils are more or less laxly arranged (three or four across the horizontal axis, as viewed from above). The sterile flowers are irregularly lobed.

Grayum (1986) cited two sterile collections as *Chlorospatha croatianana* var. *enneaphylla*, Croat 49311 (MO) and Croat 55960 (MO), both from Chocó Department, on the western slopes of the Cordillera Occidental, at 285–825 m elevation. Subsequent collections of similar material indicate that these are better assigned to a new species, *C. morae* Croat & L. P. Hannon. *Chlorospatha croatianana* var. *enneaphylla* is a larger, more robust plant than *C. morae*, with a longer petiole, sheathed one half to two thirds of its length, and larger leaf blades with longer segments with two to four pairs of primary lateral veins on all segments. In *C. morae*, the petiole is sheathed about one half of its length and the segments have six to seven (eight, nine) pairs of primary lateral veins, except on the outermost segments, which have four or five pairs. Only the midrib, major, and some secondary venation are raised on the lower blade surface in *C. croatianana* var. *enneaphylla*, which lacks the conspicuous reticulate pattern found on the lower blade surface in *C. morae*, in which all venation dries raised or prominulous and weakly to moderately darker than the surface.

One 7-lobed specimen of *Callejas et al. 4570* differs from the type in having more or less lanceolate segments (4 to) 4.2 to 5 times longer than wide versus 2.1 to 3 times longer than wide in typical specimens of variety *enneaphylla*. The leaf blade of the specimen is similar to that of *C. kolbii*, and this, combined with the more or less laxly arranged and similar pistils, would suggest a possible relationship between the two taxa.

Additional specimens examined. COLOMBIA. **Antioquia:** Mpio. Anorí, via Providencia, inlet at Algibes, along

Río Anorí, 310 m, *Callejas et al. 4570* (COL, HUA, MO); Mpio. Remedios, Sitio Otú, 3 km N of Santa Isabela distr., vic. Los Lagos, 11 km from Remedios, via Remedios–Vegachi, in forest on bank of hwy., 820 m, *Callejas et al. 4719* (HUA); Río Anorí valley, near Planta Providencia, betw. Dos Bocas & Anorí, 350–700 m, *Shepherd 899* (COL, WIS); Anorí, Providencia area, betw. Providencia & Alhibe, 400–800 m, *D. Soejarto et al. 4394* (HUA). **Chocó:** Mpio. Acandí, vic. Coquital, 150–250 m, *Fonnegra et al. 2914* (COL, HUA), 2928 (HUA). PANAMA. **Chiriquí:** Fortuna–Chiriquí Grande rd., 4.5–5 km N of dam over Fortuna Lake, 1100–1135 m, *Croat & Grayum 60078* (MO). **Coclé:** vic. Alto Calvario, near sawmill above El Copé, 5.2 km above El Copé, 930 m, *Croat 49172* (MO), 710–800 m, *Croat 68752* (F, MO), 8 km N of El Copé, 750 m, *Maas et al. 2740* (U). **Darién:** along headwaters of Río Tuquesa, ca. 2 km by air from Continental Divide, vic. of upper gold mining camp of Tyler Kittredge, *Croat 27111* (MO). **Panamá:** Cerro Campana, W of Canal Zone, 1000 m, *Croat 22815* (MO). **Veraguas:** Alto Piedra, vic. Santa Fé, along ridge extending to summit, 1 km from Escuela Circolo Alto de Piedra, on rd. to N going to Río San Luís, 800–950 m, *Croat 66996* (M, MO).

21. *Chlorospatha cutucuensis* Madison, Selbyana 5(3–4): 354. 1981. TYPE: Ecuador. Morona-Santiago: Cordillera de Cutucú, ca. 25 km SE of Logroño, ca. 1700 m, 17 May 1979, *M. Madison 6944* (holotype, SEL!; isotypes, MO!, QCA!, US!). Figure 12D.

Terrestrial herb, to 70 cm tall; stem erect, 20–30 cm long, remnants of old cataphylls persisting \pm intact at upper nodes; internodes 1.5–3 \times 1–2 cm, pale-medium brown, drying 0.5–1 cm diam., weakly glossy, pale to medium reddish brown; cataphylls 15–21 cm long, apex not known, drying weakly glossy, medium reddish or orangish brown. LEAVES 2 to 3, erect to erect-spreading; **petioles** 25–42.5 cm long, medium green, drying glabrous, matte to weakly glossy, medium to dark brown, usually darkest apically, sheathed 18–20 cm, ca. 2/3 of total length; sheath decurrent at apex; free portion 2–3.5 mm diam. midway (dry); **blades** held horizontally or drooping, sagittate-subhastate, (12–)20–29 \times (7–)15–22 cm, 1.1 to 1.3 times longer than wide, acute to weakly acuminate at apex, broadest at base, 1.5 to 1.6 times wider at base than across anterior lobe (measured tip to tip across posterior lobes), occasionally weakly constricted in area of petiole attachment, thin, moderately to conspicuously bicolorous; upper surface dull, medium green, drying matte, medium to medium-dark greenish brown; lower surface drying weakly glossy to semiglossy, occasionally gray-tinged brownish green, moderately paler; anterior lobe 16–20.5 \times 9.5–15 cm, 1.4 to 1.7 times longer than wide, 1.4 to 2 times longer than posterior lobes, broadest at base; posterior lobes directed somewhat outward, 8–14.5 \times 4–7 cm, 1.7 to 2.1 times longer than wide, narrowly

rounded at apex, rarely bluntly rounded, broadest at base, moderately inequilateral, the inner side narrower, weakly rounded at base, briefly to moderately attenuate and decurrent onto petiole; outer side 1.6 to 2.5 times wider than inner side midway, straight to weakly concave toward base; midrib drying weakly or entirely flattened on lower surface, weakly darker than surface, usually much darker toward base; **basal veins** 2 to 3 pairs, coalesced into a prominent posterior rib; primary lateral veins 4 to 5(6) pairs, arising at 15°–60°, most acutely toward apex, weakly arcuate, drying \pm flattened on lower surface, weakly darker than surface, occasionally much darker toward base; secondary veins drying in part raised, otherwise mostly flattened on lower surface, weakly darker than surface; tertiary veins drying visible, distinct on lower surface, in part weakly darker than surface, otherwise concolorous; reticulate veins drying obscure; collective veins 3, the innermost arising from apex of posterior rib or uppermost lateral vein on inner side of posterior lobe, loop-connected with all preceding lateral veins, parallel to and ca. 3 mm from margin. INFLORESCENCES erect, 2 to 4 per axil; peduncle held within the sheath, 14–18 cm \times ca. 2 mm, drying yellowish tan in basal two thirds, dark brown apically, or entirely dark brown; **spathe** erect, 8.5–9 cm long, cuspidate at apex; spathe tube green, 2.2–2.8 cm \times 6–8 mm, drying matte, dark brown; spathe blade white or cream, ca. 5.7 cm long, ca. 1 cm wide (flattened), drying matte, dark brown, marcescent, erect after anthesis; **spadix** (details from pickled inflorescence) erect, 6–6.4 cm long, sessile, adnate to spathe ca. 4 mm at base, less than 1/4 of the length of pistillate portion; pistillate portion cream to pale yellow, 2 cm \times 3–5 mm; fertile staminate portion white, 3.5–4 cm \times 3–4 mm, bluntly acute at apex, weakly thicker than broad, broadest at base, tapering; sterile staminate portion cream, 7–8 \times 4 mm; pistils weakly coherent, 4 to 5 across the axis (viewed from above), 1–1.2 mm long; ovaries cream, ovoid to \pm cylindrical, 1.5–2 mm diam., occasionally obtusely truncate at apex, (2)3- to 4-locular, with pseudoaxile placentation in basal 1/2; ovules 4 to 10 per locule, anatropous, biseriate; funicle shorter than ovule; style Type 2 (Fig. 1), 0.3–0.5 \times 0.8–1 mm, comprising ca. 1/4 of the length of pistil, weakly broadest at base, prominently narrower than ovary apex, briefly irregularly attenuate, usually \pm wrinkled, occasionally weakly shorter than and surrounding the stigma, with numerous red chromoplasts; **stigma** yellow, ca. 0.5 mm diam., elevated on style, broadest at apex; synandria ca. 1 \times ca. 1.5 mm, \pm elongated in direction of axis in basal 1/2 of spadix, coherent, truncate, 3- to 4-lobed, 3- to 4-androus (mostly 4); sterile flowers ca. 1 \times 1–3 mm, \pm

elongated in direction of axis, coherent, truncate, subprismatic to occasionally irregularly lobed, in 3 whorls. INFRUCTESCENCE (immature) 2.5 cm \times 8 mm; berries white, ca. 3 mm diam.; seeds 3 to 5 per berry (mostly 3), 1.5 mm long, ovoid, striate.

Phenology. Flowering is only known to occur in *Chlorospatha cutucuensis* during the months of May, September, and November. It is likely that flowering occurs during some of the intervening months. Fruiting is known to occur only during the month of November.

Discussion. *Chlorospatha cutucuensis* is known only from lower montane wet forest in an area near Logroño in Morona-Santiago Province, Ecuador, on the western slopes of the Cordillera de Cutucú, east of the Andes, at 1700–1900 m elevation. The species has not been collected since the type was collected except once (*Madison et al.* 3530), but it would be expected to occur elsewhere in the Cutucú and perhaps nowhere else, the Cutucú being a region noted for a high level of endemism in species of Araceae.

Chlorospatha cutucuensis is a member of *Chlorospatha* sect. *Orientales* and is characterized by its dull, medium green, somewhat triangular, sagittate-subhastate leaf blades that dry semiglossy and conspicuously smooth on the lower surface, with all venation glabrous and flattened. This is noteworthy because the blades of all other known species from the area east of the Andes in Ecuador, except *C. portillae* and *C. sizemoreae*, are reticulate and narrowly colliculate along all orders of venation on the lower surface and dry less glossy, with all venation raised, prominulous, or otherwise visibly distinct. *Chlorospatha cutucuensis* is a large plant compared to most species from the eastern slopes and is also distinguished from those species by its long petiole sheathing (ca. two thirds of total length), long peduncles (14–18 cm long), and synandria that are evenly lobed and truncate at the apex. The synandria of *C. cutucuensis* are similar to those of all species from the western slopes, but to only four species from the eastern slopes, in *Chlorospatha* sect. *Orientales*: *C. engleri*, *C. limonensis*, *C. portillae*, and *C. sizemoreae*. Although the species could not be confused, *C. cutucuensis*, *C. portillae*, and *C. sizemoreae* are the only members of *Chlorospatha* sect. *Orientales* with attenuated styles. The style of *C. cutucuensis* differs from that of the other two species in frequently having the attenuated portion wrinkled, occasionally forming a conspicuous “collar” around most of the stigma, with only the apex of the stigma exposed above the “collar” (at least in pickled material). The style is smooth and unwrinkled in *C. portillae* and *C. sizemoreae* and the stigma fully exposed.

Chlorospatha cutucuensis would be most easily confused with *C. yaupiensis*, with which it is sympatric in the area near Logroño in the Cordillera de Cutucú (cf. discussion under *C. yaupiensis*). Both species have long peduncles and leaf blades of similar shape, but the posterior lobes in *C. yaupiensis* are broader, only 1.5 times longer than wide, usually shorter, more broadly rounded at the apex, and lack the tapering aspect usually observed in those of *C. cutucuensis*. Pale linear cellular inclusions were observed in the developing blade of *C. yaupiensis* but not in that of *C. cutucuensis*. The lower blade surface is reticulate and dries matte in *C. yaupiensis*, with all orders of venation more or less raised or prominulous and crispy-puberulent to granular-puberulent, thus differing from that of *C. cutucuensis*, which dries semiglossy, with all venation glabrous and flattened.

Madison (1981) reported that the pistils of *Chlorospatha cutucuensis* were more closely crowded together than those of other species of *Chlorospatha* and suggested that this feature placed it somewhat closer to *Xanthosoma*. Numerous collections of different species of *Chlorospatha* have since been made, revealing that this feature is common and not the exception. The ovaries of *C. cutucuensis* are only weakly coherent and clearly distinct from one another, with the styles narrower than the ovary and neither coherent nor weakly connate, thus differing from the pistils of *Xanthosoma*, in which the ovaries and styles are coherent and the styles are as broad as the ovary.

Additional specimen examined. ECUADOR. **Morona-Santiago:** Cordillera de Cutucú, Logroño–Yaupi trail, 1750–1900 m, *Madison et al.* 3530 (SEL, US).

22. *Chlorospatha dodsonii* (G. S. Bunting) Madison, *Selbyana* 5(3–4): 352. 1981. Basionym: *Caladiopsis dodsonii* G. S. Bunting, *Ann. Missouri Bot. Gard.* 50: 28. 1963. TYPE: Ecuador. Pichincha: along Río Baba, 28 km S of Santo Domingo de los Colorados, 350 m, 3 Nov. 1961, *C. Dodson & Thien 1190* (holotype, MO-1782096!; isotypes, B not seen, CAS not seen, F!, K!, NY!, QCA!, US!). Figures 2A–F, 18A–D.

Terrestrial herb, rarely hemiepiphytic, to 1 m tall; stem usually erect, 25–50 cm tall, but can be decumbent or rarely hemiepiphytic and to 80 cm long, cylindrical, producing bulbils randomly along its length; bulbils solitary, 3–10 × 2–4 mm, longer than broad, sparsely covered in medium brown fibers; sap milky; internodes 1–2(–3) × 1–4 cm, weakly scurfy, matte, medium brown, drying matte, dark brown; cataphylls ultimately deciduous, 10–43 cm long,

obtuse with acumen at apex, obtusely 1-ribbed abaxially, green, drying weakly glossy, dark brown. LEAVES 4 to 8, erect-spreading; **petioles** 30–90 cm long, moderately firm, rarely weakly spongy, glabrous, matte, entirely purplish or pale, medium or dark green, or in part medium to dark green and purplish near base, drying matte to weakly glossy, occasionally semiglossy, medium-dark to dark brown, sheathed 13–46(–55) cm, ca. 1/2 to 2/3 of total length, occasionally to 3/4, usually less than 1/2 of its length when not in flower; sheath decurrent at apex, rarely free-ending, the margins frequently conspicuously narrowly undulate; free portion 0.5–1 cm diam. midway, entirely terete or in part terete and otherwise obtusely C- or D-shaped toward apex and occasionally obtusely sulcate at apex, occasionally entirely obtusely D-shaped, with obtuse medial rib; **blades** held ± horizontally, hastate to markedly hastate, 21–42 × 19–44.5 cm, usually weakly wider than long, gradually to occasionally abruptly acuminate at apex, broadest at base, 1.8 to 2.9 times wider at base than across anterior lobe (measured tip to tip across posterior lobes), thin to thinly coriaceous, rarely subcoriaceous, weakly to moderately bicolorous; upper surface weakly to moderately wrinkled, matte to semiglossy or velvety, dark green, drying matte to weakly glossy, occasionally semiglossy, medium-dark to dark greenish brown or olive-green, occasionally brownish green; lower surface reticulate, obscurely narrowly colliculate along some venation, matte to weakly glossy, occasionally semiglossy, drying weakly to moderately paler, occasionally gray-tinged green; anterior lobe 16–33.5 × 9–18.5 cm, (1.2)1.3 to 2 times longer than wide, 1.1 to 1.7 times longer than posterior lobes, broadest at or below middle, moderately to markedly constricted at base, ± symmetrical; posterior lobes directed prominently outward, frequently weakly toward apex on drying, 9.5–24 × 3.8–10.5 cm, 2.1 to 2.8(to 3.4) times longer than wide, acute to bluntly acute or occasionally ± acuminate at apex, broadest at or below middle, usually markedly constricted at base, weakly to moderately inequilateral, the outer side narrower, ± straight toward base; inner side (1)1.1 to 1.6 times wider than outer side midway, moderately to broadly rounded toward base and briefly attenuate onto posterior rib; midrib and major venation prominently round-raised on lower surface, matte, weakly paler than surface, drying raised or occasionally in part weakly flattened, weakly to moderately darker than surface, rarely paler; midrib sunken on upper surface; **basal veins** (4)5 to 7(8) pairs, coalesced into a prominent posterior rib; posterior rib naked 0.2–1.5 cm per side; primary lateral veins (5)6 to 8(9) pairs, arising at (30°–)40°–60°, most acutely toward apex,

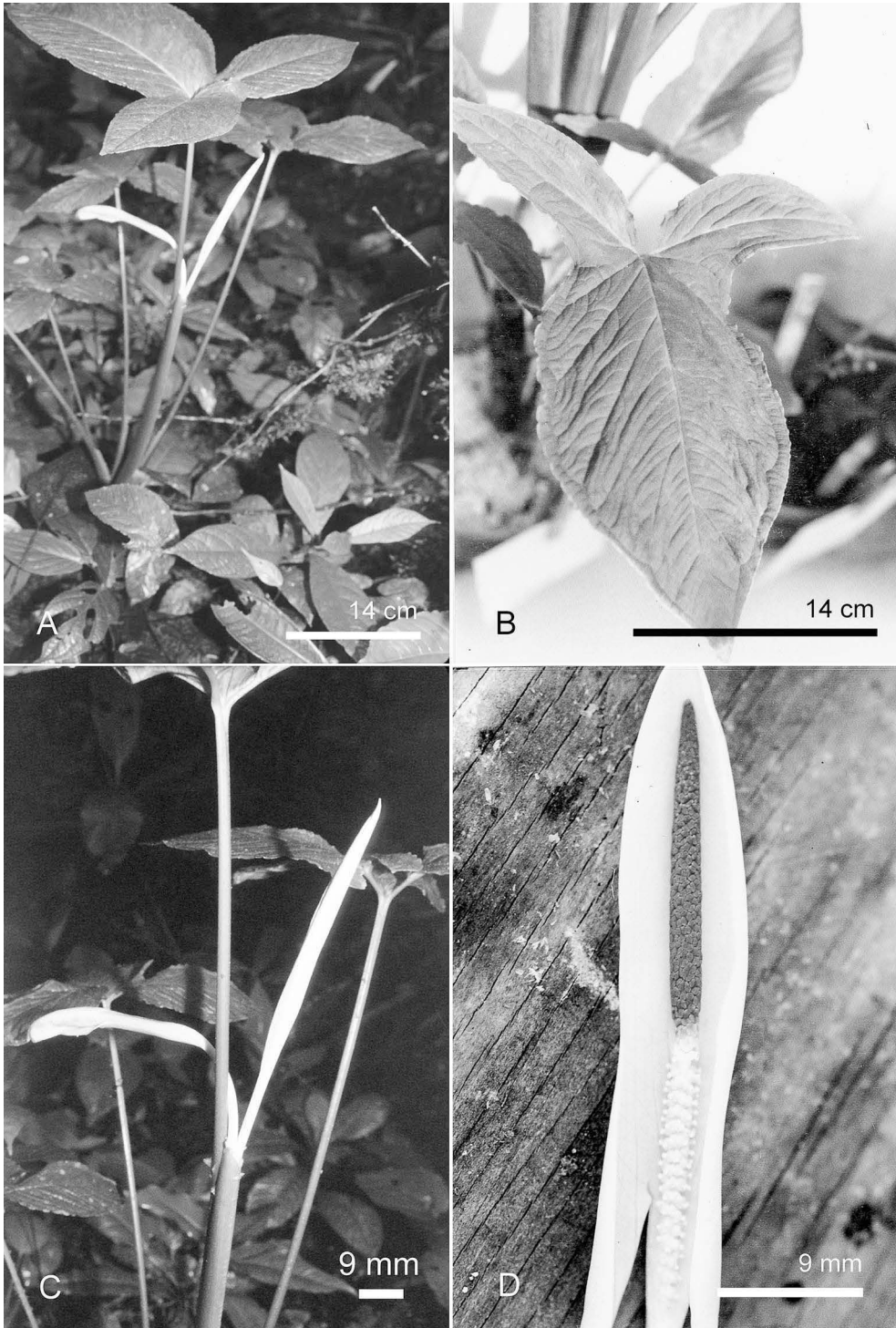


Figure 18. *Chlorospatha dodsonii* (G. S. Bunting) Madison. —A. Fertile habit, *Croat 73039* (MO). —B. Leaf blade adaxial surface, cultivated plant, from *Grayum & Zamora 9427* (MO). —C. Petiole group, the central one, with the inflorescence to the right pre-anthesis, from *Croat 73039* (MO). —D. Inflorescence at full anthesis, with spathe tube cut open, from *Dodson & Dodson 6755* (MO).

straight or weakly to moderately arcuate, quilted-sunken on upper surface; secondary veins quilted-sunken on upper surface, moderately to prominently raised and concolorous on lower surface, drying raised, concolorous to weakly darker than surface, occasionally weakly paler; tertiary veins entirely or in part weakly sunken on upper surface, moderately to prominently raised or prominulous on lower surface, \pm concolorous, drying raised or prominulous, concolorous to weakly darker than surface; reticulate veins raised or prominulous on lower surface, \pm concolorous, drying prominulous or weakly to moderately raised, concolorous to weakly darker than surface; collective veins 3(4), the innermost arising from one of the lowermost lateral veins on inner side of posterior lobe, loop-connected with all preceding lateral veins, weakly to moderately scalloped, 2–9(–11) mm from margin. INFLORESCENCES erect, 2 to 4 per axil, emitting a sweet-soapy fragrance at anthesis; inflorescence cataphyll 1-ribbed abaxially; peduncle held within the sheath, (26–)30–59 cm \times 2–4 mm, cylindroid, thicker than broad, narrowing toward base, semiglossy, greenish to yellow-green cream, drying matte to weakly glossy, medium to dark brown, rarely greenish; **spathe** erect, matte, cream or greenish cream to pale yellow-green or greenish white on outer surface, (11–)13–20 cm long, frequently conspicuously longer than spadix (1–3.5 cm longer), lanceolate, cuspidate or obtuse with acumen at apex, opening 1/2 to 2/3 of its length and \pm funnel-shaped at anthesis, \pm broadly on the blade; spathe tube semiglossy and paler on inner surface, occasionally with weakly darker longitudinal veins, 6–9.5 cm \times (4–)6–12 mm, occasionally thicker than broad, drying matte, dark brown to reddish brown on outer surface, rarely tan, weakly glossy and weakly paler on inner surface, rarely matte; spathe blade matte and weakly paler on inner surface, 6.5–14 cm \times 7–12 mm, to 3 cm wide (flattened), obtusely 1-ribbed abaxially, acutely so in apical 1.5 cm, drying matte, dark tan to brown or reddish brown on outer surface, weakly paler on inner surface, marcescent, erect after anthesis; **spadix** erect, (10.5–)12–16.5 cm long, sessile, adnate to spathe 4.8–8.8 cm at base, usually entire length of pistillate portion, rarely slightly less or also onto most of sterile portion; axis white to greenish white; pistillate portion cream, rarely weakly orangish yellow-tinged cream, (5–)5.5–9 cm \times 5–8 mm, flattened, broader than thick, broadest toward apex; fertile staminate portion matte, bright orange, rarely reddish brown or white, or in part bright orange and otherwise green (at apex), 5–7.2 cm \times 4–7 mm, bluntly acute at apex, occasionally thicker than broad, tapering, drying dark orangish brown; sterile staminate portion entirely cream-colored or in part cream toward

base and creamy yellow to medium yellow-orange at apex, 2–7(–10) \times ca. 4 mm, \pm cylindrical, occasionally with axis naked 1–2 mm at base; pistils \pm laxly arranged, ca. 4 across the axis (viewed from above), 2.2–3.2 mm long; ovaries white to cream, obtusely conical, frequently truncate at apex, 1–1.5 \times 2–2.5 mm, drying pale tan to \pm whitish, 3- to 4-locular, with axile or subaxile placentation; ovules small, to 14 per locule, hemianatropous, biseriate; funicle as long as ovule or weakly shorter; style Type 8 (Fig. 1), 1.5–2 \times ca. 1.5 mm, comprising 1/2 to 2/3 or slightly more of length of pistil (attenuate portion to 2 mm long), with red chromoplasts, the margins not coherent with those of adjacent styles; **stigma** translucent white to creamy white, 0.6–0.8 mm diam., broadest apically and truncate, markedly elevated on style; synandria ca. 1–2 \times 2–3 mm, coherent, truncate, deeply 2- to 5-lobed, 2- to 5-androus (mostly 3 to 4), occasionally lacking microsporangia in apical 2 to 3 whorls; pollen exine smooth (see Fig. 2); sterile flowers ca. 1 \times ca. 1 mm, or 1–1.5 \times 1.5–2.3 mm diam. and \pm elongated in direction of axis, \pm coherent, truncate, subprismatic, in 1 to 3(4) whorls (occasionally with none present). INFRUCTESCENCE nutant (apex directed downward), green, drying 8–13 \times 1–1.3 cm, matte to weakly glossy, dark brown to reddish brown; berries whitish, 4–7 mm diam. (dry).

Phenology. Flowering in *Chlorospatha dodsonii* has been reported or observed in all months of the year except January and May, and is likely to occur in those months as well. Inflorescences emerge in slow progression, with several days between anthesis of one inflorescence and emergence of the next inflorescence at the apex of the petiole sheath. In cultivation, flowering is not continuous but periodic. Fruiting is reported for the month of June.

Discussion. *Chlorospatha dodsonii* is widespread on the western slopes of the Andes in northern Ecuador, mainly in premontane wet forest, but also is found in tropical wet forest and premontane rainforest in Carchi, Cotopaxi, Esmeraldas, and Pichincha provinces and in premontane moist forest in Manabí Province. The species would be expected to occur to the north into Colombia and into other provinces to the south in Ecuador, particularly Los Ríos, which borders several collection sites in Cotopaxi and Pichincha.

Chlorospatha dodsonii is a member of *Chlorospatha* sect. *Occidentales* and is known from a considerable range in elevation (100–1500 m); however, there is little or no variation in distinguishing characters throughout this range, one being the fine reticulate pattern of the veins on the lower

surface of the leaf blades, with all orders of venation more or less raised. This pattern is conspicuous in both living and dried material, which, combined with its prominently hastate blades, make it easily distinguishable from all other species with which it might be confused, even when sterile. This character appears to be somewhat more pronounced in the higher elevation collections. *Chlorospatha dodsonii* is also distinguished by its large inflorescence, bright orange synandria, and its extraordinary style that represents an extreme in the genus. The style comprises ca. two thirds of the length of the pistil, with the attenuate portion as much as 2 mm long. Some inflorescences of *C. dodsonii* are the largest known in the genus, the spathe being as much as 20 cm long, though usually somewhat shorter.

Chlorospatha dodsonii could possibly be confused with *C. ilensis* in the sterile state, both occurring in Cotopaxi, Pichincha, and probably Los Ríos provinces in Ecuador. Like *C. dodsonii*, *C. ilensis* has prominently hastate leaf blades with both the anterior and posterior lobes conspicuously constricted at the base (see discussion under *C. ilensis*).

Chlorospatha dodsonii would be most easily confused with *C. litensis*, with which it is sympatric in the Lita–San Lorenzo region of Esmeraldas Province. The stems of *C. litensis* are smooth and green, unlike those of *C. dodsonii*, which are somewhat scurfy and always tan to brown. Both species have markedly hastate leaf blades and bright orange synandria. The lower surface of the leaf blade of *C. litensis* either lacks the conspicuous reticulate pattern that is so characteristic of *C. dodsonii*, or has it weakly and inconsistently expressed in dried material, and the midrib and major veins are usually darker than the surface and obtusely ribbed. *Chlorospatha dodsonii* differs in having the midrib and major veins smooth (not ribbed) and paler than the lower surface. The petiole of *C. litensis* is obtusely many-ribbed abaxially, sheathed three fourths or more of its length, with the sheath free-ending at the apex and the free portion usually sharply D-shaped, with the margins erect and acute most or all of its length. The petiole of *C. dodsonii* is smooth (not ribbed), sheathed one half to two thirds of its length, with the sheath usually decurrent at the apex and the free portion either entirely terete or in part terete and obtusely D- or C-shaped toward the apex. The inflorescence of *C. litensis* is consistently smaller than that of *C. dodsonii* (in plants of comparable size), with the pistillate portion of the spadix less than half as long as the maximum length observed in *C. dodsonii*, weakly stipitate, and adnate to the spathe only one half to three fourths of its length. The

pistillate portion of *C. dodsonii* is sessile and adnate most or all of its length, and the peduncles are usually no more than two thirds as long as the petiole (rarely three fourths as long). In *C. litensis*, the peduncles are usually nearly as long as or longer than the petiole. The sterile staminate spadix of *C. litensis* is unusually long relative to total spadix length, (1–) 1.5–2.5 cm long, with the sterile flowers arranged in five to seven whorls, thus differing from that of *C. dodsonii*, which is unusually short, typically 2–7 mm long, with the sterile flowers arranged in only one to three whorls or occasionally with none present. The spadix of *C. litensis* is consistently smaller than that of *C. dodsonii*, with the pistillate portion more densely flowered, approximately half as long as the shortest encountered in *C. dodsonii*, weakly stipitate and adnate to the spathe only one half to three fourths of its length. The pistillate portion in *C. dodsonii* is laxly flowered, sessile, and adnate most or all of its length. The sterile staminate portion is unusually long in *C. litensis*, relative to total spadix length, (1–) 1.5–2.5 cm long, usually with the axis naked up to 1 cm at the base, thus differing from that of *C. dodsonii*, which is unusually short, 2–7 mm long (on much longer spadix), with the sterile flowers in only one to three whorls or occasionally with none present. The sterile flowers of *C. litensis* are arranged in five to seven whorls. A key difference lies in the morphology of the style. In *C. litensis*, the style (Type 9, Fig. 1) comprises only one third of the length of the pistil, with the margins weakly coherent with those of adjacent styles. The style (Type 8, Fig. 1) of *C. dodsonii* comprises one half to two thirds or more of the length of the pistil, with the margins of adjacent styles not at all coherent with those of adjacent styles.

Chlorospatha dodsonii could also be confused with *C. mansellii*, especially in dried material, both having leaf blades that dry hastate. The species are sympatric in the Lita–San Lorenzo Region of northwestern Ecuador and are contrasted in the discussion for *C. mansellii*.

Although the bright orange, fertile staminate spadix of *Chlorospatha dodsonii* is a key character for the species, in one collection from Manabí, *Clark et al.* 6745, it is reported as white. In all other respects, both floral and vegetative, the collection accords with *C. dodsonii*, most significantly in the morphology of the style. *N. Pitman 1334* and *De Links & Robles 121* are from the same general area in Manabí and report this portion of the spadix as either orange and green or entirely orange. All three collections accord well with *C. dodsonii*, but interestingly, the leaf blades dry somewhat grayish green on the lower surface. The label notes from a

collection made in Pichincha (Croat 73039) possibly explain the discrepancy in spadix color, reporting that the spadix is white before anthesis and otherwise orange. However, several examinations of pre-anthesis inflorescences (in living material of other collections) in the earliest stages of development, did not confirm this. The synandria examined were paler to much paler orange, but not white.

Madison 4179 is unusual in having the style weakly orangish, yellow-tinged cream.

Croat et al. 84154 (MO), a sterile collection from Esmeraldas Province, is possibly this species. The label notes report the tertiary venation as prominently raised, but on drying, the reticulate pattern on the lower blade surface is very weak or completely lacking in some areas. Another collection that might be this species is *Croat 55831* (CM, MO), a small, juvenile collection from Cotopaxi Province, described as bullate on the label notes, a condition not observed in *C. dodsonii*.

Additional specimens examined. ECUADOR. **Carchi:** San Marcos, 600 m, *S. Thompson et al. 780* (CM, MO). **Cotopaxi:** Tenefuerte, Río Pilaló, Km. 52–53, Latacunga, 750–1300 m, *Dodson & Gentry 12216* (SEL), 750–900 m, *C. & P. Dodson 12930* (MO, SEL), Km. 55, along the hwy., to N of mtn., 850–1000 m, *Dodson et al. 14408* (MO, QCNE). **Esmeraldas:** San Lorenzo Cantón, along Lita–San Lorenzo rd., 40.1 km W of Lita, 350 m, *Croat 72326* (K, MO); vic. Lita, 550–560 m, *Madison et al. 5065* (SEL); Quinindé, Esmeraldas–Quinindé, Herrera–El Páramo hwy., Santa Isabela, Bilsa Biol. Res. 580 m, *W. Palacios et al. 13522* (MO, QCNE); Quinindé, Bilsa Biol. Res., 35 km W of Quinindé, 5 km W of Santa Isabela, along Dogala trail, 400–600 m, *N. Pitman & M. Bass 954* (MO, QCNE). **Manabí:** Pedernales Cantón, Cerro Paja de Pájaro, 10 km E of Pedernales, Finca Aroyo, 300–700 m, *J. Clark et al. 6745* (CAS, MO, QCNE), E side of main trail, 300–520 m, *T. Delinks & C. Robles 121* (MO, QCNE); Bosque Prot. Cerro Paja de Pájaro, ca. 10 km E of Pedernales, E slope of mtn., below S peak, 400–700 m, *N. Pitman 1334* (MO, QCNE). **Pichincha:** Tinalandia, 9.6 km E of Santo Domingo, S of Aloag–Quito hwy., above Río Toachi, 700 m, *Croat 55722* (MO, QCA); Santo Domingo, vic. La Centinela, 0.2 km past Escuela Mixta La Centinela, along trail to lt. of rd., 13 km E from main Santo Domingo–Quevedo hwy. in Patricia Pilar, 1000 m, *Croat 73039* (CM, M, MO, QCNE); vic. Santo Domingo, vic. Peripa, SW of Santo Domingo, 250 m, *Croat & M. Núñez 82094* (AAU, MO, NY, QCNE); San Miguel de los Bancos Cantón, along Nanegalito–Mindó rd., 16.5 km SSW of Nanegalito, 1500 m, *Croat et al. 82746, 82749* (MO, QCNE); along rd. to Chitua, departing main Quito–Santo Domingo hwy. at Km. 44, 0.4 km N of main hwy., *Croat 82836* (B, MO, NY, QCNE); along ridge-line near La Centinela at Km. 12 on Patricia Pilar–Flor de Mayo rd., Mts. de Ila, 600 m, *C. & H. Dodson 6755* (CAS, F, MO, RPSC, SEL); Coop. Santa Marta #2, at Km. 3 W of bypass around Santo Domingo, 530 m, *C. Dodson et al. 8530* (MO, SEL); outskirts of Santo Domingo, Río Chiguilpe, ca. 550 m, *Gentry et al. 24715* (MO); E side of Río Lelia, ca. 16 km (as crow flies) SE of Santo Domingo, 800 m, *Grayum & Zamora 9427* (K, MO); Res. Endesa,

turn-off at Km. 113 on Quito–Puerto Quito rd., small stream 0.5 km S of Endesa houses, 450 m, *Hammel & Wilder 17225* (MO); vic. Alluriquín, 900 m, *Madison 4015* (SEL); Quito–Puerto Quito hwy., Km. 113, 10 km N of main hwy., 800 m, 0°05'N, 79°02'W, 28 Feb. 1984, *J. Rodríguez 252* (MO, QCA); Res. Endesa, Quito–Nono–Tandayapa–Puerto Quito hwy., Km. 113, 800 m, *V. Zak 1601* (QCA).

Cultivated specimens examined. ECUADOR. **Pichincha:** Mts. de Ila, 1977, *Madison 4179* (SEL, cult. from *C. & H. Dodson 6755*; SEL live acc. 1977-2728).

23. *Chlorospatha engleri* Croat & L. P. Hannon, sp. nov. TYPE: Ecuador. Morona-Santiago: Parque Nac. Sangay, 28.6 km W of Proaño, on Macas–Riobamba rd., near river crossing, S side of rd., 1659 m, 2°14'31''S, 78°16'40''W, 13 Aug. 2002, *Croat, L. P. Hannon & P. Schmidt 86559* (holotype, MO-5763472!; isotypes, AAU!, B!, CAS!, COL!, F!, GH!, HUA!, K!, M!, MEXU!, NY!, PMA!, QCA!, QCNE!, S!, SEL!, UB!, US!, VEN!). Figure 19A–D.

Herba usque ad 50 cm; internodia (1.5–)2–4.5 × to 1.9 cm; cataphylla 5–17 cm longa. Petiolus 23–37.5(–40) cm longus; lamina foliaris triangulo-sagittata vel subhastata, 14.5–27 × 6–16 cm, lobis posterioribus 3.5–11.5 × 3–6.5 cm, nervis basalibus utroque 3 vel 4, nervis primariis lateralibus utroque 3 vel 4. Inflorescentiae 3 vel 4 in quaque axilla; pedunculus (8–)9.5–12.5 cm × 1–2 mm (in sicco); spatha 3.7–4.5 cm longa tubo 1.5–2 cm × 3–4 mm, lamina 2.2–2.4 cm longa, 4–6 mm diam.; spadix erectus, 3.3–3.7 cm longus.

Terrestrial herb, to 50 cm tall, in small colonies; stem decumbent, erect to 15 cm, remnants of old leaf bases persisting as short fragments at all nodes, with remnants of old cataphylls persisting (or not) semi-intact and ± fibrous or as linear fibers, the fibers pale to medium brown; internodes (1.5–)2–4.5 × to 1.9 cm, semiglossy, olive-green, occasionally with closely spaced longitudinal grooves near nodes, drying 5–10 mm diam., matte, medium greenish brown to brown; cataphylls 5–17 cm long, acuminate or obtuse with acumen at apex, green, obtusely or acutely 1-ribbed abaxially, becoming fibrous, drying matte, medium yellowish brown. LEAVES 3 to 6, erect-spreading; **petioles** 23–37.5(–40) cm long, matte, pale to medium green, weakly to moderately darker purplish speckled in transverse bands, most prominently so toward base, drying matte, medium greenish brown, sheathed 9–18.5 cm, 1/3 to 1/2 of total length; sheath erect-spreading, in-rolled along margins, free-ending or decurrent at apex; free portion 2–4 mm diam. midway (dry), obtusely C-shaped, weakly sulcate, entirely sparsely crispy-puberulent or only in apical 1/2, finely many-ribbed near apex; **blades** triangular-sagittate to subhastate,



Figure 19. *Chlorospatha engleri* Croat & L. P. Hannon, from the type collection *Croat et al.* 86559 (MO). —A. Entire live type plant with immature and mature infructescences (blades with abaxial surfaces exposed). —B. Leaf blade adaxial surfaces. —C. Stem with inflorescence at left in anthesis. —D. Stems with anthesal inflorescence at left and mature infructescence to right.

occasionally narrowly ovate in young plants, 14.5–27 × 6–16 cm, 1.5 to 2.5 times longer than wide, weakly acuminate or acute at apex, usually broadest at base, occasionally weakly broadest across anterior lobe, 1.1 to 1.2 times wider at base than across anterior lobe (measured tip to tip across posterior lobes), weakly to moderately or not at all constricted on one side in area of petiole attachment, thinly coriaceous, moderately bicolorous, the margins crispate-undulate; upper surface bullate, matte-subvelvety, dark green, drying matte, dark olive-green, occasionally greenish brown; lower surface reticulate, matte, weakly narrowly colliculate along all venation, drying weakly glossy to semiglossy, weakly to moderately paler; anterior lobe 11.2–18(–20.5) × 6–14 cm, 1.2 to 1.8(to 2.1) times longer than wide, 1.5 to 2.7(to 3.1) times longer than posterior lobes, broadest below middle, weakly to moderately inequilateral, with one side 0.5–1.8 cm wider than opposite side; posterior lobes directed toward the base or frequently somewhat outward, 3.5–11.5 × 3–6.5 cm, (1 to)1.3 to 1.6 times longer than wide, narrowly rounded at apex, broadest at base, weakly to moderately inequilateral, the inner side narrower, ± acute toward base, decurrent onto petiole; outer side 1.6 to 2.2 times wider than inner side midway; midrib and major venation narrowly, deeply sunken on upper surface and weakly paler than surface, narrowly round-raised on lower surface, minutely obtusely ribbed, granular-puberulent and in part sparsely crispy-puberulent (mainly toward base), concolorous to weakly paler than surface, drying weakly raised to ± flattened, weakly to moderately darker than surface; **basal veins** 3 to 4 pairs, coalesced into a prominent posterior rib or loosely coalesced into a short posterior rib 2.5–4.5 cm long, with 4 to 7 veins branching off, the first free to the base, 2 to 3 acroscopic, 2 to 4 basiscopic; primary lateral veins 3 to 4 pairs, arising at 25°–45°(–70°), most acutely toward apex, weakly to moderately arcuate, occasionally prominently arcuate or ± straight; secondary and tertiary veins narrowly quilted-sunken on upper surface and concolorous, weakly raised on lower surface, granular-puberulent and in part sparsely crispy-puberulent, weakly darker than surface, drying weakly raised, weakly to moderately darker than surface; reticulate veins conspicuous on lower surface, weakly prominulous, weakly darker than surface, drying prominulous, weakly to moderately darker than surface; collective veins 3 to 4, the innermost arising from apex of posterior rib or from a lateral vein on inner side of posterior lobe, ± parallel to margin to prominently scalloped, 3–19 mm from margin. INFLORESCENCES erect, 3 to 4 per axil, emitting a spicy-sweet

fragrance at anthesis; symposium held within a sympodial cataphyll; sympodial cataphyll 9–14 × 1–2 cm, acuminate at apex, 1-ribbed abaxially; peduncle curved, (8–)9.5–12.5 cm × 1–2 mm (dry) (to 15 cm long in fruit), moderately flattened, matte, pale to medium green, drying matte, medium greenish brown; **spathe** erect, pale to pale-medium green, 3.7–4.5 cm long, oblanceolate, cuspidate at apex, opening narrowly most of its length at anthesis, ± broadly on the blade, the margins directed outward; spathe tube 1.5–2 cm × 3–4 mm, drying matte, dark brown; spathe blade 2.2–2.4 cm × 4–6 mm, drying matte, medium to dark brown, marcescent, erect after anthesis; **spadix** erect, 3.3–3.7 cm long, ca. 4 mm shorter than spathe, sessile, adnate to spathe 7 mm at base, ca. 1/2 of the length of pistillate portion; pistillate portion yellowish white, 1.5–1.7 cm × 2–3 mm, broadest below middle; fertile staminate portion creamy white, 1.8–2 cm × 3.5–4 mm, narrowly rounded at apex, ± cylindrical; sterile staminate portion creamy white, ca. 3 × 2.6 mm; pistils weakly coherent, 3 to 4 across the axis (viewed from above), ca. 1 mm long; ovaries ca. 0.7 × 1.3–2 mm, ± cylindrical or obtusely obconical, broadly depressed medially, (2)3- to 4-locular (mostly 3), with axile or subaxile placentation; ovules 8 to 14 per locule, 0.225 mm long, hemianatropous, biseriate; funicle 0.2 mm long, shorter than ovule, lacking glands; style Type 1 (Fig. 1), 1.3–2 mm diam., as broad as ovary apex (possibly weakly attenuate medially), the margins obscure and weakly or not at all coherent with those of adjacent styles; **stigma** whitish, ca. 1 mm diam., sessile, subrounded, button-shaped (possibly weakly elevated on style); synandria 1–1.5 × 1.2–2 mm, coherent, truncate, prominently and deeply 2- to 3(4)-lobed to the center, the lobes separate apically, the margins deeply sinuate, 2- to 3(4)-androus (mostly 3), staminal pores borne along distal margins; stamens ± reniform at apex, obtusely V-cleft on outer margin, emarginate on lateral margins; pollen sacs distributed along lateral margins; sterile flowers ca. 1 × 1–1.5 mm, coherent, truncate, subprismatic (viewed from above) or lobed (as per synandria), inequilateral, the stipe nearly as long as the thickened body, this inequilateral and directed toward apex, the apical portion curved, much broader than thick, in 3 whorls. INFRUCTESCENCES 2.2–4.5 cm × 6.5–10 mm, matte, dark purple on outer surface, semiglossy and greenish on inner surface, drying matte, dark brown, purplish or purplish black; berries ca. 1.5 × 2–3.5 mm, pale creamy-green.

Phenology. Flowering and fruiting are only known to occur in *Chlorospatha engleri* during the

month of August. Inflorescences are fragrant and emerge in quick succession, each reaching anthesis approximately one to three days after anthesis of the preceding inflorescence.

Etymology. *Chlorospatha engleri* is named for Dr. Adolf Engler (1844–1930), premiere aroid specialist and prodigious monographer of aroid genera, who first recognized and published the genus *Chlorospatha* in 1878.

Discussion. *Chlorospatha engleri* is known only from the type collection made 28.6 km west of Proaño, near a small river on the Macas to Riobamba road in the Parque Nacional Sangay in Morona-Santiago Province, Ecuador, on the eastern slopes of the Andes at 1659 m elevation. The montane rainforest at the type locality was being cut as the collection was being made and had been completely felled when the site was revisited two weeks later. The species would be expected to occur elsewhere within the park, which covers a large area, also to the west and south in Chimborazo and Cañar provinces, to the north in Tungurahua and Pastaza provinces, and possibly at similar elevations in westernmost Napo Province.

Chlorospatha engleri, a member of *Chlorospatha* sect. *Orientales*, is found in small colonies and is distinguished by its moderately long internodes (2–4.5 cm long) and triangular-sagittate to subhastate leaf blades that are bullate, matte-subvelvety, dark green on the upper surface and reticulate and matte on the lower surface, with all abaxial venation more or less raised or prominulous, and the midrib and major venation finely ribbed, granular-puberulent, and in part sparsely crispy-puberulent. The margins of the blades are crispate-undulate, even in very young plants, although less so in these. The species is also characterized by its moderately long posterior lobes, usually narrowly rounded at the apex, and its matte, pale green petiole that is purple-speckled in transverse bands and sheathed about one half of its length, with the sheath erect and the margins inrolled. The most noteworthy distinction is the morphology of the synandria, which is rare in species from the eastern slopes, *C. engleri* being one of only five species from the eastern slopes with synandria more or less truncate at the apex. The ovaries of *C. engleri* are also distinctive in being (2)3- to 4-locular, a character found also in *C. cutucuensis* and in no other species from the eastern slopes. In spite of these similarities, the two species could not be confused.

Chlorospatha engleri could possibly be confused with *C. pubescens*, particularly in the sterile state,

which is widespread on the eastern slopes of the Andes in Ecuador, at 400–1400 m elevation (see discussion under *C. pubescens*). The leaf blades of *C. pubescens* are usually hastate to subhastate, velvety and broadly quilted on the upper surface, with only the midrib and major venation sunken. *Chlorospatha engleri* differs in having sagittate to weakly subhastate blades that are matte to matte-subvelvety and bullate on the upper surface.

Chlorospatha engleri could possibly be confused with *C. longipoda*, which is widespread on the eastern slopes of the Andes in Ecuador and occurs in the type locality of *C. engleri* (see discussion under *C. longipoda*). The shape of the blades of young plants of *C. engleri* is similar to that found in mature plants of *C. longipoda*. Mature leaf blades of *C. engleri* are usually somewhat triangular-sagittate, with the anterior lobe about 2.2 times longer than the posterior lobes, frequently less, and the upper surface bullate. Mature blades of *C. longipoda* are usually narrowly ovate-elliptic and subsagittate, with the anterior lobe usually 3.5 to 10 times longer than the posterior lobes and the upper surface usually quilted and never bullate. The margins of the blades are crispate-undulate in *C. engleri*, with the midrib and major venation weakly paler than the upper surface, finely ribbed and granular-puberulent on the lower surface, and in part sparsely crispy-puberulent, thus differing from *C. longipoda*, in which the margins are smooth and the venation concolorous on the upper surface and smooth and mostly glabrous on the lower surface.

A sterile collection, *Cerón et al.* 48869 (QAP), made in Parque Nacional Sangay, is possibly this species; however, all parts of the leaves are glabrous and the colliculate border along the veins is lacking.

24. *Chlorospatha feuersteiniae* (Croat & Bogner) Bogner & L. P. Hannon, comb. nov. Basionym: *Xanthosoma feuersteiniae* Croat & Bogner, *Willdenowia* 35: 327. 2005. TYPE: Ecuador. Morona-Santiago: along rd. from Patuca to Santiago through the S edge of the Cordillera de Cutucú, ca. 25 km E of Patuca, ca. 700 m, *Betsy Feuerstein in Croat 84927* (MO) (holotype, MO!; isotypes, B!, K!, M!, QCNE!, S!, US!). Figures 24C, D, 46C.

Terrestrial herb, evergreen, glabrous; stems erect, 0.6–1.5 cm in diam.; internodes short. LEAVES erect-spreading, clustered near apex of stem; cataphylls 10–11 cm long, 0.8–0.9 cm wide, green with irregular purple markings and small rounded spots, acute and purple at apex; **petioles** 12–16.5 cm long, sheathed from about the middle of 2/3 of its length, medium green, heavily tinged purple toward apex,

weakly glossy; sheath broadly spreading 7–9.7 cm long, the margins somewhat membranaceous, more lightly colored, weakly reflexed, joining to form an acute and weakly free-ending (unfused) apex; free portion of petiole broadly and shallowly sulcate, the margins bluntly acute, 4 mm wide, 3 mm thick; **blades** narrowly ovate to lanceolate or somewhat elliptic, 15–20 cm long, 6.5–9.5 cm wide, 2 to 2.1 times longer than wide, distally tapered and \pm acute, ending abruptly with a mucro ca. 1 mm long, slightly cordulate to subcordate or truncate at base, subcoriaceous, dark green and semiglossy above, completely purple and slightly less glossy below, drying weakly glossy and yellow-green above, weakly glossy and purplish to medium yellow-green below; margins slightly undulate; major veins sunken and concolorous above, prominent and purplish below; midrib narrowly sunken above, thicker and slightly more purple than remaining lower surface; primary lateral veins in 4 to 6 pairs, narrowly rounded, arising at a very acute angle, then spreading at an angle of 35°–40°, finally loop-connected along the margin; collective veins in 3 series, etched-sunken above, raised below, the innermost 4–10 mm from the margin, the second ca. 3 mm from the margin, the third antimarginal (ca. 1 mm from margin), all extending to near the apex; tertiary veins in part sunken above, raised below; reticulate veins somewhat prominulous below. INFLORESCENCE erect, usually solitary; peduncle 5.7–10 cm long, 0.2–0.4 cm wide, terete, medium yellow-green–tinged purple, matte; **spathe** 7–9 cm long, medium green in the lower 2–3 cm, then becoming whitish with the outer margins and apex purplish, not constricted but somewhat flattened above the pistillate zone; tube 2–3 cm long, 0.6–0.8 cm wide, medium yellow-green and matte outside, slightly paler and glossy within; limb 4.5–6 cm long, 0.8–1.5 cm wide, flattening to 3.5 cm wide, white toward apex with the margin purplish, \pm acute and hooked at apex; **spadix** 4–6 cm long, adnate at base for 0.8 cm shorter than spathe; pistillate zone cylindric, 1–1.5 cm long, 0.3–0.4 cm wide, creamy white; staminate zone 2.8–4 cm long, fertile to apex, white, terete and 0.35–5 mm in diam. or somewhat flattened, tapered toward apex; sterile zone 0.4–0.5 cm long, 0.25–0.3 cm wide, with 2 to 3 rows of synandrodies. Pistillate flowers densely arranged and without coherent styles; ovary ellipsoid, 1.2–1.3 mm long, 0.8–1.1 mm wide, pale green, usually with three deeply intrusive placentae, ovules several, hemianatropous; **stigma** disklike, 0.4–0.6 mm diam., darker green (drying brownish), \pm sessile, no broadened style present. Synandrodies densely arranged, 1.5–2 mm long, 0.8–1.4 mm wide, flattened

apically, sunken medially. Staminate flowers (synandria) \pm rounded, 1–1.1 mm high, 1–1.7 mm in diam., sunken in the center and incised between the thecae (as seen from above), the lowermost synandria elongate, 2 mm long and 1 mm wide, merging imperceptibly with the rounded synandria above (uppermost synandria sometimes sterile); thecae lateral, ca. 1 mm long, each opening by an apical pore, pores weakly depressed in the upper surface near the margin of the synandrium. Pollen 22 μ m long, 16–18(–22) μ m wide, ellipsoid to ellipsoid-oblong, in tetrads, exine reticulate.

Discussion. *Chlorospatha feuersteiniae* is known for certain only from the type locality in Morona Santiago in the Cordillera de Cutucú at ca. 700 m elevation, but the species has also been observed by Betsy Feuerstein in Zamora-Chinchi in the Cordillera del Condor near Los Encuentros at ca. 760 m in premontane wet forest.

Croat and Bogner (2005) described *Xanthosoma feuersteiniae* before the “Revision of the genus *Chlorospatha*” by L. P. Hannon and T. Croat (available as a manuscript in early 2006) was completed. In February 2006, Lynn Hannon visited the Munich Botanical Garden, just a few months before she passed away, and the first author showed her the material of this species. It became clear that it represents a *Chlorospatha* species, and we agreed to publish the necessary new combination.

As Bogner and Gonçalves (2005) pointed out, the delimitation of the genera *Caladium*, *Xanthosoma*, and *Chlorospatha* becomes more and more difficult in light of the new material collected in recent decades. Two of the most distinguishing characters of pollen and gynoecium turned out not to be constant. According to Madison (1981), *Caladium* species release the pollen in monads and *Xanthosoma* in tetrads, but *X. mariae* Bogner & Gonçalves and *X. latestigmatum* Bogner & Gonçalves of *Xanthosoma* sect. *Acontias* shed the pollen in monads (see also Bogner & Gonçalves, 2005). On the other hand, *C. feuersteiniae* also has the pollen in tetrads as all species of this genus have, but furthermore its tetrads are very similar to those of *C. pubescens* Croat & L. P. Hannon, *C. ceronii* Croat & L. P. Hannon, and *C. hannoniae* Croat, all of which have a reticulate exine.

Concerning the gynoecium, *Xanthosoma* has usually been distinguished by the disklike, broadened, and coherent styles with a centrally smaller stigma. *Caladium* was distinguished by stigmas as broad as the ovary, often said to be sessile, but in fact there is a broad, unmodified style or stylar region present. Now we know at least five different types of styles in *Xanthosoma* (Gonçalves, 2004), and they are

not coherent in all cases. As it turned out, *C. feuersteiniae* has sessile stigmas, also known in the genus *Chlorospatha* (e.g., *C. longipoda* (K. Krause) Madison) and representing Hannon's style Type 1, but sessile stigmas are unknown in *Xanthosoma*. The unconstructed and apically hooked spathe of *C. feuersteiniae* is not like that in any species of *Xanthosoma* or *Chlorospatha*.

The synandrodies of *Chlorospatha* are usually free to partly or completely connate into irregular, fungiform, or lobed synandrodies and also truncate (prismatic) (e.g., *C. longipoda*) as is also the case in *C. feuersteiniae*. The latter also has truncate synandrodies with a length of ca. 2.5 mm, which are densely arranged in only two rows and sometimes have an incomplete third row. As far as we have observed, *C. feuersteiniae* only has a solitary inflorescence with a robust peduncle, while *C. longipoda* usually has several inflorescences with slender peduncles in a sympodium supported by the leaf sheath (very young plants have one inflorescence at first flowering, but some species are known with only one inflorescence).

25. *Chlorospatha gentryi* Grayum, Ann. Missouri Bot. Gard. 73: 468. 1986. TYPE: Colombia. Antioquia: trail from Encarnación to Parque Nac. Nat. Las Orquídeas, W slope of W Cordillera, 1600–1800 m, 27 Jan. 1979, A. Gentry & E. Rentería 24585 (holotype, MO-2715461!; isotypes, COL not seen, HUA-231692!). Figure 20A, B.

Terrestrial herb, to ca. 50 cm tall; stem erect, at least 10 cm tall, with remnants of old cataphylls persisting semi-intact at upper nodes, \pm fibrous, the fibers pale; internodes 1–2 cm long, drying 0.6–1.3 cm diam., dark reddish brown; cataphylls 6–15 cm long, obtuse with acumen at apex, 1-ribbed abaxially, drying \pm fibrous, matte to weakly glossy, tan to dark tan or medium-dark brown. LEAVES 2 to 7, erect-spreading; **petioles** 12–25 cm long, scurfy-pubescent in apical 1/4 to 1/2, usually more densely so near apex, drying weakly glossy, dark brown to occasionally almost black, sheathed 4–8 cm, ca. 1/4 to 1/3 of total length; sheath decurrent at apex; free portion drying 2–4(–5) mm diam. midway; **blades** 5- to 7-pedatisect or occasionally obscurely alate between segments, 13–22 \times 11–23 cm, about as wide as long, thin to thinly coriaceous (dry), bicolorous, the margins of all segments crispate-undulate; upper surface drying weakly glossy to semiglossy, dark brownish green; lower surface reticulate, drying weakly glossy to semiglossy, weakly to moderately paler, rarely concolorous; all segments \pm acute at base, with margins straight to attenuate toward the

base, occasionally cuneate; **medial lobe** elliptical, 6.5–15.5 \times 2.5–6.8 cm, 2.3 to 2.8 times longer than wide, 1.1 to 3.9 times longer than lateral lobes, acuminate at apex, occasionally equal in length to or weakly shorter than innermost lateral lobes, broadest midway, \pm symmetrical, usually free to the base, rarely narrowly attached and weakly confluent with innermost lateral lobes, the confluent portion ca. 1 mm wide; **lateral lobes** (2–)4.5–15 \times (1–)1.2–6 cm, 2.2 to 3.7 times longer than wide, acuminate at apex, occasionally acute on outermost 1 to 2 segments (rarely bluntly acute), broadest at or below middle (rarely above middle), progressively shorter and narrower toward outermost segments, the outermost much shorter than innermost; sides (of lateral lobes) moderately progressively inequilateral toward outermost segments, the inner side always narrower; outer side 1.5 to 2.1 times wider than inner side midway; all orders of venation crispy-puberulent and raised or prominulous on lower surface; midrib round-raised on lower surface, drying raised to weakly flattened, moderately darker than surface; posterior rib naked 1.2–3.5 cm per side, densely scurfy-pubescent; primary lateral veins on all segments (3)4 to 6 pairs, arising at 25°–40°, straight to weakly arcuate, drying weakly raised to \pm flattened on lower surface, weakly to moderately darker than surface; secondary veins drying weakly raised on lower surface, weakly darker than surface; tertiary veins drying weakly raised or prominulous on lower surface, weakly darker than surface; reticulate veins drying in part prominulous, otherwise flat on lower surface, concolorous to weakly darker than surface; collective veins 3, the innermost arising from lowermost lateral vein at base, loop-connected with all preceding lateral veins, occasionally markedly scalloped, remote from margin, 3–15 mm from margin. INFLORESCENCES erect, 2 to 3 per axil; peduncle held within the sheath, 6.5–10 cm \times 1–1.5 mm (dry), \pm crispy-puberulent, most densely so near apex, drying matte to weakly glossy, blackish brown; **spathe** erect, ca. 4.2 cm long, cuspidate at apex; spathe tube green, greenish or whitish, densely crispy-puberulent on outer surface, white on inner surface, 2–2.5 cm \times 3.5–5 mm, drying matte to weakly glossy, dark blackish brown on both surfaces, densely cream, punctiform on inner surface; spathe blade whitish or yellow, 2–2.4 cm \times 3–3.5 mm, narrowly crispy-puberulent along the veins toward base abaxially, drying weakly glossy, dark tan to dark brown on outer surface, semiglossy on inner surface, opening broadly at anthesis, marcescent, erect after anthesis; **spadix** erect, ca. 3.8 cm long, sessile, adnate to spathe 0.7–1 cm at base, ca. 1/2 of the length of pistillate portion; pistillate portion



Figure 20. A, B. *Chlorospatha gentryi* Grayum, the type *Gentry & Rentería* 24585 (MO). —A. Herbarium isotype (COL-231692). —B. Plant with three inflorescences, with the one at far left (paler spathe) in full anthesis. —C. *Chlorospatha giraldoi* Croat & L. P. Hannon, the paratype specimen *W. Vargas* 5363 (COL-125515). —D. *Chlorospatha grayumii* Croat & L. P. Hannon, the holotype *Killip* 35298 (US-1772027).

1.2–2.2 cm long, drying 2.5–3.5 mm diam., broadest midway, medium reddish brown to dark brown; fertile staminate portion green, ca. 1.4 cm long, drying ca. 2 mm diam., narrowly rounded at apex, cylindrical, weakly pink-tinged medium brown; sterile staminate portion ca. 6 mm long, drying 1–1.75 mm diam., broadest at apex, pale to medium yellowish tan, the axis bare 1–1.5 mm at base; pistils \pm weakly coherent, 3 to 4 across the axis (viewed from above), 1–1.2 mm long; ovaries subglobose, 1.5–2 mm diam., drying tan; style Type 3 (Fig. 1), drying 0.3–0.5 mm diam., narrower than ovary apex, the margins not coherent with those of adjacent styles; **stigma** ca. 0.1–0.3 mm diam., sessile, disklike, truncate at apex, drying medium reddish brown to dark blackish brown; **synandria** ca. 1 \times 1–1.3 mm, deeply (2)3- to 4-lobed, (2)3- to 4-androus, coherent, truncate; sterile flowers drying ca. 0.5 (or less) \times ca. 1 mm, weakly elongated in direction of axis, coherent, truncate, \pm prismatic, in 4 to 5 whorls. **INFRUCTESCENCE** green, drying 2.5–4.2 cm \times 5–8 mm, weakly glossy, dark brown to blackish brown; berries green, drying 2–5 mm diam.

Phenology. Flowering is only known to occur in *Chlorospatha gentryi* during January and December, with fruiting recorded for December.

Discussion. *Chlorospatha gentryi* is known only from the Parque Nacional Natural Las Orquídeas in Antioquia Department, Colombia, in what is possibly either premontane rain forest or tropical wet forest on the western slopes of the Cordillera Occidental, at 1200–1800 m elevation.

Chlorospatha gentryi, a member of *Chlorospatha* sect. *Chlorospatha*, is a small, erect-growing plant distinguished by its 5- to 7-pedatisect leaf blades with the segments acute at the base and crispate-undulate along the margins, and all abaxial venation more or less raised and crispy-puberulent. The petiole is scurfy-pubescent for one fourth to one half of its length, prominently so toward the apex and onto the posterior rib. The inflorescence of *C. gentryi* is unusually small, with the spathe 4.2 cm long and the peduncle short (to 10 cm long) and crispy-puberulent, with the indumentum extending onto the outer surface of the spathe tube and narrowly onto the blade. The innermost collective vein is noteworthy in being markedly scalloped and remote from the margin, relative to the size of the segments. The species is also distinguished by its green **synandria**.

Chlorospatha gentryi could be confused with only one species, *C. morae* from the western slopes of the Cordillera Occidental in Chocó Department, Colombia, at 285–825 m elevation (see discussion under *C.*

morae). The latter species is a larger plant with the stem erect to 50 cm, occasionally nine segments on the blades (vs. five to seven in *C. gentryi*), longer peduncles, and larger inflorescences. The petiole of *C. morae* is sheathed about one half of its length, with both it and the midrib glabrous and finely striate-ridged, differing from *C. gentryi* in which the petiole is sheathed one fourth to one third of its length and partially pubescent, as is the midrib, with neither structure striate-ridged. Mature blades of *C. morae* have six to seven or as many as eight or nine pairs of primary lateral veins on all but the outermost segments, thus differing from those of *C. gentryi*, which have no more than four to six pairs.

The **synandria** of *Chlorospatha gentryi* appear to be unusual, at least in dried material. The lobes are conspicuously deeply divided, each appearing to be quite separate from the other, with the two pores on each lobe separated by a considerable distance, a condition also observed in *C. engleri*, known only from the eastern slopes of the Andes.

Additional specimens examined. COLOMBIA. **Antioquia:** Mpio. Frontino–Mpio. Urao, Parque Nac. Nat. Las Orquídeas, Calles–Carauta rd., *Callejas et al. 3086* (HUA, MEDEL, MO, NY); Mpio. Urao, Parque Nac. Nat. Las Orquídeas, vic. Calles, rt. side of Río Calles, *Pipoly et al. 17803* (JAUM, MO).

26. *Chlorospatha giraldoi* Croat & L. P. Hannon, sp. nov. TYPE: Colombia. Valle: Finca Zigara, Km. 18 on Calf–Buenaventura Hwy., Km. 4 via Dapa, Elvira distr., 1900 m, 3°30'N, 76°34'W, 13 Mar. 1994, *J. Giraldo & L. Agredo 228* (holotype, MO-05071722!; isotypes, CUVV not seen, TULV not seen). Figure 20C.

Herba usque ad ca. 2 m, plerumque terrestri; internodia (1.5–)2–3.5 \times 1–2.5 cm; cataphylla (15–)32–37 cm longa. Petiolus (41–)45–74 cm longus, vaginatus per (18–)38–39 cm; lamina foliaris subhastata, (18.5–)23–35.5 \times (16.5–)21–25 cm, lobis posterioribus 11–14.5 \times 2.5–5 cm, nervis basalibus utroque ca. 6, nervis primariis lateralibus utroque (5)6. Inflorescentiae usque ad 5 in quaque axilla; pedunculus (23–)25–38 cm \times 2–4 mm; spatha erecta, (9.5–)11–13 cm longa, tubo (4.5–)5–7.8 cm \times 4–5 mm, lamina 5–6 cm \times ca. 5 mm; spadix (8.5–)9.5–10 cm longus.

Terrestrial or hemiepiphytic herb, to ca. 2 m tall (probably only when hemiepiphytic); stem decumbent, with remnants of old leaf bases and cataphylls persisting \pm intact along its length; internodes (1.5–)2–3.5 \times 1–2.5 cm, drying weakly glossy, medium-dark to dark brown, occasionally gray-tinged (all measurements made from dried material); cataphylls (15–)32–37 cm long, acuminate or cuspidate at apex, drying weakly glossy to semiglossy, dark reddish brown. LEAVES 2 to 3, erect-spreading; **petioles**

(41–)45–74 cm long, drying glabrous, weakly glossy to semiglossy, dark brown, sheathed (18–)38–39 cm, ca. 2/3 of total length or slightly less; sheath decurrent at apex; free portion 3–4 mm diam. midway; **blades** subhastate, occasionally sagittate in juvenile plants, (18.5–)23–35.5 × (16.5–)21–25 cm, 1.1 to 1.4 times longer than wide, weakly to abruptly acuminate at apex, broadest at base, 2.1 to 2.8 times wider at base than across anterior lobe (measured tip to tip across posterior lobes), occasionally weakly to strongly constricted on one side in area of petiole attachment, thin, drying weakly bicolorous to concolorous; upper surface matte, dark green, drying matte, dark brown; lower surface semiglossy, drying weakly glossy to semiglossy, rarely in part weakly olive-tinged (in young plants); anterior lobe (11.5–)15–24.5 × (6.5–)7.6–10 cm, 1.7 to 2.5 times longer than wide, (1 to)1.2 to 1.6 times longer than posterior lobes, broadest at or below middle, ± symmetrical; posterior lobes directed somewhat outward, 11–14.5 × 2.5–5 cm, (3 to)3.5 to 5 times longer than wide, acute to bluntly acute at apex, broadest at or near base, ± symmetrical, the inner side ± rounded toward base, usually briefly attenuate onto petiole apex; outer side weakly concave toward base; midrib round-raised on lower surface, drying raised and weakly flattened, weakly darker than surface; **basal veins** ca. 6 pairs, coalesced into a prominent posterior rib; posterior rib rarely naked 5–10 mm per side (Vargas 5363); primary lateral veins (5)6 pairs, arising irregularly at 40°–75°, weakly or strongly arcuate to irregularly ascending, raised on lower surface, drying ± flattened, weakly darker than surface; secondary veins raised on lower surface, drying weakly prominulous, weakly darker than surface; tertiary veins drying visible and distinct on lower surface, weakly darker than surface; reticulate veins drying obscure; collective veins 3, the innermost arising from one of the lowermost lateral veins on inner side of posterior lobe, loop-connected with all preceding lateral veins, ± parallel to and 2.5–6 mm from margin. INFLORESCENCES erect, to 5 per axil; peduncle held within the sheath, (23–)25–38 cm × 2–4 mm, drying weakly glossy to semiglossy, pale-medium to dark brown; **spathe** erect, creamy yellow or yellowish white, (9.5–)11–13 cm long, cuspidate at apex; spathe tube (4.5–)5–7.8 cm × 4–5 mm, drying weakly glossy, medium-dark to dark brown on outer surface, weakly glossy on inner surface; spathe blade 5–6 cm × ca. 5 mm, drying matte to weakly glossy, medium reddish brown on both surfaces, marcescent, erect after anthesis; **spadix** erect, (8.5–)9.5–10 cm long, sessile, adnate to spathe 4–5.5 cm at base, the entire length of

pistillate portion; pistillate portion 4–5.5 cm × 2–3 mm, drying dark, reddish brown; fertile staminate portion creamy yellow, 2.5–3.7 cm × 2–5 mm, narrowly rounded to bluntly acute at apex, ellipsoid, drying pale-medium brownish yellow to medium-dark yellowish brown; sterile staminate portion (1.2–)1.4–1.8 cm × 1.5–3 mm, ± cylindrical, drying dark reddish brown; pistils ± laxly arranged, 2 to 3 across the axis (viewed from above), 1.8–2 mm long; ovaries subglobose, ca. 1 × 1.5–2.2 mm, drying pale tan to brownish cream; style Type 8 (Fig. 1), 0.8–1 × 1.5–2 mm, comprising ca. 1/2 of the length of pistil, the margins possibly weakly coherent with those of adjacent styles (in living material); **stigma** prominent, 0.5–0.9 mm diam., prominently elevated on and broader than narrowed portion of style, drying tan to dark reddish brown; synandria ca. 1 × 1.5–2 mm, coherent, truncate, 3- to 4(5)-lobed, 3- to 4(5)-androus; sterile flowers ca. 1 mm long, 0.5–2.5 × 0.5–1 mm diam. and ± elongated in direction of axis, or 0.5–1 mm diam. and deeply irregularly lobed in apical 1 to 2 whorls, otherwise 1- to 5-branched, the branches 0.6–1 mm long, broadest and obtusely truncate at apex, abruptly and weakly narrowed toward base, ± densely arranged in 8 to 10 whorls. Berries not known.

Phenology. Flowering is only known to occur in *Chlorospatha giraldoi* during the months of March and December.

Etymology. *Chlorospatha giraldoi* is named for Jorge Giraldo Gensini, Colombian botanist and one of the collectors of the type.

Discussion. *Chlorospatha giraldoi* is known only from tropical wet forest and what is either premontane wet forest or lower montane wet forest to the north and northwest of Cali, along the Continental Divide, on both the eastern and western slopes of the Cordillera Occidental in Valle Department, Colombia, at 1700–2000 m elevation. The species would be expected to occur elsewhere in the department.

Chlorospatha giraldoi is a member of *Chlorospatha* sect. *Occidentales* and is distinguished by its frequently hemiepiphytic habit and matte, dark green, subhastate leaf blades that dry dark brown and weakly or not at all bicolorous, with the posterior lobes narrow and long, relative to the length of the anterior lobe, the latter being only 1.2 to 1.6 times longer than the posterior lobes. The species is also distinguished by its large inflorescence (11–13 cm long), with the spathe entirely creamy yellow or yellowish white, the fertile staminate portion of the spadix creamy yellow and the sterile staminate

portion long (1.3–1.8 cm long), with most of the sterile flowers 1- to 5-branched. The long-attenuated style (Type 8, Fig. 1), with the mantle appressed to the ovary, is uncommon in the genus.

Chlorospatha giraldoi could be easily confused with *C. noramurphyae*, also from the vicinity of Cali on the eastern slopes of the Cordillera Occidental, and is possibly sympatric with that species (see discussion under *C. noramurphyae*). The two species are quite similar in certain respects, both having subhastate leaf blades with narrow posterior lobes and large inflorescences with similar styles and sterile flowers, but differ in significant ways. The species are probably closely related and might eventually prove to be conspecific.

Chlorospatha giraldoi could possibly be confused with *C. ricourtensis* from Reserva La Planada on the western slopes to the south, in Nariño Department, along the border with Ecuador, at 1800 m elevation (see discussion under *C. ricourtensis*). *Chlorospatha ricourtensis* has sagittate blades that dry semiglossy and greenish on both surfaces, with three pairs of primary lateral veins and the posterior lobes directed toward the base. *Chlorospatha giraldoi* differs in having subhastate leaf blades that dry dark brown on both surfaces, matte on the upper surface, with six pairs of primary lateral veins.

Paratypes. COLOMBIA. **Valle:** vic. Dapa, NW of Cali, along Continental Divide, 2000 m, *Croat 61433* (MO); Mpio. La Cumbre, Bitaco region, Res. Agua Bonita, 1700–1900 m, 10–15 Dec. 1998, *W. Vargas 5363* (COL-125515, HUA, MO).

27. *Chlorospatha grayumii* Croat & L. P. Hannon, sp. nov. TYPE: Colombia. Chocó: Corcovada region, upper Río San Juan, ridge along Yeracúí Valley, 200–275 m, 24–25 Apr. 1939, *E. Killip 35298* (holotype, US-1772027!). Figure 20D.

Herba hemiepiphytica vel terrestriis, usque ad plus quam 50 cm; internodia 1–1.5 × 1–1.3 cm; cataphylla 8–23 cm longa. Petiolus 29–61 cm longus; lamina foliaris oblongo-elliptica, sagittata, 38–62 × 9.5–23 cm, lobis posterioribus 11.5–19.5 × 3–7 cm, nervis basalibus utroque 3 vel 4, nervis primariis lateralibus utroque 6 ad 9. Inflorescentia 1 in quaque axilla; pedunculus ca. 23 cm × 2–3 mm; spathe erecta, tubo ca. 2.6 cm × 5 mm; spadix erectus, ca. 4.2 cm longus.

Hemiepiphytic or terrestrial herb, slightly more than 50 cm tall; stem erect or decumbent, with remnants of old cataphylls persisting ± intact along its length and weakly fibrous; internodes 1–1.5 × 1–1.3 cm, drying weakly glossy, dark brown (all measurements made from dried material); cataphylls 8–23 cm long, cuspidate or obtuse with acumen at

apex, 1-ribbed abaxially, drying matte to weakly glossy or semiglossy, medium-dark to dark reddish brown or blackish brown, weakly fibrous. LEAVES 2, probably erect-spreading; **petioles** 29–61 cm long, drying glabrous, matte to weakly glossy, dark reddish or blackish brown, occasionally semiglossy, sheathed 13–25 cm, ca. 1/3 of total length; sheath free-ending at apex (decurrent when sterile); free portion 3.5–8(–10) mm diam. midway, D-shaped, with low medial keel, the margins ± acute; **blades** oblong-elliptic, sagittate, 38–62 × 9.5–23 cm, 2.6 to 4 times longer than wide, briefly to abruptly acuminate at apex, rarely gradually acuminate, as broad as or weakly broader at base than across anterior lobe (measured tip to tip across posterior lobes), weakly to prominently constricted in area of petiole attachment, thinly coriaceous, weakly bicolorous; upper surface semiglossy, green, drying matte to semiglossy, medium greenish brown or blackish brown; lower surface semiglossy, drying weakly glossy to semiglossy or occasionally glossy, concolorous to weakly paler, with blotchlike, diffuse punctations (30×); anterior lobe 26–48 × 9.5–18.5 cm, 2.6 to 2.9 times longer than wide, 2.2 to 4.4 times longer than posterior lobes, broadest near base, ± symmetrical to weakly inequilateral; posterior lobes directed toward the base, occasionally weakly outward, 11.5–19.5 × 3–7 cm, (2.4 to)3.1 to 4.3 times longer than wide, narrowly rounded at apex or rarely weakly acuminate with the tip narrowly rounded, broadest at base, weakly inequilateral, the inner side narrower, rounded toward base, briefly attenuate and weakly confluent with opposite lobe at base, the confluent portion obscuring petiole apex; outer side 1.2 to 2.2 times wider than inner side midway; midrib and major veins sunken on upper surface, convex on lower surface, granular-puberulent, drying ± flattened, moderately to prominently darker than surface; **basal veins** 3 to 4 pairs, coalesced into a prominent posterior rib; primary lateral veins 6 to 9 pairs, arising at 30°–55°, most acutely toward apex, moderately to prominently arcuate; secondary veins raised on lower surface, granular-puberulent, drying raised, weakly to moderately darker than surface; tertiary veins raised on lower surface, drying in part prominulous, otherwise visible, concolorous to weakly darker than surface; reticulate veins drying in part visible or ± obscure on lower surface, ± concolorous; collective veins 3 to 4, the innermost arising from one of the lowermost lateral veins on inner side of posterior lobe, ± parallel to and 3–8 mm from margin. INFLORESCENCE erect, 1 per axil; peduncle held within the sheath, 23 cm × 2–3 mm, narrowest toward base, drying weakly glossy, pale

tan; **spathe** erect (total length not known); spathe tube 2.6 cm \times 5 mm, drying matte, medium brown on outer surface, moderately paler on inner surface; spathe blade (total length not known) drying moderately paler than tube; **spadix** erect, 4.2 cm long, sessile, adnate to spathe ca. 1.7 cm at base, most of the length of pistillate portion; pistillate portion 1.9 cm \times 3.5 mm, drying orangish tan; fertile staminate portion 2 cm \times 4–5 mm, narrowly rounded at apex, ellipsoid, drying dark reddish brown; sterile staminate portion ca. 1 cm \times 1.5–3 mm, broadest at apex, drying dark purplish brown; pistils weakly coherent, 3 to 4 across the axis (viewed from above), 1–2 mm long; ovaries subglobose, 1.5–2 mm diam., drying cream to pale tan; style Type 5 (Fig. 1), ca. 1 \times 1.5–2 mm, broader than ovary apex, the margins (probably) weakly coherent with those of adjacent styles; **stigma** ca. 0.3 mm diam., elevated on and weakly broader than narrowed portion of style; synandria ca. 1 \times ca. 1 mm, coherent, truncate, 2- to 4-lobed, 2- to 4-androus (mostly 3); sterile flowers 0.5–1 \times 0.7–1 mm, coherent in apical 3 whorls, markedly laxly arranged in basal 3 whorls (axis mostly bare), truncate, subprismatic, in 6 whorls. Berries not known.

Phenology. Flowering is only known to occur in *Chlorospatha grayumii* during the month of April.

Etymology. *Chlorospatha grayumii* is named for Michael Grayum (1949–), author of several taxa of *Chlorospatha* and one of the first modern supra-generic phylogenies of the Araceae, authority on aroid pollen and the aroid flora of Costa Rica.

Discussion. *Chlorospatha grayumii* is known from three collections made in tropical wet forest and tropical rainforest on the western slopes of the Cordillera Occidental in Colombia, in Cauca and Chocó departments, at 90–275 m elevation. The type, the only fertile collection, was collected in 1939, in the Corcovada region of the upper Río San Juan in Chocó, at 200–275 m elevation. Corcovada could not be located on current maps, and it is possible that it no longer exists as a place name. Given the elevation, the type locality is possibly in the area of Quebrada Antón, south of the road between Tado and Santa Cecilia. A second collection was made south of Quibdó, along the road to Istmina, at 90 m elevation. One collection was made near the coast, at Timbiquí, the only collection from Cauca. The species would be expected to occur in other areas within Cauca and Chocó, at similar elevations.

Chlorospatha grayumii is a member of *Chlorospatha* sect. *Occidentales* and is distinguished by its

narrowly sagittate, oblong-elliptic leaf blades that are occasionally as long as or slightly longer than the petioles, with the posterior lobes narrow and the anterior lobe more than twice as long as the posterior lobes, occasionally as much as 4.4 times longer. The inner sides of the posterior lobes are narrowly confluent at the base, obscuring the petiole apex, an unusual condition in *Chlorospatha*. The species is also distinguished by its small inflorescence with the spadix only 4.2 cm long.

Chlorospatha grayumii could be confused with only one species, *C. longiloba*, from the western slopes of the Andes in northern Ecuador near the Colombian border at 300–800 m elevation. The petiole of *C. longiloba* is sheathed one half of its length, with the sheath decurrent at the apex and inflorescences emerging from a sympodial cataphyll at the base of the sheath, thus differing from *C. grayumii*, wherein the petiole is sheathed one third of its length, with the sheath free-ending and inflorescences emerging from the apex of the sheath. The free portion of the petiole is sharply D-shaped, with a low medial keel in the latter species, and terete or subterete in *C. longiloba*. In *C. longiloba*, the spadix is adnate to the spathe one half of the length of the pistillate portion, with the fertile staminate portion tapering and broadest at the base, whereas that of *C. grayumii* is adnate almost the entire length of that portion, with the fertile portion ellipsoid. Madison (1981) originally filed the type for *C. grayumii* as *C. lehmannii* (see discussion under *C. lehmannii*).

Paratypes. COLOMBIA. **Cauca:** Timbiquí, 100 m (est.), 1903, *C. Lehmann* 390A (K). **Chocó:** ca. 15 km S of Quibdó on rd. to Istmina (Pan-American Hwy.) & 8–10 km E on rd. to petroleum exploration camp, 90 m, 5°35'N, 76°37'W, 9 July 1986, *M. Grayum, B. Hammel, J. Kress & G. Brown* 7647 (HUA, MO).

28. *Chlorospatha hammeliana* Grayum & Croat, *Ann. Missouri Bot. Gard.* 73: 466–467. 1986. TYPE: Panama. Coclé: just N of sawmill above El Copé, Atlantic slope, ca. 1000 m, 25 Aug. 1983, *B. Hammel & J. Kress* 13465 (holotype, MO-3340241!; isotype, DUKE!). Figures 4A, 21A–D.

Terrestrial herb, to ca. 1 m tall; stem erect, 5–20 cm tall, with remnants of old cataphylls persisting semi-intact, covering the stem, weakly fibrous, the fibers pale; sap milky; internodes 1–2 \times 1–3 cm, scurfy, brown, drying 1–1.5 cm diam., matte, dark brown; cataphylls 10–18 cm long, obtuse with acumen at apex (acumen 5–10 mm long), 1-ribbed abaxially, drying weakly fibrous, matte to weakly glossy, dark reddish brown on outer surface, weakly



Figure 21. *Chlorospatha hammeliana* Grayum & Croat. —A. Leaf blade adaxial surface, with simple ovate-cordate blade, photo of MO cultivar from Croat 75071. —B. Leaf blade adaxial surface, with two constricted posterior lobes, this condition intermediate to the simple and 3-lobed leaves and variable within collections attributed to this species, from Croat 44589 (MO). —C. Leaf blade adaxial surface, with 3-lobed blade, from Croat & Zhu 76881 (MO). —D. Inflorescence at anthesis, from Croat 44589 (MO).

to moderately paler on inner surface. LEAVES 1 to 3, erect-spreading; **petioles** (21–)26–70 cm long, spongy to moderately firm, glabrous, semiglossy, entirely medium to dark green, violet-purple or purple-tinged green, or green to medium yellow-green and violet-purple- or dark purple-mottled, drying matte to weakly glossy, medium-dark to dark reddish brown, frequently with the epidermis in part weakly separated \pm intact and semiglossy, sheathed 6.5–15.5 cm, 1/6 to 1/4 (to 1/3) of total length; sheath decurrent at apex; free portion 3–7(–15) mm diam. midway (dry), terete or subterete; **blades** simple, ovate and cordate, or sagittate, subhastate or sub-3-lobed (rarely 3-lobed), (21–)25–44 \times (13.2–)16–40(–43) cm, (1)1.1 to 1.7 (to 2) times longer than wide (2 times wider than long when 3-lobed), briefly or abruptly acuminate at apex, as broad as or weakly to prominently narrower or wider at base than across anterior lobe (measured tip to tip across posterior lobes), (1 to)1.3 to 1.6 (to 1.9) times wider at base, or 1.5 to 2 times wider across anterior lobe than at base, weakly to prominently or not at all constricted in area of petiole attachment, the constriction 1.5–8.5 cm narrower than anterior (or medial) lobe, subcoriaceous, conspicuously bicolorous, drying thinly coriaceous, moderately to conspicuously bicolorous; upper surface \pm flat or weakly to moderately quilted, semiglossy to glossy, dark green, drying matte to semiglossy, dark green, olive-green or occasionally brownish; lower surface semiglossy, drying semiglossy to glossy, green to gray-tinged or yellow-tinged green; anterior lobe (17.2–)18–30.5(–35) \times (13.2–)16–27(–31) cm, (1)1.1 to 1.5 times longer than wide, (1.2)1.3 to 3.5 (to 3.8) times longer than posterior lobes, broadest below middle, rarely midway, weakly to prominently or not at all constricted at base, \pm symmetrical; **medial lobe** (when present) 27.5 \times 22.5 cm, 1.2 times longer than wide, 1.3 times longer than lateral lobes, abruptly acuminate at apex, broadly attached at base, 5 cm wide at point of attachment, \pm symmetrical; posterior lobes directed toward the base or weakly to moderately outward, (3.8–)5–17.5(–21) \times 5–15.5(–17.5) cm, (1 to)1.2 to 2.3 times longer than wide, broadly rounded, acute to bluntly acute or rarely narrowly rounded at apex, broadest at base or below middle, \pm symmetrical or moderately inequilateral, the outer side narrower; inner side (1 to)2 to 2.5 times wider than outer side midway, \pm acute to truncate at base; **lateral lobes** (when present) directed toward the apex, 21–22.2 \times 11.2–11.5 cm, 1.8 to 2 times longer than wide, weakly briefly acuminate at apex, broadest at or below middle, moderately inequilateral, the inner side narrower, \pm acute toward base, narrowly confluent with medial

lobe, the confluent portion 5–6 mm wide; outer side 2.4 to 2.7 times wider than inner side midway; midrib and major veins convex, dark green on lower surface, drying \pm flattened, conspicuously to occasionally moderately darker than surface, frequently blackish; midrib weakly to moderately sunken on upper surface, rarely paler than surface; **basal veins** 4 to 9 branching off, weakly coalesced into a short posterior rib, first 1 to 5 fused at the base, 2 to 4 acroscopic, 2 to 5 basiscopic, or with 3 to 4 pairs coalesced into a prominent posterior rib; posterior rib naked 0.5–1.5 cm per side or not at all (naked 8 mm per side when 3-lobed); primary lateral veins (of medial or anterior lobe) 3 to 4 pairs, arising at 20°–65°(–75°), most acutely toward apex, \pm straight to weakly arcuate, weakly to moderately sunken or weakly depressed on upper surface; primary lateral veins (on lateral lobes, when present) 4 pairs, aggregated toward base, arising in basal 1/3, weakly to moderately arcuate; secondary veins sunken or flat on upper surface, raised on lower surface, darker than surface, drying entirely or in part weakly raised and otherwise visibly distinct, moderately darker than surface; tertiary veins occasionally weakly sunken or etched on upper surface, obscure to occasionally weakly etched on lower surface, occasionally darker than surface, drying entirely obscure and concolorous, or in part visibly distinct and otherwise obscure; reticulate veins drying obscure; collective veins 3, the innermost arising from base or one of the lowermost lateral veins on inner side of posterior lobe (outer side on lateral lobes), loop-connected with all preceding lateral veins, moderately to markedly scalloped, markedly remote and ca. 0.8–2.3(–2.8) cm from margin. INFLORESCENCES erect to erect-spreading, 2 to 3 per axil; peduncle held within the sheath only toward the base, 23.7–40 cm \times ca. 5 mm, terete, \pm spongy, green, drying weakly glossy, dark brown; **spathe** curved forward, 8.5–12 cm long, 3.6–4.5 cm wide in lower 1/3 (flattened), to 4 cm longer than spadix, lanceolate, cuspidate or abruptly acuminate at apex; spathe tube matte, green or greenish on outer surface, semiglossy, purplish or green on inner surface, 3.5–5.5 cm \times ca. 7 mm (dry), drying matte, dark brown on outer surface, weakly glossy to semiglossy and weakly to moderately paler on inner surface; spathe blade matte, white or greenish white on outer surface, semiglossy on inner surface, 5–6.5 cm long, 2–3.5 cm wide (flattened), drying matte, dark tan on outer surface, weakly glossy on inner surface, opening narrowly at anthesis, marcescent, erect after anthesis; **spadix** 5.7–7.5 cm long, sessile, adnate to spathe ca. 6–8 mm at base, 1/4 to 1/3 of the length of pistillate portion; pistillate portion greenish

white, 2.4–3.5 cm long, drying 3–5.5 mm diam., \pm cylindrical, pale yellowish to purplish; fertile staminate portion white or cream, 1.6–2 cm long, weakly clavate or tapering, narrowly rounded to bluntly acute at apex, drying ca. 5 mm diam., dark brown to weakly purplish brown; sterile staminate portion white or whitish, (1–)1.4–2.2 cm long, usually with axis naked 1–3 mm at base, drying ca. 5 mm diam., pale yellowish tan to yellowish cream, with reddish chromoplasts; pistils weakly coherent, 4 to 6 across the axis (viewed from above), 1.6–2.2 mm long; ovaries greenish white, \pm conical to cylindrical, 1.3–1.8 mm diam., drying whitish; style Type 3 (Fig. 1), as broad as or weakly narrower than ovary apex, the margins not coherent with those of adjacent styles; **stigma** yellowish, 0.3–0.5 mm diam., sessile, disklike, obtusely truncate at apex; **synandria** ca. 1 \times ca. 1 mm, coherent, truncate, deeply 3- to 5-lobed, 3- to 5-androus (mostly 4); pollen (from Grayum, 1986) in planar tetrads, inaperturate, minutely rugulate or verruculate, the individual grains 23–25 μ m (mean, 24 μ m) diam., starchless, binucleate; sterile flowers 1–1.2 \times 0.7–2.2 mm, \pm laxly arranged to weakly coherent, irregularly deeply 4- to 6-lobed, usually (1)2- to 4-branched in basal 1 to 2 whorls, in 5 to 7 whorls. Berries not known.

Phenology. Flowering is known in *Chlorospatha hammeliana* from one wild collection made on 25 August. The live voucher of a sterile collection (Croft 44589) later flowered in cultivation on 13 August.

Discussion. *Chlorospatha hammeliana* is known from two geographically isolated areas along the Continental Divide in west-central Panama: in the area of the sawmill above El Copé in Coclé Province on the Atlantic slopes at 710 to ca. 1000 m elevation, in lower montane wet forest and premontane rainforest; and in the vicinity of Santa Fé on the slopes of Cerro Tute in Veraguas Province. Three sterile collections were made in the latter area, two in premontane rainforest and premontane wet forest on the Pacific slopes at 800–1150 m elevation, and one in lower montane rainforest on the Atlantic slopes at 700 m elevation. The species is one of only two species in *Chlorospatha* sect. *Chlorospatha* that can usually or occasionally have other than divided blades. There are notable differences in the vegetative parts of the collections made in Coclé and those made in Veraguas, the most significant being the prominently 3-lobed leaf blade of one specimen of a collection from Veraguas (Croft & Zhu 76881, seen in Fig. 21C), the second specimen of the same collection having an ovate-cordate blade similar to the typical collections from Coclé. The other two collections from Veraguas exhibit a condition interme-

diate between the 3-lobed blade and the simple blade of the Coclé collections, having the blades prominently constricted in the area of petiole attachment (approaching the 3-lobed condition, as in Fig. 21C), with the posterior lobes narrow (2 to 2.3 times longer than wide), well-developed, and acute to weakly acuminate at the apex. The constriction is almost half as wide as the anterior lobe. The above suggests the possibility that more mature plants might eventually develop 3-lobed blades, as seen in Croft & Zhu 76881 (Fig. 21B). Some blades of the Coclé collections are sagittate to subhastate at the base and moderately constricted in the area of petiole attachment, but with the constriction weak or less prominent, more than three fourths as wide as the anterior lobe. These also have well-developed posterior lobes, but the lobes are broad, 1 to 1.5 times longer than wide, and broadly rounded at the apex. The petioles of the Coclé collections are entirely green, whereas those of the Veraguas collections are purple-violet, purple-tinged, or green with purple-violet or dark purple mottling. It is unfortunate that all three of the Veraguas collections are sterile and that floral characters could not be compared, but in all other respects, these collections accord well with both living and dried material from Coclé. However, it is possible that the collections from these two areas represent different taxa.

The typical form of *Chlorospatha hammeliana* is distinguished by its semiglossy, dark green petiole, sheathed one sixth to one fourth of its length, and subcoriaceous, semiglossy to glossy, conspicuously bicolorous leaf blades that are simple, ovate to sagittate, cordate at the base, and weakly or not at all constricted in the area of petiole attachment, with the major venation dark green on the lower surface. The species is also distinguished by the unusually long sterile staminate spadix (1.4–2.2 cm long), frequently longer than the fertile staminate portion, with the sterile flowers more or less laxly arranged and deeply irregularly 4- to 6-lobed or occasionally branched in the basal one or two whorls. The typical form could not be confused with any other taxon.

The 3-lobed specimen of *Chlorospatha hammeliana* is remarkably similar to *C. mirabilis*, a primarily Colombian species that has been collected in sterile condition in southern Darién Province, Panama (see discussion under *C. mirabilis*). The petiole of the latter species is matte to weakly glossy, sheathed one third to two thirds of its length, and the blades are weakly to moderately bicolorous and usually paler maculate, with the lower surface purple, purple-tinged, or purple-mottled. *Chlorospatha hammeliana* differs in having a semiglossy petiole sheathed one sixth to one fourth of its length and conspicuously

bicolorous, entirely green blades lacking maculations. The similarities of the spadices and floral morphology reflect the sectional relationship between the species. The spadix of *C. mirabilis* is adnate to the spathe one half to three fourths of the length of the pistillate portion, with the pistillate, fertile, and sterile staminate portions of almost equal lengths and the sterile flowers subprismatic. *Chlorospatha hammeliana* differs in having the spadix adnate one fourth to one third of the length of the pistillate portion, with that portion longer, occasionally nearly twice as long as the fertile or sterile staminate portions, and the sterile flowers prominently 4- to 6-lobed or occasionally branched.

The 3-lobed specimen of *Chlorospatha hammeliana* (Croat & Zhu 76881) could possibly be confused with *C. croatianana* subsp. *croatiana*, but all 3-lobed specimens of the latter taxon are moderately to prominently auriculate.

Additional specimens examined. PANAMA. **Coelé:** near Continental Divide, along lumber rd. 5.2 mi. N of El Copé, 1.5 mi. N of lumber camp, 900 m, *Croat 44589* (MO); Alto Calvario, above El Copé, along trail leading W off old lumber trail leading down to Las Ricas, Limón & San Juan, 710–800 m, *Croat 68750* (MO); vic. El Copé, N slope of Cordillera, ca. 1/2 mi. N of Continental Divide, at Alto Calvario, ca. 5.6 mi. N of El Copé, 800 m, *Croat 75071* (CM, MO). **Veraguas:** vic. Escuela Agrícola Alto Piedra near Santa Fé, 0.3 mi. beyond fork in rd. near agricultural school toward Atlantic coast, along trail to top of Cerro Tute, 1050–1150 m, *Croat 48895* (MO); along Santa Fé–Calovébora rd. beyond Escuela Agrícola Alto Piedra, along first major stream, ca. 3 mi. from fork in the rd. at school, 700 m, *Croat 48993* (MO); vic. Santa Fé, along Alto Piedra–Calovébora rd., 0.5 mi. N of Alto Piedra, on slopes of Cerro Tute, Parque Nac. Cerro Tute, 800–1030 m, *Croat & Zhu 76881* (MO).

29. *Chlorospatha hannoniae* Croat, sp. nov. TYPE: Ecuador. Morona-Santiago: Limón–Méndez rd., 940 m, 2°54'49"S, 78°24'04"W, Mar. 1996, *Croat & L. P. Hannon 81477* (holotype, MO-04901596!; isotypes, AAU!, B!, BR!, CAS!, COL!, CUVCI!, F!, GB!, GH!, HUA!, INB!, K!, M!, MEXU!, NY!, PMA!, QCA!, QCNE!, RSA!, S!, SEL!, TEX!, U!, UB!, US!, USM!, WU!). Figure 22A–D.

Herba usque ad 50 cm; internodia 1.5–4 × 1.5–2.5 cm. Petiolus 22–27 cm longus, vaginatus per 10–15 cm; lamina foliaris ovato-cordata, interdum late sub-triangularis, 16–20.5 × 10–15.5 cm, lobis posterioribus (5.7–)6–8 × (4.5–)5–7.5 cm, nervis basalibus utroque 2 vel 3, nervis primariis lateralibus utroque (3)4. Inflorescentiae 3 ad 5 in quaque axilla; pedunculus 6–8 cm × 1.2–2.2 mm; spathe 4.5–6 cm longa, tubo 5–7 mm diam., lamina 2.7–4.5 × 7–9 mm diam.; spadix 3.8–5 cm longus.

Terrestrial herb, to 50 cm tall, in small colonies; stem decumbent, erect 10–20 cm, with bulbils

produced randomly and remnants of old leaf bases persisting as a few short fibers along its length; bulbils solitary, green, 5–12 × 3–8 mm, ± ovoid; sap clear; internodes 1.5–4 × 1.5–2.5 cm, matte, dark green, becoming weakly scurfy at nodes with age, drying 1–1.5 cm diam., matte to weakly glossy, medium-dark green; cataphylls ultimately deciduous, 13 per node, erect-spreading, 14–15 cm long, inequilateral, obtuse with acumen at apex (acumen ca. 1 cm long), obtusely 1- to 2-ribbed abaxially, matte, pale green, weakly irregularly darker green-mottled in narrow transverse bands. LEAVES 8 to 14, erect, erect-spreading, spreading to reflexed-spreading; **petioles** 22–27 cm long, glabrous, matte, dark green, weakly darker green-mottled in narrow transverse bands toward base, drying matte to weakly glossy, medium-dark green, sheathed 10–15 cm, ca. 1/2 of total length; sheath free-ending and inequilateral at apex, paler and weakly glossy on inner surface, the sides 5–8 mm wide, widest at base, broadly flaring to 90° midway, appearing winged; free portion ca. 6 mm diam. midway (drying 2–4 mm diam.), U-shaped, entirely obtusely flattened adaxially or only in apical 1/3, the margins bluntly acute toward apex; **blades** held erect, erect-spreading, spreading to reflexed-spreading, ovate-cordate, occasionally broadly subtriangular, 16–20.5 × 10–15.5 cm, 1.1 to 1.6 times longer than wide, weakly acuminate to apiculate at apex, broadest at base, ca. 1.1 times broader at base than across anterior lobe (measured tip to tip across posterior lobes), occasionally narrower at base, occasionally weakly constricted in area of petiole attachment, thinly coriaceous, moderately bicolorous; upper surface broadly quilted and sub-bullate, weakly glossy, dark blackish green, drying matte to weakly glossy, dark green; lower surface reticulate, narrowly minutely colliculate along all venation, weakly glossy, medium green, drying weakly glossy, moderately paler; anterior lobe (14–)16–18 × (10.5–)12.5–14.5 cm, 1.1 to 1.3(1.4) times longer than wide, 2 to 2.3(to 2.7) times longer than posterior lobes, broadest below middle, usually at base, rarely weakly constricted on one side; posterior lobes directed toward the base, occasionally weakly outward, (5.7–)6–8 × (4.5–)5–7.5 cm, 1 to 1.2 times longer than wide, bluntly to narrowly rounded at apex, broadest at base, moderately to prominently inequilateral, the inner side always narrower, weakly to broadly rounded toward base, decurrent onto petiole; outer side 2.2 to 3.1 times wider than inner side midway; all orders of venation matte on lower surface, weakly darker than surface, drying concolorous or weakly to moderately darker than surface; midrib deeply sunken on upper



Figure 22. *Chlorospatha hannoniae* Croat, photos of MO cultivar from the type collection Croat & L. P. Hannon 81477. —A. Potted plant, showing leaf blade adaxial surfaces. —B. Stem with petioles showing the erect-spreading sheaths. —C. Stem with inflorescence at anthesis. —D. Stem with petiole bases and spathe of anthesis in side view.

surface, weakly paler than surface toward base, otherwise concolorous, round-raised on lower surface, drying weakly flattened; **basal veins** 2 to 3 pairs, coalesced into a prominent posterior rib; posterior rib round-raised and bluntly acute medially on lower surface, drying raised; primary lateral veins (3)4 pairs, arising at 45°–65°, most acutely toward apex, moderately arcuate, quilted-sunken on upper surface, weakly paler than surface toward base, otherwise concolorous, raised and obtusely angular on lower surface, drying weakly raised to ± flattened; secondary veins quilted-sunken on upper surface, in part weakly raised and otherwise prominulous on lower surface, drying weakly raised or prominulous; tertiary veins obtusely sunken on upper surface, mostly flat on lower surface, otherwise prominulous, visibly distinct, drying flat, distinct, and visible; reticulate veins weakly obtusely sunken on upper surface, visible, distinct and flat on lower surface, drying visible, distinct, and flat; collective veins 2(3), the innermost arising from apex of posterior rib, loop-connected with all preceding lateral veins, weakly scalloped, 3–8 mm from margin. INFLORESCENCES 3 to 5 per axil, erect, emitting a faint, sweet fragrance at anthesis; sympodium held within a sympodial cataphyll; sympodial cataphyll 4.5–10 × 1.5–2.5 cm, obtuse with apiculum at apex, obtusely 1- to 2-ribbed abaxially, weakly glossy to semiglossy, pale to medium green; inflorescence cataphyll 2-ribbed abaxially; peduncle 6–8 cm × 1.2–2.2 mm, cylindroid, thicker than broad, or subterete in apical 2–3 cm, narrowest toward base, weakly glossy, pale to pale-medium green, palest at base, narrowly purple-tinged apically, drying matte, dark brown; **spathe** cucullate, 4.5–6 cm long, oblanceolate, cuspidate at apex, opening narrowly most of length at anthesis, more broadly on blade; spathe tube weakly glossy, medium green, conspicuously purple-tinged in medial 1/3 and at base abaxially, paler and glossy on inner surface, 1.1–2 cm × 5–7 mm, drying 2.5–4 mm diam., matte to weakly glossy, medium to dark brown on outer surface, weakly glossy and much paler on inner surface; spathe blade matte to weakly glossy, dark maroon to greenish purple, occasionally with the veins medium green on outer surface, glossy, green, with veins and margins deeply purple-tinged on inner surface, 2.7–4.5 cm × 7–9 mm, 1.4 cm wide (flattened), acutely 1-ribbed abaxially, drying matte to weakly glossy, dark brown on outer surface, rarely greenish, weakly glossy and much paler on inner surface, marcescent, erect after anthesis; **spadix** curving weakly forward, 3.8–5 cm long, sessile, ± cylindrical, adnate to spathe 2–3 mm at base, 1/4 or less of the length of pistillate portion; pistillate

portion whitish, 0.7–1.2 cm × 2–4 mm, weakly broadest midway; fertile staminate portion glossy, creamy white, 2.5–3.5 cm × 3–3.5 mm, weakly ellipsoid, narrowly rounded at apex; sterile staminate portion glossy, white, 0.7–1.2 cm × 2–3 mm, broadest apically; pistils weakly coherent, 2 to 3 across the axis (viewed from above), 0.6 mm long; ovaries ± cylindrical or obtusely obconical, white to creamy white, 1–1.3 mm diam., 2-locular, with subaxile placentation and ca. 8 ovules per locule, or rarely 1-locular with a sub-basal placental ring and 10 to 20 ovules on incomplete axis; ovules hemianatropous, 2- to 3-seriate; funicles shorter than ovule; style Type 1 (Fig. 1), white and densely, minutely dark purple-speckled, 1–1.3 mm diam., weakly narrower than to as broad as ovary apex, the margins distinct, not coherent with those of adjacent styles; **stigma** cream-colored, 0.3–0.5 mm diam., sessile, cylindrical, obtusely truncate at apex, depressed medially; synandria ca. 1 × ca. 2 mm, coherent, occasionally bilaterally symmetrical and weakly elongated in direction of axis, occasionally subrounded, prominently and deeply 2- to 4(5)-lobed (occasionally almost to center), mostly 3- to 4-androus, broadly concave medially, the margins of lobes thickened and sinuate-undulate, weakly interlocking with those of adjacent flowers; pollen creamy white, in tetrahedral tetrads, the exine reticulate; sterile flowers frequently purple-tinged along margins, ca. 0.6 mm long, 1.5–2 × 0.8–1 mm diam. and ± elongated in direction of axis, less so in basal whorls, coherent, truncate, irregularly subprismatic, in 3 to 7 whorls. Berries not known.

Phenology. Flowering occurs in *Chlorospatha hannoniae* only during the months of May through September. Sterile collections were made in March and later flowered in cultivation only during those months, over a 5-year period. Inflorescences are fragrant and emerge in quick succession, each reaching anthesis approximately one to three days after anthesis of the preceding inflorescence.

Etymology. *Chlorospatha hannoniae* is named for Mrs. Lynn P. Hannon (1948–2006), of Odessa, Florida, an associate of the University of South Florida, whose many field trips to Ecuador and excellent living collections made this revision substantially more complete (please see dedication footnote at beginning of manuscript).

Discussion. *Chlorospatha hannoniae* is known only from the type collection made along the road between Limón and Méndez, in premontane moist forest on the eastern slopes of the Andes, at 940 m

elevation. The species would be expected to occur elsewhere within the province and possibly to the south in Zamora-Chinchipe Province and eastward into Peru.

Chlorospatha hannoniae, a member of *Chlorospatha* sect. *Orientalis*, is found in small colonies and is distinguished by its sub-bullate, weakly glossy, dark blackish green, broadly ovate-cordate leaf blades with the posterior lobes more or less rounded at the apex, approximately half as long as the anterior lobe and frequently overlapping on the inner sides. Although it is a robust plant with stems to 2.5 cm in diameter, it is less than 50 cm tall and has eight to 14 leaves held erect, erect-spreading, spreading, and reflexed-spreading. The petioles are short (22–27 cm long), relative to blade length, almost as long as the blades and sheathed approximately half of the total length, with the sides of the sheath broadly flaring, thus appearing winged, a condition observed in only one other species. *Chlorospatha hannoniae* is also distinguished by producing cataphylls only during the flowering cycle. The inflorescence is small, no more than 6 cm long, with the spathe tube maroon-tinged green and the blade dark maroon. The species is also distinguished by its white ovaries and styles, with the latter densely, minutely dark purple-speckled. The glossy, white, staminate portion of the spadix is also distinctive, with the sterile portion almost as long as the pistillate portion, unusual for species from the eastern slopes.

Chlorospatha hannoniae is probably most closely allied and would be most easily confused with *C. boosii* (see discussion under *C. boosii*).

Chlorospatha hannoniae could possibly be confused with *C. longipoda*, which is widespread on the eastern slopes of the Andes in Ecuador, at 470–1700 m elevation, and is probably sympatric with *C. hannoniae* in Morona-Santiago Province (see discussion under *C. longipoda*). *Chlorospatha hannoniae* is a more robust plant when mature, with stems to 2.5 cm diameter versus 1.3 cm diameter in mature specimens of *C. longipoda* in which the remnants of old cataphylls and petiole bases are retained more or less intact along the length of the stem, differing from *C. hannoniae* in which only the petiole bases are retained as a few short fibers.

30. *Chlorospatha hastata* Croat & L. P. Hannon, sp. nov. TYPE: Ecuador. Esmeraldas: Lita–San Lorenzo rd., 3.4 km E of El Durango, 17.3 km W of Alto Tambo, 375 m, 1°12'31"N, 78°37'02"W, 8 July 1998, Croat, L. P. Hannon, D. Mansell & J. Whitehill 82531 (holotype, MO-04889546!; isotypes, B!, CAS!, F!, K!, NY!, US!). Figures 23A–D, 24A.

Herba usque ad 1 m; internodia 0.5–1.5 × 1–2 cm; cataphylla 16–37 cm longa. Petiolus 35–69 cm longus, vaginatus per 15–33 cm; lamina foliaris hastata, 19–32 × 20–33 cm, lobis posterioribus 10.5–20 × (3.2–)4–7 cm, nervis basalibus utroque 6 ad 9, nervis primariis lateralibus utroque 7 vel 8. Inflorescentiae 1 vel 2 in quaque axilla; pedunculus 15–25 cm × 2–4 mm; spatha 9–13.5 cm longa, tubo 0.5–1.2 cm diam., lamina 4–6.5 cm × 8–9 mm diam.; spadix 5.3–9.2 cm longus.

Terrestrial herb, to 1 m tall; stem decumbent, erect to 20 cm, remnants of old leaf bases and cataphylls persisting as a few short fibers along its length; sap milky; internodes 0.5–1.5 × 1–2 cm, semiglossy, medium to dark green, drying weakly glossy, medium gray-tinged brown; cataphylls 16–37 cm long, obtuse with acumen at apex (acumen to 3 mm long), obtusely 1-ribbed abaxially in apical 1/2, pale green, weakly darker purple-mottled in narrow transverse bands, drying weakly glossy to semiglossy, medium-dark reddish brown. LEAVES 2 to 3, erect-spreading; **petioles** 35–69 cm long, glabrous, matte, pale to medium green, moderately to densely purple-mottled in narrow transverse bands, most densely so toward base, rarely greenish adaxially and otherwise entirely purplish and darker purple-mottled, drying matte to weakly glossy, medium to dark brown, sheathed 15–33 cm, 1/3 to 1/2 of total length; sheath free-ending at apex; free portion 3–6 mm diam. midway, terete, narrowly sulcate; **blades** hastate, 19–32 × 20–33 cm, 1 to 1.2(to 1.4) times longer than wide, usually as wide as long to occasionally 1.2 times wider than long, gradually acuminate to narrowly acuminate at apex, broadest at base, 3 to 4 times wider at base than across anterior lobe (measured tip to tip across posterior lobes), thin, markedly bicolorous; upper surface velvety to matte-subvelvety, dark green, drying dark green to olive-green, rarely brown; lower surface semiglossy, rarely weakly glossy, pale green and markedly discolorous, narrowly to ± broadly dark purple along midrib and major veins, drying semiglossy to glossy, green to brownish, weakly to moderately paler and usually markedly discolorous; anterior lobe 15.5–22 × 5–11 cm, 1.9 to 2.8(to 3.4) times longer than wide, 1.1 to 1.5 times longer than posterior lobes, broadest at or below middle, moderately to markedly constricted at base, ± symmetrical; posterior lobes directed prominently outward, 10.5–20 × (3.2–)4–7 cm, 2.4 to 3.6(to 4) times longer than wide, acute to bluntly acute at apex or weakly acuminate with the tip bluntly acute, broadest midway, usually markedly constricted at base, ± symmetrical, the inner side weakly to broadly rounded toward base, briefly attenuate onto posterior rib; outer side ± straight toward base; midrib and major venation moderately to deeply



Figure 23. *Chlorospatha hastata* Croat & L. P. Hannon, photos of the type collection Croat *et al.* 82531 (MO). —A. Fertile habit. —B. Leaf blade abaxial surfaces. —C. Petiole with inflorescence at anthesis. —D. Anthesal inflorescence with spathe tube open to expose entire spadix.

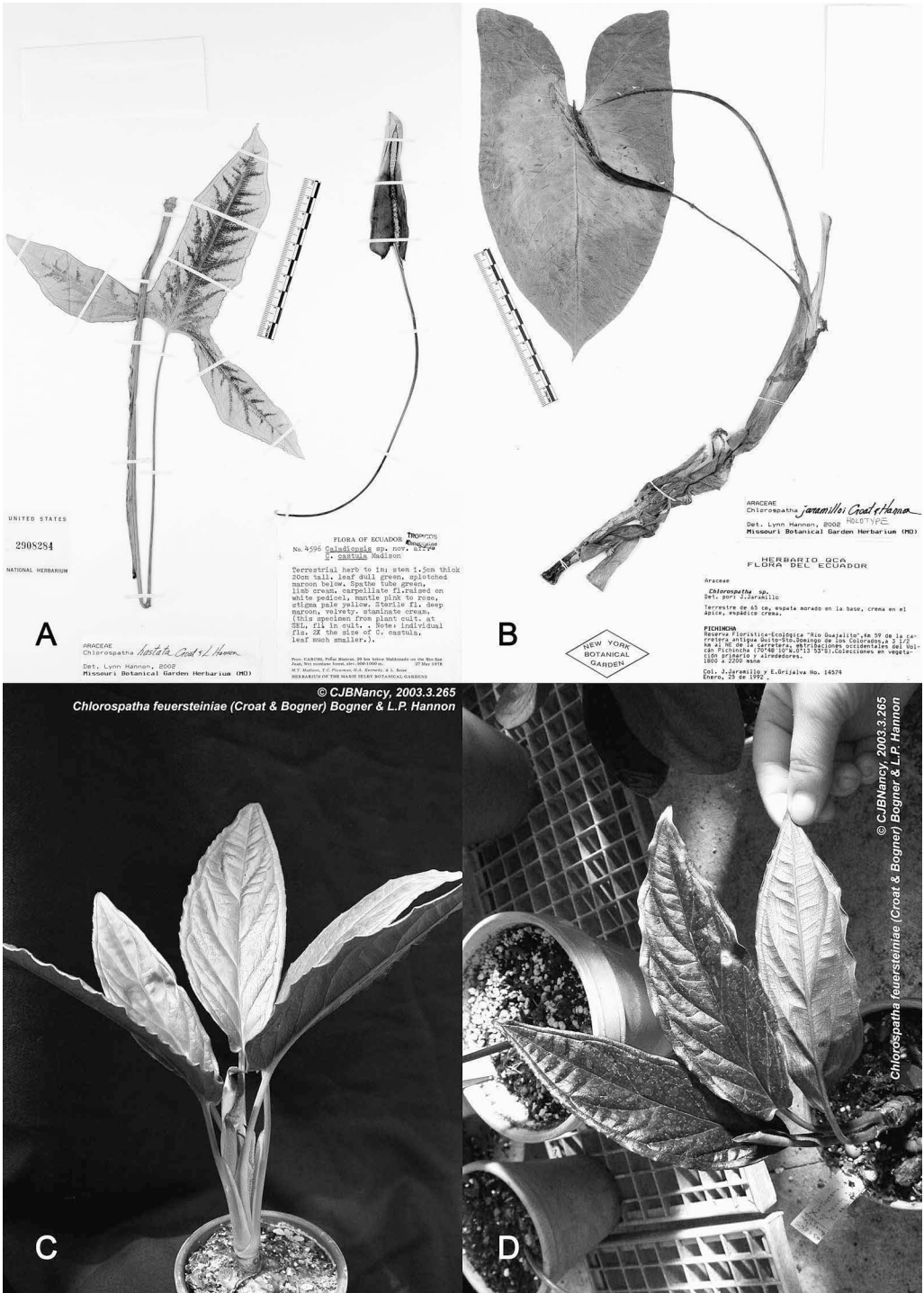


Figure 24. —A. *Chlorospatha hastata* Croat & L. P. Hannon, paratype specimen Madison et al. 4596 (MO). —B. *Chlorospatha jaramilloi* Croat & L. P. Hannon, Jaramillo & Grijalva 14574 (NY holotype specimen). C, D. *Chlorospatha feuersteiniae* (Croat & Bogner) Bogner & L. P. Hannon. —C. Habit of potted plant. —D. Habit showing purple underside of leaf. Photos used by permission of Nancy Botanical Garden.

sunken on upper surface, weakly granular-puberulent on lower surface, \pm dark purple, drying weakly raised and \pm flattened, weakly to moderately darker than surface, usually purplish; midrib round-raised on lower surface, occasionally minutely ribbed; **basal veins** 6 to 9 pairs, coalesced into a prominent posterior rib; posterior rib naked 1–2 cm per side; primary lateral veins 7 to 8 pairs, arising at (30° – 40° – 60° – 70°), weakly to moderately arcuate, occasionally \pm straight, convex on lower surface; secondary veins raised, frequently in part dark purple on lower surface, drying weakly raised or prominulous, rarely moderately raised, darker than surface; tertiary veins raised or prominulous on lower surface, drying entirely prominulous or in part prominulous and otherwise flat, concolorous to weakly darker than surface; reticulate veins obscure; collective veins 3(4), the innermost arising from lowermost lateral vein on inner side of posterior lobe, loop-connected with all preceding lateral veins, parallel to margin or weakly scalloped, 3–4(–10) mm from margin. INFLORESCENCES erect, 1 to 2 per axil, emitting a sweet or musty-fruity fragrance at anthesis; peduncle held within the sheath, terete to elliptical or terete midway and obtusely D-shaped or U-shaped toward apex, 15–25 cm \times 2–4 mm, narrowest toward base, pale green, weakly irregularly darker purplish mottled in narrow transverse bands, drying matte to weakly glossy, medium to dark brown, occasionally dark green; **spathe** \pm erect, 9–13.5 cm long, lanceolate, weakly cuspidate at apex, the margins in-rolled toward apex, opening broadly at anthesis, nearly to base, the margins directed forward; spathe tube weakly glossy to semiglossy, medium to medium-dark green on outer surface, matte to weakly glossy and moderately paler on inner surface, occasionally with the longitudinal veins weakly darker on both surfaces, 5–7 \times 0.5–1.2 cm, drying matte to weakly glossy or semiglossy, dark brown to dark green on outer surface, matte to weakly glossy, concolorous to weakly paler on inner surface; spathe blade weakly glossy to semiglossy, greenish cream to yellow-green cream on outer surface, matte on inner surface (rarely semiglossy), concolorous, occasionally with longitudinal veins weakly darker than surface, 4–6.5 cm \times 8–9 mm, 2–3.2 cm wide (flattened), drying matte to weakly glossy, brownish cream to yellow-green cream, rarely tinged reddish brown, marcescent, erect after anthesis; **spadix** erect, stipitate 1–1.8 cm, 5.3–9.2 cm long, adnate to spathe 0.9–1.7 cm at base, only along stipe, the stipe frequently emerging from a sheath in the spathe, with sheath margins to 1 mm wide; pistillate portion pink or pale purplish, 2.5–4.7 cm \times 4–6 mm, broadest

midway or toward apex, drying purplish; fertile staminate portion cream to yellowish cream or yellow-green cream, (1.4–)2.4–3.3 cm \times 2.5–6 mm, narrowly rounded to bluntly acute at apex, terete to weakly cylindroid (thicker than broad), broadest at or below middle, \pm cylindrical to tapering, drying pale to dark tan; sterile staminate portion \pm purple to dark maroon, 1–2.7 cm \times 2.5–4 mm, usually broadest at base; pistils \pm laxly arranged, ca. 3 across the axis (viewed from above), 1.2–2 mm long; ovaries white, cream, or greenish cream (rarely tan), \pm subglobose, 1.7–2 mm diam., 2- to 3(4)-locular, with subaxile placentation; ovules 4 to 8 per locule, small, anatropous, biseriate; funicles longer than ovules; style Type 4 (Fig. 1), rarely tan (post-anthesis), 2–2.5 mm diam., 0.15 mm thick, obscurely attenuate, markedly broader than ovary apex, with red chromatoplasts present, the margins frequently \pm coherent with those of adjacent styles; **stigma** pale orangish yellow to orangish white, rarely tan-white, 0.5–1 mm diam., appearing sessile, \pm cylindrical to obconical, depressed medially, obscurely elevated on style; synandria 1–1.5 \times 1.2–2.3 mm, coherent, truncate, (2)3- to 4(5)-lobed, mostly 3- to 4-androus, occasionally with some flowers at apex 1- to 2-lobed and lacking microsporangia; thecae oblong; pores apical; sterile flowers entirely purple to maroon or in part cream medially and purple to maroon on sides, rarely with some flowers entirely cream (on same spadix), ca. 1 mm long, 2–3 \times 1 mm diam. and \pm elongated in direction of axis, fungiform, broadly and deeply concave medially, frequently almost to base, the margins markedly sinuate-undulate, \pm laxly arranged, in 4 to 8 whorls. INFRUCTESCENCE (immature) 8 cm \times 11 mm, drying dark purplish brown; berries (immature) ca. 3 mm diam., drying brownish white.

Phenology. Flowering is only known to occur in *Chlorospatha hastata* during the months of May, July, August, and December. Inflorescences emerge in slow progression, with several days between anthesis of one inflorescence and emergence of the next inflorescence at the apex of the petiole sheath. In cultivation, flowering is not continuous but periodic.

Etymology. The epithet is taken from the Latin “hastatus,” meaning “hastate,” with the posterior lobes of *Chlorospatha hastata* directed outward.

Discussion. *Chlorospatha hastata* is known only from premontane wet forest on the western slopes of the Andes in Carchi and Esmeraldas provinces in northern Ecuador, at 375–1800 m elevation. The species is likely to occur also in southern Colombia,

there being no significant differences in the habitat or conditions there.

Chlorospatha hastata is a member of *Chlorospatha* sect. *Occidentales* and is distinguished by its hastate, velvety, dark green leaf blades, usually as wide as long, with the lobes prominently constricted at the base, the lower surface conspicuously paler and usually sharply and narrowly or broadly discolorous dark purple along the major veins. The thin, pink to purplish, broadly spreading style, much broader than the ovary apex and obscurely attenuated, the long sterile staminate portion of the spadix, which comprises one fourth to one third of total length, and unusual concave-fungiform sterile flowers are also noteworthy. The attenuated portion of the style is markedly short and obscured by the mantle; therefore, the stigma only appears to be sessile. The sterile flowers are laxly arranged; deeply concave medially, either sessile or weakly stipitate and usually entirely dark purple, occasionally with the concave portion white or cream-colored. The long sterile staminate portion of the spadix, with these unusual flowers, is a condition found in only two other species, either of which might be confused with *C. hastata*: *C. atropurpurea* and *C. castula*. All three species have leaf blades that are velvety, dark green on the upper surface and either purple-tinged, dark purple-mottled, or entirely purple on the lower surface.

Chlorospatha atropurpurea and *C. hastata* share the same striking coloration on the lower surface of the blade, whereas in *C. castula*, the surface is only purple-tinged medially or entirely green with the major veins purplish. The spathe is cucullate in *C. atropurpurea* and *C. castula*, but erect in *C. hastata* (see discussions under both species).

The label notes for *D. Rubio et al. 1733* report that in Carchi Province, the fruits are used for snakebites and the local name for the species is "papa de la culebra."

Paratypes. ECUADOR. **Carchi:** Peñas Blancas, 20 km below Maldonado, 900–1000 m, May 1978, *Madison et al. 4596* (MO, QCA, SEL, US-2908284); 45 km below Maldonado, Nov. 1979, *Madison & Besse 7080* (SEL); Tulcán Cantón, Res. Indígena Awá, Gualpi Alto comm., Chical parish, 1800 m, 1°02'N, 78°14'W, 15–28 June 1991, *D. Rubio, C. Quelal & P. Nastacuaz 1733* (MO, QCNE); Res. Vida Awá, 2004, *G. Toasa 9580* (QCNE). **Esmeraldas:** vic. Alto Tambo, along Lita–San Lorenzo rd., 17.1 km W of Río Lita near Lita, 822 m, 0°54'06"N, 78°32'27"W, 20 July 2000, *Croat, L. P. Hannon, D. Hannon, G. Walther & K. Tuniak 84232* (MO).

31. *Chlorospatha hastifolia* Bogner & L. P. Hannon, *Willdenowia* 37: 334–336. 2007. TYPE: Colombia. Comisaria del Amazonas, confluencia de

los ríos Amazonas y Loretoyacu. 12 Apr. 1975, *I. Cabrera 3353* (holotype, COL-184576!). Figure 46D.

Plant glabrous, with short stem and 3 leaves; stem ca. 2.5 cm long and ca. 0.8 cm in diam., covered with branched roots, those of first order ca. 0.5 mm in diam. LEAVES; **petiole** 25–27 cm long and ca. 0.3 cm in diam., purple; sheath 11.5–12.5 cm long; **blade** hastate, coriaceous, 25–27 × 7–7.5 in the middle; anterior lobe ca. 20 × 7–7.5 cm, apex of anterior lobe cuspidate; basal lobes 7–7.5 × 2 cm, apex ± obtuse; venation reticulate; 4 to 5 primary lateral veins on each side of a strong midrib, one of the primary lateral veins running into each basal lobe, second order veins forming an interprimary collecting vein, third and fourth order veins forming an irregular network (well visible underneath); inner collective vein 4–5 mm from the margin, second outer collecting vein thinner and 0.9–1.5 mm from the margin, also a very thin third collective vein running along the margin. INFLORESCENCE; peduncle ca. 7 cm long and placed within the leaf sheath; **spathe** incomplete, but clearly constricted (purple testae collector's notes); lower part ellipsoid, ca. 1.5 cm long and ca. 0.8 cm in diam. at the constriction ca. 0.3 cm in diam., upper part of spathe lacking; **spadix** ca. 6 cm long (cream-colored testae collector's notes), fertile to apex and narrowing toward apex; female part ca. 1.2 cm long and 0.4 cm in diam.; male part 4–4.2 cm long and 0.5 cm in diam.; sterile part between female and male flowers ca. 1.5 cm long, at most of its length 1.8–2 mm in diam., at base 3 mm in diam. FLOWERS unisexual, naked; female flowers somewhat laxly arranged; ovary 0.9–1(–1.1) mm in diam.; **stigma** button-like, yellow, ca. 0.4 mm in diam.; style broader, 0.9–1 mm in diam., somewhat lobed (usually 4-lobed), thin, dark-colored, not coherent; synandria somewhat laxly arranged; synandrium truncate, ca. 1 mm tall, from above irregularly rectangular to ± elliptic, 1.2–1.5 × 0.8–1 mm, with incisions of the thecae (as seen from above), thecae lateral, ca. 1 mm long (thecae still closed in the specimen); pollen grains in tetrads, 55–60 μm in diam., exine smooth (psilate); synandrodes between female and male flowers very long and narrow, truncate, ± linear and narrowed at both ends, very slightly sunken in the center, from above 2.5–3 × 0.3–0.4 mm, the lowermost up to 1 mm wide and narrowly lanceolate in shape. Berries unknown.

Phenology. The type specimen flowered in April.

Discussion. *Chlorospatha hastifolia* is only known from the type locality. It was collected at the junction

of the rivers Amazonas and Loretoyacu, where it grows on red heavy sandy soil (laterite) in a half-shaded place.

Chlorospatha hastifolia is a member of *Chlorospatha* sect. *Occidentales*.

32. *Chlorospatha huilensis* Croat & L. P. Hannon, sp. nov. TYPE: Colombia. Huila: Finca Merenberg, 100 km E of Popoyán, 2300 m, 5–6 Dec. 1980, *Croat 51944* (holotype, MO-2886244!; isotype, COL-308247!). Figure 25A–D.

Herba 0.3–1 m; internodia (1–)1.5–3.5 × 1–2 cm; cataphylla 11.5–18 cm longa. Petiolus 21.5–43.5 cm longus, vaginatus per 12–21 cm; lamina foliaris sagittata vel debiliter subhastata, (11.4–)16–23 × (5.5–)8–12.7 cm, lobis posterioribus (4.5–)5.5–9.4 × (1.8–)2.8–4.5 cm, nervis basalibus utroque (2)3 vel 4, nervis primariis utroque 3 ad 5. Inflorescentiae 2 ad 5 in quaque axilla; pedunculus 8–14.5 cm × 1–2 mm; spatha 6–10.5 cm longa, tubo 3–4.5 cm × 3.5–6 mm; spadix 5.3–8.5 cm longus.

Terrestrial herb, 0.3–1 m tall; stem decumbent, remnants of old cataphylls persisting ± intact at upper nodes; internodes (1–)1.5–3.5 × 1–2 cm, drying weakly glossy, pale grayish brown to medium brown (all measurements made from dried material); cataphylls 11.5–18 cm long, abruptly acuminate at apex, drying weakly glossy to semiglossy, medium orangish brown, occasionally paler. LEAVES 3 to 4, erect-spreading; **petioles** 21.5–43.5 cm long, glabrous, weakly glossy, medium-dark pink-tinged green, finely and irregularly darker transversely lineate in basal 1/2, drying weakly glossy, dark reddish or orangish brown to almost black (apically), paler near base, sheathed 12–21 cm, ca. 1/2 of total length; sheath free-ending at apex; free portion 1–3 mm diam. midway, terete or subterete; **blades** sagittate to weakly subhastate, (11.4–)16–23 × (5.5–)8–12.7 cm, 1.7 to 2 times longer than wide, acuminate at apex, rarely acute or abruptly acuminate, broadest at base, 1.4 to 1.6 times wider at base than across anterior lobe (measured tip to tip across posterior lobes), weakly or not at all constricted in area of petiole attachment, thin, moderately bicolorous; upper surface possibly bullate, semiglossy, dark green, drying matte to weakly glossy, medium to medium-dark yellowish brown (rarely green); lower surface semiglossy, drying matte to weakly glossy (glossier than upper surface), weakly paler or concolorous; anterior lobe (8–)11.5–17.5 × (4–)6.5–8.8 cm wide, 1.7 to 1.9(to 2.1) times longer than wide, 2.2 to 2.4(to 2.6) times longer than posterior lobe, broadest at or near base, symmetrical to weakly inequilateral; posterior lobes directed toward the base or occasionally weakly outward, (4.5–)5.5–9.4 ×

(1.8–)2.8–4.5 cm, (2.1 to)2.3 to 2.9 times longer than wide, bluntly acute at apex, rarely narrowly rounded, broadest at base, moderately inequilateral, the inner side narrower, weakly rounded toward base, briefly to moderately attenuate and weakly confluent with opposite lobe at base, obscuring petiole apex; outer side 1.8 to 2 times wider than inner side midway, ± straight toward base; all venation (except reticulate) markedly impressed on upper surface, prominently raised on lower surface, weakly granular-puberulent and matte; midrib and major veins round-raised on lower surface, drying round-raised, concolorous or weakly to moderately darker than surface; **basal veins** (2)3 to 4 pairs, coalesced into a prominent posterior rib; primary lateral veins 3 to 5, arising at 25°–60°(–70°), most acutely toward apex, straight to moderately arcuate; secondary veins drying raised on lower surface, concolorous to weakly or moderately darker than surface; tertiary veins drying entirely raised or in part raised and otherwise prominulous on lower surface, weakly darker than surface; reticulate veins drying ± prominulous on lower surface, concolorous to weakly darker than surface; collective veins 3, the innermost arising from lowermost lateral vein on inner side of posterior lobe, rarely from apex of posterior rib, ± parallel to and 3.5–9 mm from margin. INFLORESCENCES erect, 2 to 5 per axil; peduncle held within the sheath, 8–14.5 cm × 1–2 mm, narrowest at base, weakly glossy, pale green, irregularly weakly darker transversely lineate in basal 2/3, drying matte to weakly glossy, dark blackish brown, occasionally paler toward base; **spathe** 6–10.5 cm long, weakly cucullate, cuspidate at apex; spathe tube pale to medium green on outer surface, 3–4.5 cm × 3.5–6 mm, drying weakly glossy, dark blackish brown; spathe blade white or yellow, 3.2–6 cm × ca. 7 mm, drying matte to weakly glossy, pale tan or orangish tan to occasionally medium-dark brown on outer surface, paler on inner surface, opening broadly at anthesis, marcescent, erect after anthesis; **spadix** erect, 5.3–8.5 cm long, sessile, adnate to spathe 3–4.2 cm at base, entire length of pistillate portion; pistillate portion greenish, 3–4.2 cm × 2.5–3 mm, narrowest at base, drying medium brownish; fertile staminate portion white or dark yellow, 2.5–4.5 cm × 3–5 mm, acute to bluntly acute at apex, ± ellipsoid, broadest at or below middle, drying pale grayish tan to yellowish; sterile staminate portion 6–9 × 1.5–2 mm, broadest at apex, drying yellowish tan; pistils weakly coherent, 2 to 4 across the axis (viewed from above), 1.5–1.9 mm long; ovaries subglobose, 0.6–0.8 × 1.5–2.5(–3) mm, drying pale tan with darker veins; style Type 5 (Fig. 1), ca. 2 × ca. 1.6–2.2 mm (attenuate portion to ca. 0.8 mm long), greenish,



Figure 25. *Chlorospatha huilensis* Croat & L. P. Hannon. A–C. Photos and images for the type collection, *Croat 51944* (MO). —A. Fertile habit. —B. Isotype specimen (COL-308247). —C. Inflorescence post-anthesis. —D. Paratype specimen of *C. huilensis*, *Croat 51832* (COL-306928).

comprising ca. 1/2 of the length of pistil, much broader than ovary apex, the margins \pm weakly coherent with those of adjacent styles; **stigma** ca. 0.3 mm diam., elevated on and broader than narrowed portion of style; synandria 1–1.2 \times 1–1.2 mm, coherent, truncate, deeply (2)3- to 4-lobed, mostly 3- to 4-androus; sterile flowers ca. 1 mm long, 1–2 \times 1 mm diam. and \pm elongated in direction of axis, coherent, truncate, irregularly subprismatic, in 3 to 4 whorls. Berries not known.

Phenology. Flowering is only known to occur in *Chlorospatha huilensis* during the months of August and December.

Etymology. The epithet is taken from the name for Huila Department of Colombia, in which the type locality of *Chlorospatha huilensis* is located.

Discussion. *Chlorospatha huilensis* is known from the southern end of the Magdalena River drainage between the Cordilleras Central and Oriental in southern Colombia, at 2000–2420 m elevation in Huila Department, and rarely from the Amazon drainage in Putumayo Department. The species appears to be endemic to this area of premontane rainforest and lower montane rainforest, though it possibly occurs also in the broad areas of lower montane wet forest that border the rainforest. The species would be expected to occur in that portion of Nariño Department that lies between Huila and Putumayo departments on the eastern slopes and possibly southward into northern Ecuador. It is one of only two species in *Chlorospatha* sect. *Occidentales* that occurs exclusively or occasionally on the eastern slopes of the Andes.

Chlorospatha huilensis is distinguished by its long internodes (1.5–3.5 cm) and usually sagittate, semiglossy, dark green leaf blades with all venation but the reticulate markedly impressed on the upper surface and prominently raised and matte on the lower surface. The posterior lobes are weakly confluent at the base, obscuring the petiole apex. The species is also distinguished by its short peduncles (less than 15 cm long) and greenish styles.

Chlorospatha huilensis could be confused with *C. antioquiensis* from the Magdalena River drainage in Antioquia Department, Colombia, at 1800–3000 m elevation (see discussion under *C. antioquiensis*).

Chlorospatha bullata also might be confused with *C. huilensis*. *Chlorospatha bullata* occurs only on the western slopes of the Cordillera Occidental in Valle Department. In the latter species, the petiole is purple-tinged, occasionally the lower blade surface as

well, differing from *C. huilensis* in which both are entirely green (see discussion under *C. bullata*).

Chlorospatha huilensis might be confused with *C. congensis* from Cauca Department on the western slopes of the Cordillera Occidental in Colombia, which differs in having shorter internodes, the petiole sheath decurrent at the apex and leaf blades that dry subcoriaceous, with the upper surface velvety-matte (see discussion under *C. congensis*).

Chlorospatha huilensis is also similar to *C. sucumbensis*, a species known only from the eastern slopes of the Andes in Sucumbíos Province in northernmost Ecuador, along the El Carmelo–La Bonita road that parallels the border with Colombia, at 2200–2350 m elevation. In *C. huilensis*, the petiole is sheathed one half of its length; the internodes dry pale grayish brown to medium brown, and the blades dry yellowish brown and not reticulate on the lower surface, with all venation weakly darker than the surface (see discussion under *C. sucumbensis*).

Idrobo et al. 2869 was previously filed as *Chlorospatha lehmannii* by Madison (1981), but was found to accord with *C. huilensis* in all respects. This collection differs from the type of *C. huilensis* in having dark yellow (not white) synandria. *Chlorospatha lehmannii* differs from *C. huilensis* in having coriaceous leaf blades that are velvety on the upper surface, with the posterior lobes narrower, longer (relative to the length of the anterior lobe), and directed outward. The posterior rib is naked 5–7 mm per side, with the inner margin decurrent onto the posterior rib. The blades of *C. huilensis* are thin and semiglossy on the upper surface, with the posterior lobes directed toward the base and weakly confluent at the base, obscuring the petiole apex. The major venation dries flattened on the lower surface in *C. lehmannii*, but for the most part is raised in *C. huilensis*. The peduncle, spathe, and spadix are longer in *C. lehmannii*, with the pistils laxly arranged and Type 7 styles (Fig. 1). *Chlorospatha huilensis* has weakly coherent pistils and Type 5 styles (Fig. 1). The sterile flowers of *C. lehmannii* are fungiform or branched, whereas those of *C. huilensis* are subprismatic.

Paratypes. COLOMBIA. **Huila:** Finca Merenberg, 100 km E of Popayán, 2300 m, 5–6 Dec. 1980, *Croat 51911* (MO); Macizo Colombiano, Hoya del Magdalena, Km. 17 on San Agustín–Santa Rosa rd., “La Candela,” 2420 m, 27 Aug. 1958, *J. Idrobo, Pinto & Bischler 2869* (P). **Putumayo:** along Pasto–Macoa rd., vic. Km. 95, near Restaurante Buenos Aires; ca. 2000 m, 3 Dec. 1980, *Croat 51832* (COL-306928, MO).

33. *Chlorospatha ilensis* Madison, Selbyana 5(3–4): 355. 1981. TYPE: Ecuador. Pichincha: path following ridgeline at La Centinela at crest of

Montañas de Ila, at Km. 12 on Patricia Pilar–24 Mayo rd., 600 m, 6 Feb. 1979, *C. Dodson, A. Gentry & J. Duke 7547* (holotype, SEL!; isotypes, MO!, QCNE!, RPSC not seen). Figure 26A–D.

Terrestrial herb, rarely hemiepiphytic, over 1 m tall; stem erect, 5–24 cm long, cylindrical, with remnants of old cataphylls persisting intact at upper few nodes, otherwise as pale fibers, with bulbils produced in basal 1/3; bulbils solitary, ovoid, ca. 5 × 5 mm on exposed stem, elongated below soil surface and 10 cm × 5 mm; sap clear; internodes 1–1.5 × 1–4 cm, weakly scurfy, dull tan, drying matte, medium-dark to dark brown; cataphylls 10–30 cm long, obtuse with acumen at apex (acumen 1–5 mm long), weakly glossy, pale to medium green, entirely irregularly finely purple-mottled in narrow transverse bands, most densely so toward base, occasionally entirely purple-tinged on outer surface, semiglossy and much paler on inner surface, drying weakly glossy to semiglossy, medium-dark to dark reddish or orangish brown. LEAVES 3 to 5, erect-spreading; **petioles** 43–100 cm long, moderately firm, rarely fleshy, glabrous, matte to weakly glossy, dark purple for most of length, or green apically and darker purple-mottled toward base, or entirely pale yellow-green to medium-dark green or weakly olive-green and pale to moderately dark maroon- or purplish-mottled, most densely so toward base, rarely entirely medium green with sheath margins dark maroon when in flower, drying weakly glossy to semiglossy (rarely matte), medium to dark brown, sheathed 22.5–60 cm, 1/2 to 2/3 of total length (ca. 1/4 when sterile); sheath decurrent at apex, rarely free-ending, rarely with margins weakly undulate; free portion 5–10 mm diam. midway, terete or subterete, occasionally obtusely 1-ribbed medially; **blades** held horizontally, hastate or deeply 3-lobed, occasionally subhastate, 24–40.5 × 27–56 cm, usually wider than long, gradually or narrowly acuminate at apex, rarely abruptly acuminate, broadest at base, 2.6 to 3.6 (to 4.2) times wider at base than across anterior lobe (measured tip to tip across posterior lobes), thin, moderately bicolorous; upper surface quilted, semiglossy to glossy, medium green, drying weakly glossy to semiglossy, dark greenish brown to olive-brown or olive-green, rarely grayish green; lower surface glossy, drying semiglossy to glossy, weakly to moderately paler; anterior (or medial) lobe 16.5–32 × 7–19 cm, 1.7 to 2.6 times longer than wide, 1.1 to 1.4 times longer than posterior (or lateral) lobes, usually broadest at or below middle, rarely above middle, moderately to markedly constricted at base, weakly inequilateral; posterior lobes directed outward, frequently toward

the apex on drying, 13.5–28 × (4–)5.5–13.5 cm, 1.8 to 2.9 (to 3.7) times longer than wide, acuminate at apex, rarely acute or narrowly rounded, broadest at or below middle, usually markedly constricted at base (weakly to moderately constricted in young plants), weakly to moderately inequilateral, occasionally markedly so, the outer side narrower, straight to weakly concave toward the base; inner side (1)1.1 to 3 (to 4.3) times wider than outer side midway, weakly to broadly rounded toward base and briefly to gradually attenuate onto posterior rib, occasionally decurrent onto petiole; **lateral lobes** (when present) as per posterior lobes but directed toward the apex, narrowly confluent with medial lobe, the confluent portion 1–2 cm wide; midrib and major venation sunken on upper surface, concolorous to weakly paler on lower surface, drying ± flattened, prominently darker than surface, occasionally moderately darker; midrib round-raised on lower surface; **basal veins** (or primary lateral veins on lateral lobes) (5)6 to 9 pairs, coalesced into a prominent posterior rib; posterior rib naked 3–9 mm per side, occasionally not at all; primary lateral veins (5)6 to 9 (10) pairs, arising at (35°–)45°–90°, most acutely toward apex, straight to weakly arcuate, or in part moderately arcuate or irregularly ascending, convex on lower surface; secondary veins obtusely sunken on upper surface, raised on lower surface, drying weakly to moderately raised, usually darker than surface; tertiary veins distinct, visible on lower surface, drying distinct, in part weakly prominulous, otherwise flat, darker than surface; reticulate veins obscure; collective veins 3, arising from one of the lowermost lateral veins on inner side of posterior (or lateral) lobe, loop-connected with all preceding lateral veins, ± parallel to margin, occasionally moderately scalloped, 2–7 (–10) mm from margin. INFLORESCENCES erect to erect-spreading, 5 to 6 per axil, emitting a sweet mintlike to spicy fragrance at anthesis; peduncle held within the sheath, 21–57 cm × 1–4 mm, cylindroid, thicker than broad, or terete and obtusely flattened adaxially toward apex, narrowing toward base, weakly glossy to semiglossy, pale green to yellow-green or medium green, occasionally finely, irregularly, weakly darker-mottled, most prominently toward base, drying weakly glossy to semiglossy, medium-dark to dark brown, rarely greenish brown; **spathe** cucullate, 7.5–12 cm long, ± acute at apex, occasionally weakly cuspidate, opening broadly most of its length at anthesis, the margins directed forward or occasionally somewhat outward; spathe tube matte to semiglossy, pale to medium green or yellow-green on outer surface, glaucous medially toward apex, frequently narrowly conspicuously paler at margins, glossy on



Figure 26. *Chlorospatha ilensis* Madison. A–C. Cultivar at Selby 79-1718 from Dodson *et al.* 9135 (MO). —A. Leaf with anthesis inflorescence evident on petiole. —B. Leaf blade adaxial surface. —C. Inflorescence at anthesis, with the spathe tube cut open. —D. Fertile cultivar of Croat 57003 (MO).

inner surface, 3.5–6 × 0.6–1.3 cm, drying matte to weakly glossy, medium to dark brown or greenish brown on both surfaces; spathe blade matte to semiglossy, pale green to yellow-green, occasionally cream near apex or entirely creamy white to greenish cream and narrowly pale green medially on outer surface, matte to weakly glossy on inner surface, 4–7 × 0.8–1.2 cm, to 2.5 cm wide (flattened), obtusely 1-ribbed abaxially, drying matte to weakly glossy, medium to dark brown or greenish brown on both surfaces, usually weakly paler than tube, marcescent, erect after anthesis; **spadix** curved weakly forward, 5.5–10 cm long, sessile to weakly stipitate (to 3 mm), adnate to spathe 0.8–2.5 cm at base, ca. 1/3 to 1/2 of the length of pistillate portion; pistillate portion pale green to dull or bright yellow-green, (1.9–)2.6–5 cm × 3–5.5 mm, weakly broadest midway, drying medium to dark brown or medium greenish; fertile staminate portion cream-colored, pale green to yellow-green or greenish white, 2.5–4.7 cm × 4.5–6 mm, narrowly rounded at apex, ± cylindrical or weakly tapering, occasionally weakly thicker than broad, drying tan to dark brown; sterile staminate portion cream-colored, 5–10 × ca. 4 mm, ± cylindrical; pistils weakly coherent, ca. 4 across the axis (viewed from above), 1–1.3 mm long; ovaries pale green or greenish white, ± cylindrical, obtusely truncate at apex, 1.3–2 mm diam., drying pale brownish white with darker veins, 2-locular, with axile placentation, 10 to 12 ovules per locule, the ovules small, hemianatropous, biseriately; funicles shorter than ovules; style Type 3 (Fig. 1), 1.2–1.5 mm diam., weakly broader than ovary apex, the margins weakly sinuate and not coherent with those of adjacent styles; **stigma** pale yellow-green to white, 0.5–0.8 mm diam., sessile, obtusely truncate; **synandria** 1–1.4 × 1.5–2.5 mm, coherent, truncate, 2- to 5-lobed, (2)3- to 5-androus (mostly 4); sterile flowers 0.8–1.2 mm long, 1.5 × 2.2–3 mm diam. and ± elongated in direction of axis, weakly coherent, truncate, prismatic to subprismatic, in 2 to 3 whorls. **INFRACTESCENCE** green, 8–10 × 1.2–1.5 cm (dry); berries 3–4 mm diam. (dry).

Phenology. *Chlorospatha ilensis* is known to flower during all months except June, September, and November, with fruiting recorded for the month of August. In cultivation, *C. ilensis* flowers only periodically, with approximately one month between flowering cycles. Inflorescences emerge in slow progression, with several days between anthesis of one inflorescence and emergence of the next inflorescence at the apex of the petiole sheath.

Discussion. *Chlorospatha ilensis* is relatively widespread on the western slopes of the Andes in

central Ecuador and represents the southern limit of the genus. The northernmost collection of *C. ilensis*, which is endemic to Ecuador, was made approximately 500 km south of the southernmost collection of any other member of the section.

The species has been collected in the provinces of Azuay, Bolívar, Cotopaxi, El Oro, Los Ríos, and Pichincha at 550–1530 m elevation, most frequently in premontane wet forest, but also in tropical moist forest, premontane moist forest, and lower montane moist forest. The GPS coordinates for some collections fall in tropical dry forest, premontane dry forest, and montane dry forest in the southern provinces of El Oro and Los Ríos, where these ecological life zones predominate; however, these are presumably erroneous.

Chlorospatha ilensis is the only Ecuadorian member of *Chlorospatha* sect. *Chlorospatha* and one of only two species in the section, the latter species being *C. dodsonii*, which can have other than divided leaf blades (see discussion under *C. dodsonii*).

A number of specimens of *Chlorospatha ilensis* have previously been incorrectly determined as *C. mirabilis*, which is similar in many respects, but with notable differences, not the least of which is its distribution. *Chlorospatha mirabilis* is known only from Panama and northern and central Colombia, in Antioquia, Chocó, and Valle departments, with no collections of either species or of intermediate forms having been made in the considerable area between the known localities, although this intervening area has seen much collecting activity. The blades of *C. mirabilis* are consistently 3-lobed, usually maculate, and always more or less purple on the lower surface, thus differing from *C. ilensis* in which the blades are usually hastate, only occasionally 3-lobed, entirely green, and lack maculations. The inflorescences are sufficiently similar to indicate the sectional relationship between the species, particularly as regards the morphology of the pistils, both species having cylindrical ovaries and disklike styles. However, the ovary of *C. ilensis* is 2-locular and the style is green, whereas the ovary of *C. mirabilis* is 3- or 4-locular (possibly 5- or 6-locular) and the style is pink, pale yellow, or pale orange. The sterile staminate portion of the spadix of *C. mirabilis* is unusual in the genus in comprising ca. one third of the length of the spadix, with the sterile flowers laxly arranged in seven to nine (to 11) whorls, thus differing from that of *C. ilensis*, which occupies one tenth of the spadix or less, with the flowers densely arranged in only two or three whorls.

Plowman 14110 is unusual in the sterile state in having the petiole and sheath mostly green with some

bands of weakly darker purplish reptilian markings. When in flower, the sheath margins are broadly dark maroon and undulate (observed in cultivation at MO).

Croat 73743 is a small, sterile collection of *Chlorospatha ilensis* from Cotopaxi Province, made at 1480–1530 m elevation, well above that of the other collections (550–1010 m), most of which were made below 900 m. It differs in having fleshy petioles with free-ending sheaths, whereas those of the other collections are moderately firm and decurrent at the apex. In the course of this treatment, a sterile collection from Cañar Province was examined, *Croat 50868* (MO), which is possibly this species, but the leaf blades dry partially weakly purple-tinged on the lower surface, suggesting that the collection possibly represents *C. atropurpurea*. Cañar Province is also geographically isolated from the other provinces where *C. ilensis* has been collected.

Additional specimens examined. ECUADOR. **Azuay:** Hac. Yacopiana, on ridge bordering Río Patul, above Sanagüín, 850 m, *J. Steyermark 52802* (NY). **Bolívar:** Clementina Farms, Cerro Samana, 5.7 km S & W of main Pueblo-Viejo-Caluma rd., 5.2 km W from bridge over Río Pita (turn-off is 6.3 km E from Potosí), 371–600 m, *Croat et al. 93345* (MO, QCNE). **Cotopaxi:** along Quevedo-Latacunga rd., 55.5 km from Quevedo, 23.5 km E of La Mana, 930–950 m, *Croat 57021* (CM, MO); La Mana Cantón, along rd. betw. Guayacán (13.1 km N of La Mana) & Montenuovo (N of Pucayacu), at end of rd. branching to rt. 23.6 km from Guayacán, vic. Escuela Quindigua, 1480–1530 m, *Croat 73743* (MO, QCNE), 73772 (K, MO, QCNE); Km. 55 on Quevedo-Latacunga rd., 850–1000 m, *Dodson et al. 14409* (MO, QCNE). **El Oro:** along Machala-Loja rd., 25 km SE of rd. jct. to Piñas, 890 m, *Croat 50723* (MO); 11 km W of Piñas on rd. to Santa Rosa, 850 m, *Dodson et al. 9135* (MO, SEL, US). **Los Ríos:** along rd. E of Santo Domingo-Quevedo rd. (beginning 10.5 km N of Patricia Pilar) at Casería Palmar de Bimbe, 550–575 m, *Croat 57003* (MO, NY, US); Quevedo Cantón, Centinela-Pirámide parish, along Santo Domingo-Quevedo rd. approaching Patricia Pilar, Km. 41, 650 m, *C. Quelal & G. Tipaz 337* (MO); Hac. Clementina, Cerro Samana, La Torre, 700–750 m, *B. Ståhl & X. Cornejo 5946* (GUAY). **Pichincha:** along old rd. to Quito from Alluriquín vía Chiriboga, 2–3 km from main Aloat-Santo Domingo de los Colorados rd., 890–1010 m, *Croat 56972* (MO); vic. Chiriboga, 900 m, *Croat 81096* (MO); 12 km W of Patricia Pilar, at Km. 45 on Santo Domingo-Quevedo rd., 600 m, *C. Dodson & D. Neill 15536* (MO, QCNE), *Dodson & Duke 7648* (SEL).

Cultivated specimens examined. ECUADOR. **El Oro:** 11 km W of Piñas on rd. to Santa Rosa, 850 m, *Plowman 14110* (F, MO, SEL, cult. from *Dodson et al. 9135*, SEL live acc. 1979-1718, cf. Fig. 26). **Pichincha:** La Centinela, 600 m, *E. Christenson 1483* (MO, cult. from type clone *Dodson et al. 7547*), *Madison s.n.* (US, cult. from type clone *Dodson et al. 7547*, SEL live acc. 79-467).

34. *Chlorospatha jaramilloi* Croat & L. P. Hannon, sp. nov. TYPE: Ecuador. Pichincha: Reserva Flor.-Ecol. Río Guajalito, Km. 59 on old Quito–

Santo Domingo de los Colorados Hwy., 3.5 km NE of hwy., foothills of Volcán Pichincha, 1800–2200 m, 0°13'53''S, 78°48'10''W, 25 Jan. 1992, *J. Jaramillo & E. Grijalva 14574* (holotype, NY!; isotype, QCA!). Figure 24B.

Herba usque ad 1 m; internodia 1.2–3.5 cm × ca. 8 mm; cataphylla 15–27.5 cm longa. Petiolus 32–68 cm longus, vaginatus per 19–40 cm; lamina foliaris ovato-sagittata, 21.5–42 × 11.5–18 cm, lobis posterioribus 8.5–18 × 5–9 cm, nervis basalibus utroque ca. 5; nervis primariis lateralibus utroque 6 vel 7. Inflorescentiae usque ad 3 in quaque axilla; pedunculus 18.5–20 cm × ca. 2 mm; spatha erecta, 9.8–11.5 cm longa, tubo ca. 5 mm diam., lamina ca. 6 cm × 6–7 mm.; spadix 6.8–9 cm longus.

Terrestrial herb, to 1 m tall; stem decumbent, with remnants of old leaf bases and cataphylls persisting ± intact along its length (all measurements made from dried material); internodes 1.2–3.5 cm × 8 mm, drying weakly glossy, dark greenish brown to reddish brown; cataphylls 15–27.5 cm long, acuminate at apex, drying weakly glossy, medium-dark to dark reddish brown. LEAVES 1 to 2, erect-spreading; **petioles** 32–68 cm long, glabrous, drying weakly glossy, medium-dark to dark reddish brown, darkest apically, sheathed 19–40 cm, slightly more than 1/2 of total length; sheath decurrent at apex; free portion 2.5–3 mm diam. midway; **blades** ovate-sagittate, 21.5–42 × 11.5–18 cm, 1.8 to 1.9 times longer than wide, abruptly acuminate at apex, weakly broadest at base, occasionally weakly narrower, 1 to 1.1 times wider at base than across anterior lobe (measured tip to tip across posterior lobes), drying thinly coriaceous, weakly bicolorous; upper surface drying matte to weakly glossy, brownish green; lower surface drying semiglossy to glossy, green; anterior lobe 15–26.5 × 12–18.5 cm, 1.2 to 1.3 times longer than wide, 1.7 to 1.8 times longer than posterior lobes, broadest below middle, ± symmetrical; posterior lobes directed toward the base, 8.5–18 × 5–9 cm, 1.6 times longer than wide, bluntly acute to narrowly rounded at apex, broadest at base or midway, or as wide midway as at base, weakly to moderately inequilateral, the inner side narrower, weakly to broadly rounded toward base, moderately to narrowly attenuate and weakly confluent with opposite lobe at base, the confluent portion obscuring petiole apex; outer side 1.5 to 1.7 times wider than inner side midway, ± straight toward base; sinus ± V-shaped, obtuse at apex; midrib and major veins round-raised on lower surface, drying raised, ± concolorous, weakly darker than surface at base; **basal veins** ca. 5 pairs, coalesced into prominent posterior rib; primary lateral veins 6 to 7 pairs, arising at 45°–65°, weakly arcuate or straight; secondary veins drying raised on

lower surface, concolorous; tertiary veins drying weakly to moderately prominulous on lower surface, weakly darker than surface; reticulate veins drying in part weakly prominulous on lower surface, otherwise distinct and flat, concolorous, occasionally in part weakly darker than surface; collective veins 3, the innermost arising from one of the lowermost lateral veins on inner side of posterior lobe, \pm parallel to and 5–7 mm from margin. INFLORESCENCES erect, to 3 per axil; peduncle held within the sheath, 18.5–20 cm \times ca. 2 mm, drying dark, blackish brown; **spathe** erect, 9.8–11.5 cm long, acuminate at apex; spathe tube purple, 3.8–5.5 cm \times ca. 5 mm, drying matte to weakly glossy, dark reddish brown on outer surface, weakly glossy to semiglossy on inner surface; spathe blade cream-colored, 6 cm \times 6–7 mm, drying matte to weakly glossy, brownish cream to pale tan on outer surface, weakly glossy to semiglossy on inner surface, marcescent, erect after anthesis; **spadix** erect, 6.8–9 cm long, sessile, adnate to spathe 2.7–4 cm at base, the entire length of pistillate portion and onto sterile staminate portion ca. 2.7 mm; pistillate portion 2.5–3.8 cm \times 2–3 mm, drying dark reddish brown; fertile staminate portion cream-colored, 3.6–4.2 cm \times 2–3 mm, bluntly acute at apex, weakly ellipsoid, drying medium reddish brown; sterile staminate portion 7–10 \times 2–3 mm, drying dark reddish brown, almost black, the axis naked ca. 1 mm at base; pistils \pm laxly arranged to weakly coherent, ca. 3 across the axis (viewed from above), 2–2.5 mm long; ovaries obtusely conical, \pm truncate at apex, 1–1.2 \times 1.5–2 mm, drying dark tan; style Type 5 (Fig. 1), ca. 1–1.2 \times 1.2–1.5 mm (attenuate portion ca. 1 mm long), the margins usually weakly coherent with those of adjacent styles; **stigma** 0.8 mm diam., prominent, truncate at apex, markedly elevated on and broader than narrowed portion of style, drying yellowish; synandria ca. 1 \times 1.5–2 mm, coherent, truncate, weakly 3- to 5-lobed, 3- to 5-androus (mostly 4), lacking microsporangia in apical 1 to 2 whorls; sterile flowers (in ca. 6 whorls) in part ca. 1 \times 1 mm in apical 2 to 3 whorls and 2- to 3-branched, the branches obtusely truncate at apex, weakly narrowed below, otherwise ca. 2 mm long, 1 \times 2–2.5 mm diam. in basal 2 to 3 whorls and elongated in direction of axis, 3- to 6-branched, the branches 1–1.3 mm long, weakly broadest at apex, coherent. Berries not known.

Phenology. Flowering is only known to occur in *Chlorospatha jaramilloi* during the months of January and February.

Discussion. *Chlorospatha jaramilloi* is known only from premontane wet forest on the western

slopes of the Andes in Pichincha Province, Ecuador, at 1800–2200 m elevation, and would be expected to occur elsewhere within the province and possibly northward into Imbabura Province. The species, a member of *Chlorospatha* sect. *Occidentales*, is characterized by its broadly sagittate leaf blades that dry matte on the upper surface and somewhat glossy on the lower surface, with the posterior lobes broad and weakly confluent at the base, the confluent portion obscuring the petiole apex. It is also distinguished by its purple spathe tube, cream-colored blade 2.5–3 cm longer than the spadix, and its 2- to 6-branched sterile flowers.

Chlorospatha jaramilloi could possibly be confused with *C. antioquiensis*, especially in the sterile state, but the latter species is known only from the northern end of the Cordillera Central in Antioquia Department, Colombia (see discussion under *C. antioquiensis*).

Chlorospatha jaramilloi is also similar to *C. bayae* from Valle Department, Colombia (see discussion under *C. bayae*).

Chlorospatha jaramilloi is most similar to *C. sagittata* from Imbabura Province, Ecuador, on the western slopes of the Andes, both having purple spathe tubes, leaf blades of similar shape and drying characteristics, and a like number of primary lateral veins (see discussion under *C. sagittata*).

Etymology. *Chlorospatha jaramilloi* is named for Jaime Jaramillo (1944–), Pontificia Universidad Católica del Ecuador), botanist, prodigious collector, and teacher, who collected the type specimen.

Paratype. ECUADOR. **Pichincha:** Res. For. La Favorita, 2.5 km from main Quito–Chiriboga–Santo Domingo rd., departing main rd. 0.7 km S of Chiriboga, 1800–1830 m, 0°12'S, 78°47'W, 15 Feb. 1992, Croat 72150 (B, K, MO, QCNE, US).

35. *Chlorospatha kolbii* Engl., Gartenflora 27: 98. 1878. TYPE: Colombia. Collected by *Wallis s.n.* & cultivated at Munich Botanical Garden, lost after 1879 (type, tab. 933 in Engler [1878] serves as the type [Madison, 1981]). Figures 2G–L, 28A–C.

Terrestrial herb, to ca. 50 cm tall; stem erect to 15 cm, in part subterranean, with remnants of old cataphylls persisting \pm intact and bulbils produced randomly along its length; bulbils solitary, 0.5–5 \times 4–6 mm on exposed stem, elongated below soil surface, to 5 cm \times 8 mm, weakly glossy, dark green; internodes 3–8 mm \times 1.2–1.7 cm, weakly glossy, pale-medium green, occasionally with nodes in part weakly raised and brownish with age; cataphylls 2 to

3 per leaf, (5–)10–25 cm long, obtuse with acumen or cuspidate at apex, obtusely 1-ribbed toward apex abaxially, weakly glossy, pinkish or pale-medium green, densely dark brown-, dark purplish- or black-variegated, most densely so abaxially and toward base. LEAVES 2 to 4, erect to erect-spreading; **petioles** 21.5–45 cm long, glabrous, matte, pale to medium or dark green, densely dark brownish-, purplish-, or black-variegated, less densely so toward apex, almost entirely dark brownish, purplish, or blackish toward base, minutely many-ribbed throughout, drying matte, dark brown to brownish gray, sheathed 4–20(–32) cm, 1/2 to 2/3 of total length, rarely 1/3 (ca. 1/4 of length when sterile); sheath free-ending at apex (when in flower), the margins occasionally entirely narrowly medium green; inner surface glossy, conspicuously paler; free portion 3–6 mm diam. midway, terete, obtusely 1-ribbed laterally (on both sides), acutely so to occasionally weakly alate toward apex, 1-ribbed medially; **blades** held \pm horizontally, deeply (7 to)9 to 14(15)-pedatisect, (14–)17–35.5 \times (16–)20–44 cm, 1.1 to 1.2 times wider than long, thin, moderately to conspicuously bicolorous, the margins of all segments \pm narrowly undulate; upper surface quilted, velvety, dark green to bright green, sparsely to conspicuously irregularly white-, greenish cream-, or pale yellow-green maculate, drying matte, dark green, the maculations moderately to conspicuously paler than surface, occasionally obscure; lower surface weakly glossy, weakly paler green maculate, drying weakly glossy to semiglossy, moderately paler; all segments narrowly elliptical to lanceolate or oblanceolate, moderately acuminate to long-acuminate at apex, weakly to moderately narrowed and broadly attached at base, narrowly confluent between segments, the confluent portion 2–6 mm wide; **medial lobe** 8–23.5 \times 2–3(–4.7) cm, (3.3 to)6 to 6.6 times longer than wide, occasionally equal in length to or weakly shorter than innermost lateral lobes, \pm symmetrical; **lateral lobes** 2.5–20 \times 0.6–3(–4.7) cm, (3.3 to)4.5 to 6.6 times longer than wide, progressively shorter and narrower toward outermost segments, progressively and moderately inequilateral, the inner side always narrower, most prominently so on outermost segments; outer side 1.2 to 1.6 times wider than inner side midway; outermost 1 to 2 segments markedly shorter and narrower than innermost, 3.1 to 4.4 times longer than wide; midrib and major venation deeply sunken and concolorous on upper surface, round-raised on lower surface, minutely many-ribbed and weakly granular-puberulent, weakly paler than surface, occasionally weakly purplish variegated toward base; midrib frequently entirely obtusely to acutely 1-ribbed

medially or in part only toward base on lower surface, drying weakly raised to weakly flattened, \pm concolorous, weakly darker toward base; posterior rib markedly curved, naked 3.5–6.5 cm per side, acutely 1-ribbed medially on lower surface, the rib contiguous with lateral ribs on petiole; primary lateral veins (on all segments) 2 to 4 pairs, arising at 10°–30°, weakly arcuate, drying weakly raised to weakly flattened on lower surface, \pm concolorous to weakly paler than surface, weakly darker toward base; secondary veins in part obtusely sunken on upper surface, raised or prominulous on lower surface, concolorous, drying weakly raised, concolorous; tertiary veins entirely or in part prominulous on lower surface, otherwise visible and distinct, weakly darker than surface, drying visible, distinct, \pm concolorous; reticulate veins obscure; collective veins 2 to 3, the innermost arising from lowermost lateral vein at base, loop-connected with all preceding lateral veins, frequently markedly scalloped and remote from margin (relative to blade width), 2–8 mm from margin. INFLORESCENCES erect, 4 to 8 per axil, emitting a sweet-spicy fragrance at anthesis; peduncle held within the sheath, 15–30 cm \times 2–3.5 mm, weakly broader than thick, narrowest toward base, glabrous, weakly glossy, pale yellow-green, weakly irregular darker-mottled in narrow transverse bands, drying weakly glossy to semiglossy, medium-dark green to greenish brown; **spathe** erect, (7–)8–10.5 cm long, 2.5–3.5 cm wide (flattened) toward base, lanceolate, acute or abruptly acuminate with acumen at apex (acumen ca. 1.5 mm long), \pm funnel-shaped at anthesis, the margins in-rolled in apical 2 cm; spathe tube matte to weakly glossy, medium yellow-green on outer surface, matte and weakly paler on inner surface, 4–5.5 cm \times 4–9 mm, drying weakly glossy, medium-dark greenish brown on outer surface, much paler on inner surface, sparsely pale-speckled on both surfaces; spathe blade \pm erect, matte, concolorous to weakly paler than tube, with margins paler in apical 2/3 on outer surface, matte and weakly paler on inner surface, (3–)4–5 cm \times 4–9 mm, to 2.3 cm wide (flattened), obtusely 1-ribbed abaxially, drying weakly glossy, weakly paler than tube along margins on outer surface, much paler on inner surface, opening broadly at anthesis, marcescent, erect after anthesis; **spadix** erect, stipitate 0.7–1.5 cm (stipe green, 0.5–1 mm diam.), 6–9 cm long, adnate to spathe 1–1.5(–2) cm at base, only along stipe or possibly narrowly onto pistillate portion, axis green; pistillate portion yellowish, 2–5 cm \times 4–6 mm, drying weakly pinkish brown; fertile staminate portion cream to yellowish cream, (1.6–)2.4–3.8 cm \times 3–4 mm, narrowly rounded to bluntly acute at apex,

± cylindrical to weakly tapering, broadest at base, occasionally weakly thicker than broad, drying pale yellow-tan; sterile staminate portion white to creamy white, ± cylindrical or weakly to moderately tapering, (5-)9-13 × ca. 4 mm, weakly narrower than fertile staminate and pistillate portions, drying pale tan; pistils markedly laxly arranged, 2 to 3 across the axis (viewed from above), 1.5-2 mm long; ovaries subglobose, ovoid or ± cylindrical, white, 1.5-2 mm diam., with 2 to 3 deeply intrusive parietal placentae and subaxile placentation (pseudoaxile in basal 2/3); ovules 6 to 10 per locule, anatropous, biseriate; funicles as long as or longer than ovules; style Type 3 (Fig. 1), collar-like disk, 1.2-1.5 mm diam., with mantle to 0.5 mm thick, weakly narrower than to as broad as ovary apex, the margins not coherent with those of adjacent styles; **stigma** yellow or yellowish, 0.5-0.7 mm diam., sessile, subrounded or ± cylindrical and obtusely truncate at apex, 3- to 4-lobed; synandria ca. 1.5 × ca. 1.5 mm, coherent, ± truncate, 2- to 4-lobed, 2- to 4-androus (mostly 3), occasionally lacking microsporangia in apical 1 to 2 whorls; pollen white, in tetrads, ± ellipsoid-oblong, 30-32(-35) × 23-25 μm, occasionally subquadrangular and 33 × 33 μm, with exine variable perforated, irregularly reticulate to foveolate (Fig. 2G-L); sterile flowers in 4 to 5 whorls, 0.5-2 × 1-1.5 mm, markedly laxly arranged, entirely ± fungiform (like small toadstools) to 3- to 4-lobed throughout or only in apical 3 whorls and otherwise 1- to 3-branched (in basal 1 to 2 whorls), a few 1- to 2-branched and interspersed among apical 1 to 3 whorls of pistils, the branches clavate. Berries not known.

Phenology. Flowering is known to occur in *Chlorospatha kolbii* during the month of April and from July through December, and possibly occurs throughout the year. Inflorescences are fragrant and emerge in slow progression, with several days between anthesis of one inflorescence and emergence of the next inflorescence at the apex of the petiole sheath.

Discussion. *Chlorospatha kolbii* is the type species of the genus and of *Chlorospatha* sect. *Chlorospatha*. The species is known only from near sea level, in tropical wet forest on the Pacific Coast in Chocó Department, Colombia, and possibly occurs elsewhere in that department. The collections made prior to 1900 were recorded with only the country of origin, Colombia, and until recently no additional collections had been made in over 120 years. *Mora 50* is the first collection with specific locality information from a known source. Of the three modern collections, two were from Estación Biológica

El Amargal near Nuquí. The exact locality of the third collection is not known, but it is also from Chocó Department.

Chlorospatha kolbii is a strikingly beautiful species distinguished by its velvety, dark green, pale maculate, (7- to)9- to 14(to 15)-pedatisect leaf blades with long, narrow segments broadly attached and narrowly confluent at the base. The green petiole is densely dark brown-, purplish-, or almost black-mottled and sheathed one half to two thirds of its length when in flower. The species is also distinguished by its inflorescence, which can occasionally be quite large (to 10.5 cm long) for a relatively small plant, with unusual pistils and sterile flowers. The spadix is conspicuously stipitate, with the stipe to ca. 1.5 cm long, and usually adnate to the spathe only along the stipe. In most taxa with disklike styles (Type 3, Fig. 1) and sessile stigmas, the pistils are weakly coherent, but in *C. kolbii*, these are markedly laxly arranged and not at all coherent. The style itself is unusual in being collar-like as well as disklike, surrounding, but usually not coherent with the stigma. The sterile staminate portion of the spadix is also markedly laxly flowered, frequently with more than one type of sterile flower on a single spadix. The sterile flowers can be lobed (similar to the synandria), fungiform (like toadstools), or several-branched. Some of the last type is usually interspersed among the apical one to three whorls of pistils. Engler and Krause (1920) described the upper surface of the leaf blade as "scabra" and "subholosericea." The upper surface of *Hort. Bull. s.n.*, possibly a specimen from the original Wallis collection, was examined and no "hairs" were found. The surface is minutely alveolate in the dried material, which could possibly explain their use of the term "scabra," meaning "rough to the touch." The upper surface of the modern collections is velvety, with subhemispherical elevations, as seen under low magnification (10×) in both living and dried material.

Chlorospatha kolbii could be confused with only one species, *C. kressii*, known only from its type locality near Quibdó, also in Chocó Department, at 90 m elevation. The two species are remarkably similar and would be difficult to distinguish in the sterile state, although mature specimens of *C. kolbii* are significantly larger than those of *C. kressii*, with the petiole to 15 cm longer and the blades wider and as much as 10 cm longer. When in flower, the petiole of *C. kolbii* is sheathed one half to two thirds of its length and the peduncle is 15-30 cm long, thus differing from *C. kressii* with the petiole sheathed one third of its length and the peduncle 8.8-13.7 cm long. The upper surface of the leaf blade of *C. kressii*

is matte, whereas that of *C. kolbii* is velvety; however, in dried material, both have subhemispherical elevations when viewed under low magnification (10×). When *C. kressii* was published, no collections of *C. kolbii* had been made since 1878 and in delimiting the two species, Grayum (1991a) cited the difference in the number of segments (seven to nine segments in *C. kolbii* vs. 11 to 13 in *C. kressii*), with the segments narrower and longer in *C. kressii*. Recent collections of *C. kolbii* reveal that this species usually has nine to 13 or as many as 15 segments and both species have similarly shaped leaflets. Other differences mentioned by Grayum still pertain. The inflorescence of *C. kolbii* can be even larger than reported by Engler and K. Krause (1920), significantly larger than that of *C. kressii*, (7–)8–10.5 cm long versus 5–6.2 cm in *C. kressii*, and there is no purple or violet on or within the spathe or on the axis in *C. kolbii*, these structures being entirely green. Although Engler and K. Krause did not describe the blade of *C. kolbii* as maculate, there are clearly some obscure maculations on *Hort. Bull s.n.* and numerous, conspicuous maculations on all modern collections. The blade of *C. kressii* is not maculate. The habit of *C. kolbii* is erect, with some portion of the rhizome subterranean, commensurate with its short internodes (3–3 mm long). The habit of *C. kressii* is decumbent and longer internodes (8–10 mm long) accord well with this habit. Grayum did not elaborate on the morphology of the pistils in *C. kressii*, but it would appear that they, as well as the synandria and sterile flowers, are similar to those of *C. kolbii*. Only dried material of *C. kressii* was available for examination, and it is frequently difficult to discern details of flowers, particularly those of the style and stigma, which can be nearly destroyed in the drying process. It is possible that the two species will eventually prove to be conspecific; however, with so few collections presently available, it would seem best to retain the status of both until more material can be examined.

Cultivated specimens examined. COLOMBIA. s. loc., Dpto. Cult. at Hort Bull, Hort. Bull s.n., 20 Sep. 1878 (K). **Chocó:** Mpio. Nuquí, Arusí District, Est. Biol. El Amargal, sea level, 5°34'N, 77°31'W, 22 June 2000, *Croat & Mora 83727* (AAU, B, CAS, COL, F, K, MEXU, MO, NY, SEL, TEX, US, WU) [= *Mora 345*, COL], flowered in cult., *Mora 50* (MO); *J. Jacome s.n.* (COL); *T. Franke s.n.* (K, MO, US), flowered in cult., Munich Bot. Garden, Dec. 1995.

36. *Chlorospatha kressii* Grayum, *Novon* 1: 12–14. 1991. TYPE: Colombia. Chocó: ca. 10–15 km S of Quibdó, on rd. to Istmina (Pan-American Hwy.) & 8–10 km E on rd. to petroleum exploration camp, ca. 90 m, 5°35'N, 76°37'W,

9 July 1986, *M. Grayum, B. Hammel, J. Kress & G. Brown 7643* (holotype, COL-353940 and COL-353941!; isotypes, CHOCO not seen, K!, MO!). Figure 27A, B.

Terrestrial herb, less than 50 cm tall; stem decumbent, remnants of old cataphylls persisting as reddish brown fibers at upper nodes; internodes 8–10 mm long, possibly to 2.5 cm diam. when fresh, drying 8–12 mm diam., matte, dark brown; cataphylls 3.1–11.3 cm long, apex not known, broadly to narrowly lanceolate, drying fibrous, matte to weakly glossy, dark brown to blackish brown. LEAVES 3 to 4, erect-spreading; **petioles** 25.1–30.5 cm long, glabrous, green, obscurely dark-mottled, drying weakly glossy to semiglossy, dark brown to blackish brown, sheathed 1.7–11.8 cm, ca. 1/3 of total length; sheath weakly free-ending at apex; free portion 2–3 mm diam. midway (dry), terete; **blades** deeply 11- to 13(14)-pedatisect, ca. 20–27 × 22–38 cm, thin, weakly bicolorous, the margins of all segments ± undulate; upper surface matte, green, drying matte, dark greenish brown; lower surface weakly glossy, drying ± semiglossy, brownish green, weakly to moderately paler; all segments narrowly elliptical to lanceolate or oblanceolate, gradually long-acuminate at apex, occasionally moderately acuminate, weakly to moderately narrowed at base, narrowly confluent between segments, the confluent portion 0.5–2 mm wide (dry); **medial lobe** (9.8–)15–22.1 × (0.8–)2.1–3.2 cm, ca. 7 times longer than wide, usually longer than to occasionally equal in length to innermost lateral segments, ± symmetrical; **lateral lobes** 4.9–20 × ca. 1–3 cm, 4.6 to 10 times longer than wide, progressively shorter and narrower toward outermost segments, with outermost 1 to 2 segments markedly shorter than innermost, progressively weakly to moderately inequilateral, the inner side always narrower, most prominently so on outermost segments; outer side 1 to 1.7(to 2) times wider than inner side midway; midrib and major veins sunken on upper surface, round-raised and granular-puberulent on lower surface, drying weakly raised to ± flattened, concolorous to weakly darker than surface; posterior rib markedly curved, naked 3.5–7 cm per side; primary lateral veins (on all segments) 2 to 4 pairs, arising at ca. 10°–30°, straight to weakly arcuate; secondary veins drying weakly raised on lower surface, ± concolorous; tertiary veins visible on lower surface, weakly darker than surface, drying in part distinct and weakly darker than surface; reticulate veins obscure; collective veins 3, the innermost arising from lowermost lateral vein at the base, loop-connected with all preceding lateral veins, frequently markedly scalloped and remote from

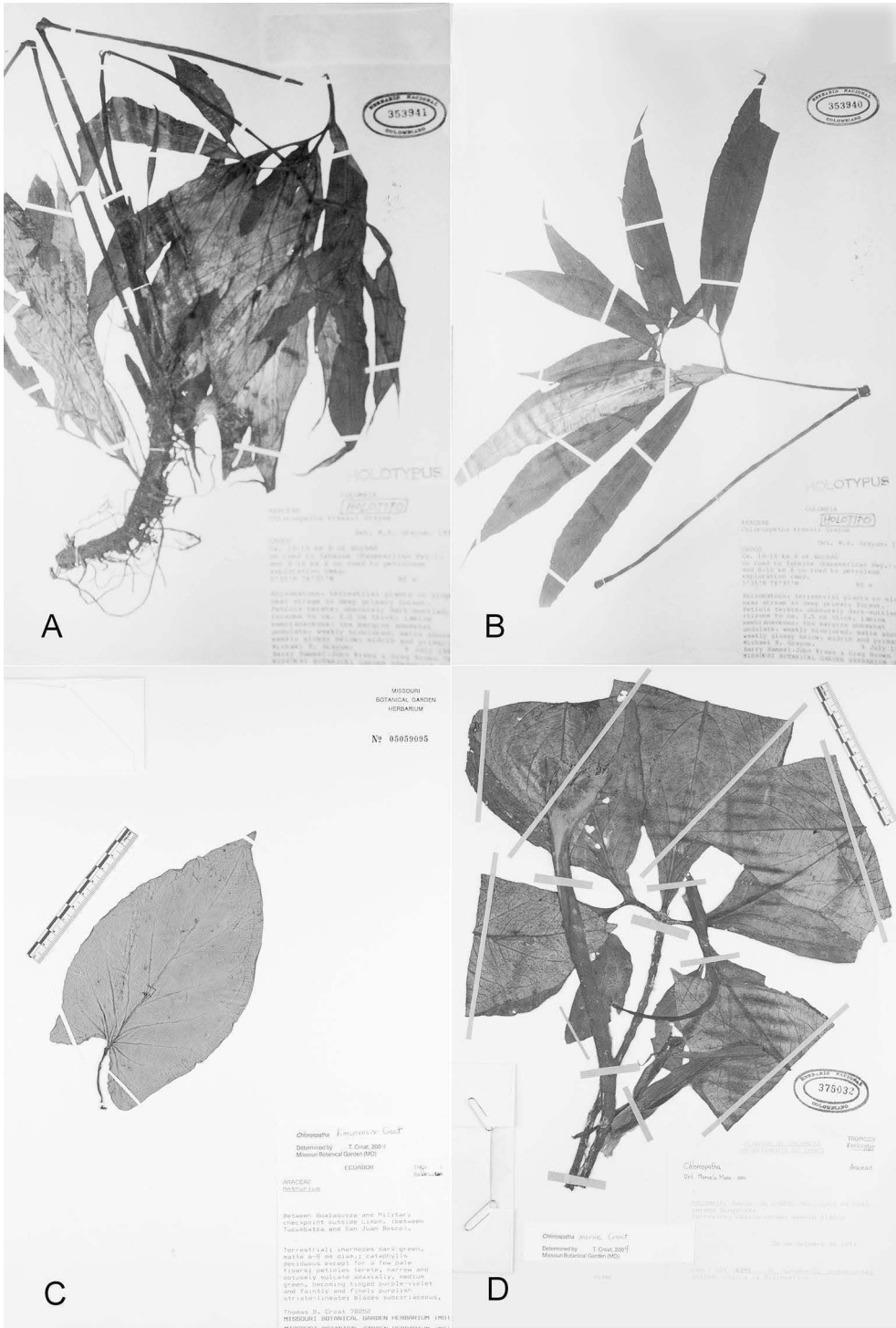


Figure 27. A, B. *Chlorospatha kressii* Grayum, specimens of the type Grayum *et al.* 7643 (MO). —A. Fertile holotype sheet 1 of 2 (COL-353941). —B. Sterile holotype sheet 2 of 2 (COL-353940). —C. *Chlorospatha limonensis* Croat & L. P. Hannon, the holotype Croat 78252 (MO-05059095). —D. *Chlorospatha morae* Croat & L. P. Hannon, the holotype G. Lozano *et al.* 6291 (COL-378032).

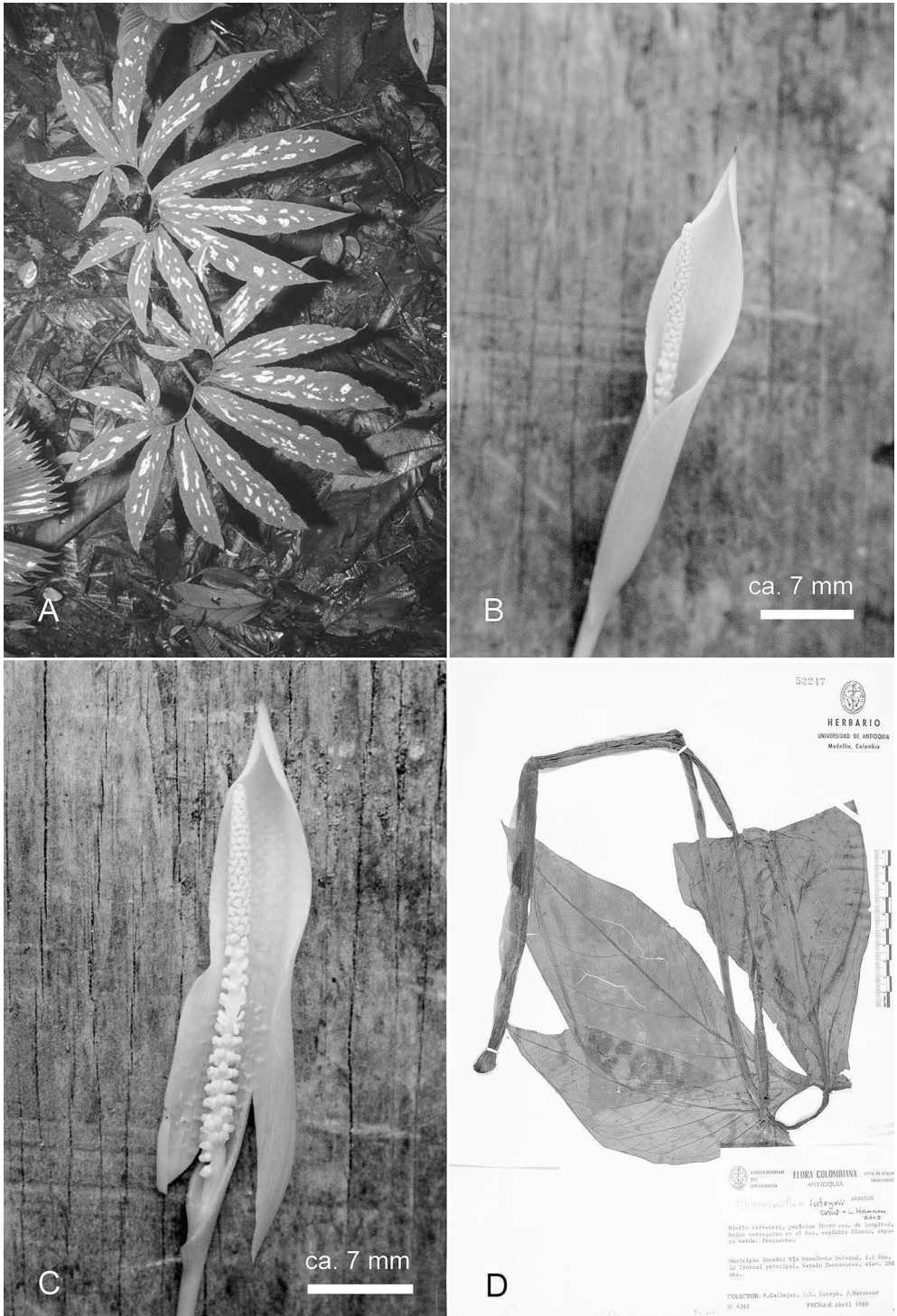


Figure 28. A–C. *Chlorospatha kolbii* Engl., photos of the collection *Croat & Mora 83727* (MO). —A. Leaf blade adaxial surfaces and plant habit. —B. Inflorescence at anthesis. —C. Inflorescence at anthesis, with spathe tube cut open. —D. *Chlorospatha luteynii* Croat & L. P. Hannon, *J. Luteyn & R. Callejas 11780* (HUA isotype). See also Figure 33B for the NY type.

margin (relative to blade width), 2–8 mm from margin (dry). INFLORESCENCES erect, to 4 per axil; peduncle held within the sheath, 8.8–13.7 cm × ca. 1 mm (dry), terete, drying matte to weakly glossy, dark brown to blackish brown; **spathe** erect, uniformly green on outer surface, deep violet on inner surface in basal 3/4, pale yellow-green in apical 1/4, drying weakly glossy, medium-dark to dark brown, weakly and sparsely pale-speckled on outer surface, less so on blade, weakly paler on inner surface, with conspicuous reticulate venation when dry, 5–6.2 cm long, ± acute at apex; spathe tube 2.7–3.2 cm × 4–8 mm; spathe blade ± erect, 2.3–3 cm × 4–8 mm, marcescent, erect after anthesis; **spadix** cream-colored, erect, stipitate 5–8 mm (stipe ca. 1 mm diam. when dry), 3.9–4.2 cm long, adnate to spathe ca. 1 cm at base, only along stipe or possibly narrowly onto pistillate portion; axis violet, ca. 1 mm diam.; pistillate portion 1.7–2.2 cm long, drying ca. 2–4 mm diam., dark brownish; fertile staminate portion 1.3–1.6 cm × 2.6–2.8 mm, bluntly acute at apex, weakly clavate or weakly broadest near base and weakly tapering, drying yellowish tan; sterile staminate portion ca. 2.5–4 × ca. 2–2.5 mm, drying medium tan; pistils laxly arranged, 2 to 3 across the axis (viewed from above), 1.3–1.5 mm long; ovaries broadly conical, 2–2.4 mm diam., drying pale tan; style Type 3 (Fig. 1), 1–1.3 mm diam. (dry), weakly narrower than to as broad as ovary apex, the margins not coherent with those of adjacent styles; **stigma** 0.3–0.4 mm diam. (dry), sessile, obtusely truncate at apex, drying tan to dark brown; synandria ca. 1 × 0.8–1.9 mm, coherent, ± truncate, 2- to 3(4)-lobed, the stamens solitary or 2- to 3(4)-androus; sterile flowers 0.7–1.1 × 0.6–0.8 mm, somewhat fungoid to ± anvil-shaped, markedly laxly arranged. Berries not known.

Phenology. Flowering is only known to occur in *Chlorospatha kressii* during the month of July.

Discussion. *Chlorospatha kressii* is known only from the type collection made in more or less intact transitional forest between tropical wet forest and premontane rainforest on the western slopes of the Cordillera Occidental near Quibdó, in Chocó Department, Colombia, at approximately 90 m elevation. According to Grayum (1991a), the primary forest throughout the region was being actively cut when the type was collected and the only known population of *C. kressii* was probably destroyed. The label notes indicate that *C. kressii* was found on slopes near a stream. The species would be expected to occur elsewhere in Chocó, in similar habitats.

Chlorospatha kressii is a member of *Chlorospatha* sect. *Chlorospatha* and is distinguished by its small size (less than 50 cm tall) and 11- to 13(14)-pedatisect, matte, dark green leaf blades with the segments long, narrow, broadly attached at the base, and narrowly confluent between segments. There are notably few pairs of primary lateral veins (two to four) on all segments, all arising at an acute angle. The species is also distinguished by its short peduncle (to 13.7 cm long) and small inflorescence with the spathe less than 6.5 cm long and deep violet three fourths of its length on the inner surface, and the spadix cream-colored, stipitate, and adnate to the spathe only along the stipe, with the axis violet.

Chlorospatha kressii could be confused with only one species, *C. kolbii*, known only from near sea level, in tropical wet forest on the Pacific Coast in Chocó Department, Colombia, and which possibly occurs elsewhere in that department. The two species are remarkably similar and would be difficult to distinguish in the sterile state, although mature specimens of *C. kolbii* are significantly larger than those of *C. kressii*, with the petiole to 15 cm longer and the blades wider and as much as 10 cm longer (see discussion under *C. kolbii*).

37. *Chlorospatha lehmannii* (Engl.) Madison, Selbyana 5(3–4): 356. 1981. Basionym: *Caladiopsis lehmannii* Engl., Bot. Jahrb. Syst. 37: 140. 1905. TYPE: Colombia. Cauca: La Conga, W of Popayán, 1500–1800 m, *C. Lehmann 5315* (hololectotype, B not seen, photo at MO!; isoelectotypes, F!, K!). Figure 29A, B.

Terrestrial herb, less than 1 m tall; stem decumbent, erect 15 cm, remnants of old cataphylls persisting ± intact, covering the stem (all measurements made from dried material); internodes ca. 1–1.5 × 1.5–2.3 cm; cataphylls 15–30 cm long, acuminate at apex, acutely 1-ribbed abaxially, drying weakly glossy, medium orangish brown. LEAVES 3 to 4, erect-spreading; **petioles** 23–50 cm long, glabrous, drying matte to weakly glossy, dark brown, usually darkest basally, sheathed ca. 20 cm, ca. 1/2 or slightly more of total length (ca. 1/4 when sterile); sheath free-ending at apex; free portion 2–3 mm diam. midway; **blades** sagittate, subhastate on drying, 16–25 × 12.5–14 cm, 1.3 to 1.8 times longer than wide, moderately acuminate to long-acuminate at apex, rarely abruptly acuminate, broadest at base, (1.7 to) 2.6 to 3 times wider at base than across anterior lobe (measured tip to tip across posterior lobes), weakly or not at all constricted in area of petiole attachment (rarely moderately constricted), coriaceous, moderately to conspicuously bicolorous; upper surface velvety, dark

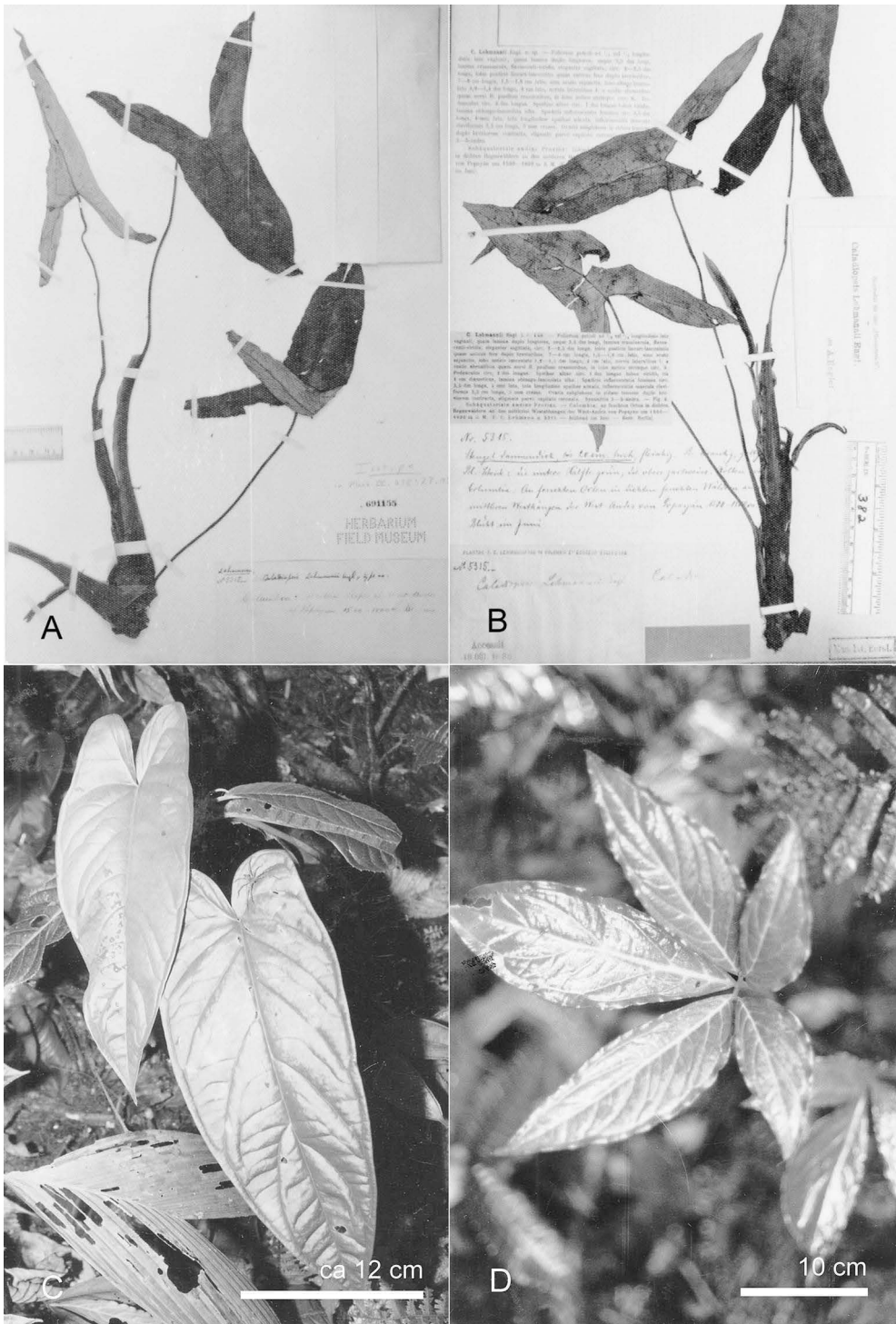


Figure 29. A, B. *Chlorospatha lehmannii* (Engl.) Madison, photos of the type collection *Lehmann 5315* (B). —A. Isotype specimen (F). —B. Holotype specimen. —C. *Chlorospatha longiloba* Croat & L. P. Hannon, photographed from the holotype *Croat et al. 82326* (MO); plant habit, showing adaxial blade surfaces. —D. *Chlorospatha morae* Croat & L. P. Hannon, photographed from the paratype collection *Croat 56303* (MO); plant habit, showing adaxial blade surfaces.

yellowish green, drying velvety-matte, dark brown, densely dark purple-brown, punctiform (speckles regularly rounded, appearing as subepidermal cellular inclusions); lower surface drying matte, moderately to conspicuously paler, narrowly dark purple-brown, punctiform (usually in single row) along major veins; anterior lobe $10.5\text{--}16 \times (3\text{--})4.5\text{--}6\text{--}(9)$ cm, (1.6 to) 1.8 to 2.8 times longer than wide, 1.4 to 1.5 times longer than posterior lobes, broadest at or near base, weakly inequilateral; posterior lobes directed toward the base, usually outward on drying, $(6\text{--})7\text{--}11 \times (1\text{--})1.5\text{--}3\text{--}(4)$ cm, usually 3.1 to 4 times longer than wide, bluntly acute at apex, broadest at or below middle, \pm symmetrical to weakly inequilateral, the inner side weakly narrower, weakly rounded to occasionally broadly rounded toward base, gradually attenuate onto posterior rib; outer side \pm straight, rarely weakly convex toward base; midrib sunken on upper surface, round-raised on lower surface, drying raised, \pm concolorous to weakly darker than surface; **basal veins** 3 to 4 pairs, coalesced into prominent posterior rib; posterior rib naked 5–7 mm per side; primary lateral veins 4 to 6 pairs, arising at $45^\circ\text{--}65^\circ\text{--}(80^\circ)$, straight or weakly arcuate, drying weakly raised near base on lower surface, otherwise flattened, moderately to prominently darker than surface; interprimary veins drying weakly raised on lower surface; secondary veins drying in part prominulous, otherwise flat on lower surface, in part weakly darker than surface; tertiary veins drying flat on lower surface, weakly darker than surface; reticulate veins drying obscure; collective veins 3, the innermost arising from one of the lowermost lateral veins on inner side of posterior lobe, \pm parallel to and ca. 5 mm from margin. **INFLORESCENCES** erect, 2 to 3 per axil; peduncle held within the sheath, $(15\text{--})20\text{--}27$ cm \times 1.5–3 mm, drying matte, dark brown; **spathe** erect, 10.5–11 cm long, acuminate at apex, drying sparsely dark purple-brown, punctiform on outer surface; spathe tube green, 4.5–6.2 cm \times 5–10 mm, drying matte, dark brown on outer surface, \pm concolorous and dark violet-tinged in medial 1/3 on inner surface; spathe blade white, 4.5–5 cm long, drying 1.3–2 cm wide (flattened), narrowly elliptical, pale to medium tan, much paler than tube, marcescent, erect after anthesis; **spadix** 9–9.3 cm long, sessile, adnate to spathe 3.5–5 cm at base, most or all of the length of pistillate portion; pistillate portion 3.5–5 cm \times 4–5 mm, drying dark purplish brown; fertile staminate portion 3.5–3.7 cm \times 2.5–5 mm, narrowly rounded at apex, clavate or tapering, drying medium grayish brown; sterile staminate portion ca. $9 \times 2\text{--}3.5$ mm, drying medium brown; pistils laxly arranged, ca. 3 across the axis (viewed from above), ca. 2.5 mm long; ovaries subglobose to

obtusely conical, truncate at apex, ca. 1.5 mm diam., 2- to 3-locular, with 2 to 3 deeply intrusive parietal placentae and pseudoaxile placentation, drying brownish cream; ovules ca. 12 per locule (est.), hemianatropous, 3- to 4-seriate; funicles longer than ovule; style Type 7 (Fig. 1), ca. $0.7 \times 1\text{--}1.5$ mm, comprising ca. 1/2 of the length of pistil, the margins not coherent with those of adjacent styles; **stigma** ca. 0.2 mm diam., capitate, coronate, markedly elevated on and weakly broader than narrowed portion of style, drying dull, pale amber; synandria $1\text{--}1.5 \times 1\text{--}1.5$ mm, coherent, truncate, deeply 3- to 5-lobed, 3- to 5-androus; sterile flowers in 4 to 5 whorls, $1.5\text{--}2 \times$ ca. 1.5 mm, \pm fungiform (like toadstools), broadest at apex and broadly concave medially in apical 3 whorls, 2- to 5-branched in basal 1 to 2 whorls, the branches broadest and darker apically, abruptly narrowing below apex, \pm coherent. Berries not known.

Phenology. Flowering is only known to occur in *Chlorospatha lehmannii* during the month of June.

Discussion. *Chlorospatha lehmannii* is known only from two Lehmann collections made on the western slopes of the Cordillera Occidental in Cauca Department in southern Colombia, at 1500–1800 m elevation, presumably in a premontane rainforest. The label notes report the type locality as “La Conga, thick rain forest west of Popayán.” La Conga cannot be located on any map and it is possible that it no longer exists as a place name, many place names that are 100 years old or more having been completely abandoned. However, the label notes for *C. congensis* also mention La Conga and that it was situated along the banks of the Río Timbiquí, which would place the site on the western slopes of the Cordillera Occidental. The first author recently found the supposed area somewhat on the dry side, with no towns or farms, but the area could still easily support *Chlorospatha* in secluded habitats within the region.

Chlorospatha lehmannii, the type species for *Chlorospatha* sect. *Occidentales*, is a small plant distinguished by its coriaceous, velvety, dark yellowish green leaf blades that dry prominently subhastate, with the lobes narrow, particularly the posterior lobes, which are 3 to 4 times longer than wide. The posterior lobes are acute at the apex and long, relative to the length of the anterior lobe that is only 1.4 to 1.5 times longer than the posterior lobes. The upper surface of the blade dries densely dark purplish brown, punctiform, with the speckles regularly rounded, appearing as subepidermal cellular inclusions, a condition observed in only one other species. The lower blade surface dries matte-subvelvety and narrowly dark purplish brown, punctiform along the

major veins, with all but the midrib and interprimary veins flattened. It is also distinguished by its inflorescence, which is large relative to plant size, with the pistillate portion of the spadix conspicuously longer than the fertile staminate portion.

Two species from Valle Department, Colombia, at similar elevations, *Chlorospatha giraldoi* and *C. noramurphyae*, have similar blades that lack the purple speckling observed in *C. lehmannii*, and in both, the petiole sheath is proportionally longer and decurrent at the apex. The lower surface of the blade dries somewhat glossy in both species, the spathe is either red or yellow, and the sterile staminate portion of the spadix is more than 1.2 cm long. In *C. lehmannii*, the lower surface dries subvelvety, the spathe tube is green and the blade white, and the sterile portion is less than 1 cm long (see discussions under *C. giraldoi* and *C. noramurphyae*).

Madison (1981) originally filed *Madison 3988*, the type for *Chlorospatha carchiensis*, as *C. lehmannii*. *Chlorospatha carchiensis* could not be easily confused with that species and should be considered distinct. The leaf blades of *C. lehmannii* dry subhastate, subcoriaceous, and not at all constricted in the area of petiole attachment, with the upper surface velvety-matte and dark brown and the lower surface matte, with all venation except the midrib more or less flattened and darker than the surface. The blades of *C. carchiensis* dry sagittate, thin, and moderately to prominently constricted, with the upper surface matte to weakly glossy green and the lower surface semiglossy, with the major and secondary venation conspicuously raised and concolorous or slightly paler than the surface. The posterior lobes are less than 2 to 2.5 times longer than wide, whereas those of *C. lehmannii* are much narrower, 3 to 4 times longer than wide. The peduncle and spadix are proportionally longer in *C. carchiensis*, with the spadix adnate to the spathe about three fourths of the length of the pistillate portion, the pistils densely arranged, and the style (Type 9, Fig. 1) broader than the ovary apex, comprising one third of the length of the pistil, with the margins more or less coherent with those of adjacent styles. In *C. lehmannii*, the spadix is adnate to the spathe most or all of the length of the pistillate portion and pistils are laxly arranged, with the style (Type 7, Fig. 1) comprising one half of the length of the pistil and the margins not at all coherent with those of adjacent styles. The synandria of the latter species dry matte, medium grayish brown, and differ from those of *C. carchiensis*, which dry weakly glossy, medium orangish brown to dark reddish brown.

Madison (1981) also originally filed the type for *Chlorospatha grayumii* as *C. lehmannii*. *Chlorospatha*

grayumii differs from that species in significant ways and should be considered distinct. The leaf blades of *C. lehmannii* are subhastate, with the posterior lobes nearly twice as long as those of *C. grayumii*, relative to the length of the anterior lobe, and acute at the apex as opposed to narrowly rounded in *C. grayumii*, which has sagittate blades. In *C. grayumii*, the inner sides of the posterior lobes are narrowly confluent at the base, obscuring the petiole apex, differing from those of *C. lehmannii*, which are decurrent onto the posterior rib, with the rib naked 5–7 mm on each side. The blades of *C. lehmannii* dry matte on both surfaces, densely dark purplish brown, punctiform on the upper surface and moderately to conspicuously paler on the lower surface, with all orders of venation except the midrib flattened. In *C. grayumii*, the blades dry matte to semiglossy and not at all dark purplish brown, punctiform on the upper surface, and weakly glossy to semiglossy and concolorous to weakly paler on the lower surface, with the secondary and tertiary venation raised or prominulous. The latter species has six to nine pairs of primary lateral veins versus four to six pairs in *C. lehmannii*. In *C. grayumii*, the petiole is sheathed one third of its length and the inflorescence is small, with the spadix 4.2 cm long, thus differing from *C. lehmannii* in which the petiole is sheathed one half or more of its length and the inflorescence is significantly larger, with the spadix more than twice as long (9–9.3 cm long). The pistillate portion of the spadix is 3.5–5 cm long, with the pistils laxly arranged and the style approximately as wide as the ovary apex (not broadly spreading) in *C. lehmannii*. In *C. grayumii*, the pistillate portion is only 1.9 cm long, with the pistils weakly coherent and the style broadly spreading and much wider than the ovary apex. The sterile flowers of the latter species are subprismatic and laxly arranged in the basal three whorls (of six whorls), differing from *C. lehmannii*, which has densely arranged, fungiform (like toadstools), and branched sterile flowers throughout. The synandria of the latter species are 3- to 5-androus and dry medium grayish brown, whereas those of *C. grayumii* are 2- to 4-androus (mostly 3) and dry dark reddish brown.

Additional specimen examined. COLOMBIA. **Cauca:** La Conga, *C. Lehmann s.n.* (K).

38. *Chlorospatha limonensis* Croat & L. P. Hannon, sp. nov. TYPE: Ecuador. Morona-Santiago: betw. Gualaquiza & military checkpoint south of Limón, betw. Tucumbatza & San Juan Bosco, ca. 1200 m, Nov. 1995, *Croat 78252* (holotype, MO-05059095!). Figure 27C.

Herba terrestris; internodia 6–8 mm diam. Petiolus vaginatus usque ad 1 cm infra apicem; lamina foliaris ovato-elliptica, subsagittata, ca. 18.5×11 cm (6.2 cm lata ad basim), lobis posterioribus $3.5\text{--}4 \times 3.8\text{--}4$ cm, nervis basalibus utroque 5 vel 6, nervis primariis lateralibus utroque 4 vel 5. Inflorescentia 1 in quaque axilla; pedunculus ca. $25 \text{ cm} \times 3 \text{ mm}$; spatha erecta, ca. 4.6 cm longa, tubo ca. $1.4 \text{ cm} \times 5 \text{ mm}$, lamina erecta, ca. $3.2 \text{ cm} \times 4 \text{ mm}$; spadix ca. 3.7 cm longus.

Terrestrial herb; stem not known; internode length not known, 6–8 mm diam., drying matte, dark green; cataphylls drying as pale fibers (all measurements made from dried material). LEAVES 1; **petiole** total length unknown, glabrous, medium green becoming purple-violet and weakly, finely purplish striate-lineate toward apex, drying matte, dark brown, weakly purplish at apex; sheath not known; free portion ca. 1 mm diam. midway, terete, narrowly and obtusely sulcate; **blade** ovate-elliptic, subsagittate, 18.5×11 cm (6.2 cm wide at base), 1.7 times longer than wide, apiculate at apex, broadest across anterior lobe, ca. 1.8 times wider across anterior lobe than at base, subcoriaceous, conspicuously bicolorous, drying moderately bicolorous; upper surface matte, dark green, drying matte, dark green; lower surface reticulate, narrowly minutely colliculate along all venation, matte, drying matte; anterior lobe 16.2×11 cm, 1.5 times longer than wide, 4 to 4.6 times longer than posterior lobes, broadest midway; posterior lobes directed toward the base, $3.5\text{--}4 \times 3.8\text{--}4$ cm, about as long as wide, narrowly to bluntly rounded at apex, broadest at base, markedly inequilateral, the inner side narrower, acute to weakly rounded toward the base and decurrent onto petiole; outer side ca. 5 times wider than inner side midway, weakly concave toward the base; midrib and major veins convex on lower surface, drying raised, weakly darker than surface; midrib bluntly angular on upper surface, weakly paler than surface; **basal veins** 5 to 6, coalesced into short posterior rib ca. 1 cm long, 3 acroscopic, 2 to 3 basiscopic, the first free to the base, second and third fused near the base; primary lateral veins 4 to 5 pairs, arising at $25^\circ\text{--}45^\circ$, most acutely toward apex, weakly arcuate, etched-sunken on upper surface; secondary veins weakly raised on lower surface, drying raised, concolorous; tertiary veins weakly raised on lower surface, drying in part raised, otherwise prominulous, concolorous; reticulate veins drying visible, distinct, in part prominulous, otherwise flat on lower surface, darker than surface; collective veins 3, the innermost arising from lowermost lateral vein on inner side of posterior lobe, loop-connected with all preceding lateral veins, markedly scalloped and remote from margin (relative to blade size), 5–10 mm from margin. INFLORESCENCE (description of dimensions of

inflorescence and flowers made from pickled material and label notes) erect, 1 per axil; peduncle possibly held within the sheath, $25 \text{ cm} \times 3 \text{ mm}$, weakly purple-tinged green; **spathe** erect, weakly glossy, medium green, 4.6 cm long, lanceolate, acuminate at apex; spathe tube $1.4 \text{ cm} \times 5 \text{ mm}$; spathe blade erect, $3.2 \text{ cm} \times 4 \text{ mm}$, obtusely 1-ribbed abaxially, reflexing after anthesis; **spadix** erect, 3.7 cm long, sessile, adnate to spathe 8 mm at base, $2/3$ of the length of pistillate portion; pistillate portion $1.2 \text{ cm} \times 2.5 \text{ mm}$, broadest midway, the axis naked in basal 2 mm; fertile staminate portion dark purple-violet, $2.2 \text{ cm} \times 1.5\text{--}3 \text{ mm}$, bluntly acute at apex, tapering; sterile staminate portion $3 \times 1.5\text{--}2 \text{ mm}$, broadest at apex, the axis naked $0.5\text{--}0.8 \text{ mm}$ at base; pistils \pm laxly arranged, 3 to 4 across the axis (viewed from above), ca. 1 mm long, \pm coherent laterally, less so between whorls; ovaries \pm cylindrical to obtusely obconical, 1–1.5 mm diam., obtusely truncate at apex, 2-locular with axile placentation, rarely 1-locular with subaxile placentation; ovules 6 to 10 per locule, hemianatropous, 2- to 3-seriate; funicles shorter than ovules; style Type 1 (Fig. 1), 1–1.5 mm diam., as broad as ovary apex, the margins conspicuous, not coherent with those of adjacent styles; **stigma** ca. 0.25 mm diam., sessile, cylindrical; synandria 6 to 7 per spiral, ca. $1 \times 2 \text{ mm}$, coherent, deeply (2)3- to 4-lobed, to the middle or occasionally nearly so, truncate or with the lobes weakly thickened in apical 2 to 3 whorls, (2)3- to 4-androus (mostly 3), the margins weakly sinuate; sterile flowers ca. 1 mm long, $1.3\text{--}1.5 \times 1\text{--}1.1 \text{ mm}$ diam. and \pm elongated in direction of axis, coherent, truncate, irregularly prismatic, with numerous minute red chromoplasts, in 3 whorls. Berries not known.

Phenology. Flowering is only known to occur in *Chlorospatha limonensis* during mid-June, the species having been collected in the sterile state in the month of November and later flowering in cultivation. *Chlorospatha limonensis* is one of only three species in which the spathe is known to reflex after anthesis and one of only five species from the eastern slopes with synandria that are truncate at the apex. The species is unique among those from the eastern slopes in having the fertile staminate portion of the spadix dark purple-violet, this portion being white to cream-colored and occasionally weakly greenish to yellowish-tinged (rarely yellow) in all others.

Etymology. *Chlorospatha limonensis* is named for the town of Limón, Ecuador, in Morona-Santiago Province, near which the type was collected.

Discussion. *Chlorospatha limonensis* is known only from the type collection made in Morona-

Santiago Province, Ecuador, between Gualaquiza and the military checkpoint south of Limón, between Tucumbatza and San Juan Bosco, in premontane moist forest on the eastern slopes of the Andes at approximately 1200 m elevation. The species would be expected to occur elsewhere within the province, southward into Zamora-Chinchipe Province, and possibly eastward into Peru.

Chlorospatha limonensis is represented by a single, incomplete herbarium specimen and pickled inflorescence; therefore, much of the description of the living plant comes from extensive label notes. The species is a member of *Chlorospatha* sect. *Orientalis* and is distinguished by its subcoriaceous, ovate-elliptic, subsagittate leaf blades that are matte on both surfaces, with the upper surface dark green and the lower surface reticulate and conspicuously paler. The upper surface is flat (not quilted), with the midrib and major venation etched-sunken. The midrib is noteworthy, possibly unique in the genus, in being bluntly angular on the upper surface, the midrib usually being flat and featureless in *Chlorospatha*. The species is also distinguished by its medium green petiole that is finely purplish striate-lineate toward the apex and long, purple-tinged peduncle (25 cm long), the longest recorded for a species from the eastern slopes of the Andes. The inflorescence of *C. limonensis* is small (4.6 cm long), with the spathe entirely medium green and the spadix adnate to the spathe two thirds of the length of the pistillate portion, a greater portion of the length than in any other species from the eastern slopes in Ecuador, except *C. succumbens*.

Chlorospatha limonensis could possibly be confused with *C. longipoda*, which is widespread on the eastern slopes of the Andes in Ecuador, at 470–1700 m elevation, and is possibly sympatric with *C. limonensis* in Morona-Santiago Province. The species could be confused only in the sterile state. Both species have leaf blades that are usually narrower at the base than across the anterior lobes, but the blades of *C. limonensis* are subcoriaceous and more or less flat on the upper surface, with the midrib and major veins etched-sunken, differing from those of *C. longipoda*, which are quilted on the upper surface and thin to thinly coriaceous, with the midrib and major veins deeply sunken. The petioles of *C. longipoda* are green, usually not at all purplish, and not striate-lineate as they are in *C. limonensis*. In the latter species, the peduncle is 25 cm long versus 4–10 cm long in *C. longipoda*. The spadix of *C. limonensis* is adnate to the spathe two thirds of the length of the pistillate portion, with the fertile staminate portion tapering and dark purple-violet

and the syndandria truncate at the apex. *Chlorospatha longipoda* differs in having the spadix adnate one half of the length or less of the pistillate portion, with the fertile staminate portion more or less cylindrical and whitish or green, yellow-green to yellow-tinged white, and the syndandria broadly concave medially with the lobes prominently thickened. The ovaries of the latter species are 2- or 3-locular versus (1)2-locular in *C. limonensis*.

39. *Chlorospatha litensis* Croat & L. P. Hannon, sp. nov. TYPE: Ecuador. Esmeraldas: Lita–San Lorenzo rd., 14.2 km W of old Río Lita bridge (below Lita, prior to 1999), 425 m, 0°52'11"N, 78°27'16"W, 4 July 1998, Croat, L. P. Hannon, D. Mansell & J. Whitehill 82311 (holotype, MO-04889302!; isotypes, B!, K!, NY!, QCNE!, US!). Figure 30A–D.

Herba usque ad 1.5 m; internodia 1–3 × 2–3.5 cm; cataphylla 15–28 cm longa. Petiolus 35–70 cm longus, vaginatus per (25–)32–60 cm; lamina foliaris hastata, 17–33 × 23–36 cm, lobis posterioribus (11–)14–21 × 4.5–6.2 cm, nervis basalibus (6)7, nervis primariis lateralibus utroque (7)8 ad 10(11). Inflorescentiae 3 in quaque axilla; pedunculus 37–62 cm × ca. 2 mm; spatha erecta, 8.8–12 cm longa, tubo 3–5 mm diam., lamina 6–8.5 cm × ca. 6 mm; spadix 8.2–9.5 cm longus.

Terrestrial herb, to 1.5 m tall; stem decumbent, with remnants of old cataphylls persisting ± intact at upper nodes, otherwise as short linear fibers; sap milky; internodes 1–3 × 2–3.5 cm, matte to weakly glossy, dark green to gray-green, drying matte, medium-dark to dark reddish brown (most measurements made from dried material); cataphylls 15–28 cm long, moderately thick, obtuse at apex, with subapical apiculum (apiculum to 1.3 cm long), prominently obtusely 1-ribbed and matte, medium yellow-green on outer surface, glossy and paler on inner surface, drying weakly glossy, dark reddish brown. LEAVES 2 to 6, erect-spreading; **petioles** 35–70 cm long, moderately firm, glabrous, matte, markedly dark green, rarely purplish brown toward base and yellow-green at apex, drying matte, medium-dark reddish brown, sheathed (25–)32–60 cm, ca. 3/4 or more of total length (1/2 to 2/3 when sterile); sheath free-ending at apex, the sides rarely prominently narrowly undulate; free portion 2.5–6 mm diam. midway, finely and obtusely many-ribbed abaxially in apical 4 cm or more, sharply D-shaped or U-shaped, with margins erect and acute most or all of its length, rarely terete or subterete, obtusely 1-ribbed medially, occasionally obtusely sulcate near apex; **blades** held ± horizontally, hastate to markedly hastate, 17–33 × 23–36 cm, 1.1 to 1.3 times wider than long, weakly



Figure 30. A, B. *Chlorospatha litensis* Croat & L. P. Hannon, photos from the paratype collection *Croat et al.* 82512 (MO). —A. Fertile habit. —B. Closer view of the leaf blade adaxial surface. C, D. Photos of the holotype *Croat et al.* 82311 (MO). —C. Fertile plants lying on floor. —D. Closer view, showing the leaf blade abaxial surface. Note the post-anthelial inflorescence at center.

acuminate at apex, broadest at base, 2.4 to 2.6(to 3.5) times wider at base than across anterior lobe (measured tip to tip across posterior lobes), thin to thinly coriaceous, weakly to moderately bicolorous; upper surface usually \pm corrugate, weakly glossy to matte-subvelvety (rarely glossy), dark green, drying weakly glossy, dark blackish brown or reddish brown, rarely medium-dark olive-brown; lower surface weakly glossy to semiglossy (rarely matte), drying semiglossy, weakly paler; anterior lobe 15–30 \times 7–15 cm, 1.8 to 2.4 times longer than wide, 1.1 to 1.6 times longer than posterior lobes, broadest at or below middle, moderately to markedly constricted at base, \pm symmetrical to weakly inequilateral; posterior lobes directed prominently outward, (11–)14–21 \times 4.5–6.2 cm, (2.4 to)2.8 to 4.2 times longer than wide, acute to weakly acuminate at apex, broadest at or below middle, markedly constricted at base, weakly to moderately inequilateral, the outer side narrower, \pm straight toward the base; inner side 1.1 to 1.5(to 2.1) times wider than outer side midway, weakly rounded toward the base and gradually to abruptly attenuate onto posterior rib; midrib and major veins prominently narrowly sunken on upper surface, round-raised on lower surface, minutely obtusely many-ribbed, glabrous, matte, weakly darker than surface, rarely weakly paler, drying \pm raised, in part weakly flattened; midrib concolorous on upper surface, rarely weakly paler, drying concolorous to weakly darker than lower surface; **basal veins** (6)7 pairs, coalesced into prominent posterior rib; posterior rib naked 0.5–2 cm per side, acutely 1-ribbed medially on lower surface, the rib contiguous with acute margins of petiole; primary lateral veins (7)8 to 10(11) pairs, arising at 30°–50°(–65°), most acutely toward apex, \pm straight to weakly or moderately arcuate, drying concolorous to weakly darker than lower surface; secondary veins obtusely sunken on upper surface, raised on lower surface, drying raised, concolorous to weakly darker than surface; tertiary veins in part obtusely sunken on upper surface, in part raised on lower surface, otherwise flat, distinct, and darker than surface, drying in part \pm prominulous to weakly raised, otherwise flat and distinct, concolorous to weakly darker than surface; reticulate veins mostly obscure, occasionally in part weakly prominulous on lower surface, concolorous, drying \pm obscure, occasionally in part weakly prominulous; collective veins 3, the innermost arising from lowermost lateral vein on inner side of posterior lobe, loop-connected with all preceding lateral veins, \pm parallel to and 2–7 mm from margin. INFLORESCENCES erect, to 3 per axil, emitting a sweet fragrance at anthesis; peduncle held within the sheath, 37–62 cm \times ca. 2 mm, weakly

shorter to weakly longer than petiole, pale green, drying weakly glossy, dark brown (rarely tan); **spathe** erect, 8.8–12 cm long, occasionally to 3.5 cm longer than spadix, acuminate or cuspidate at apex; spathe tube matte, pale yellow-green on outer surface, glossy on inner surface, 3–3.5 cm \times 3–5 mm, drying matte, dark reddish brown to blackish brown on outer surface, weakly glossy on inner surface; spathe blade matte, white to greenish white or pale yellow-green on outer surface, glossy on inner surface, 6–8.5 cm \times ca. 6 mm, drying matte, pale tan to medium-dark brown or reddish brown on outer surface, marcescent, erect after anthesis; **spadix** erect, weakly stipitate 1–3 mm, 8.2–9.5 cm long, adnate to spathe 1.5–2.5 cm at base, along stipe and ca. 2/3 to 3/4 of the length of pistillate portion; pistillate portion bright orange, rarely white (pinkish to pale orange pre-anthesis), 2.2–3.5 cm \times 2–4 mm, wider than thick, broadest midway; fertile staminate portion bright orange, 3.8–4.2 cm \times 3.5–5 mm, bluntly acute at apex, tapering, broadest just above the base, drying dark, reddish brown; sterile staminate portion (probably cream-colored), (1–)1.5–2.5 cm \times 2–3 mm, usually with axis naked between whorls and to 1 cm at base, rarely flowered entire length, drying brownish cream to medium brown; pistils weakly coherent (more laxly arranged in basal whorls), ca. 4 across the axis (viewed from above), ca. 1.5 mm long; ovaries subglobose, 1.2–2 mm diam., drying \pm tan; style Type 6 (Fig. 1), ca. 0.5 \times 1.2–2 mm, comprising ca. 1/3 of the length of pistil, the margins \pm coherent with those of adjacent styles, drying red-brownish cream; **stigma** ca. 0.2–0.3 mm diam., weakly elevated on and weakly broader than narrowed portion of style, drying medium to dark red-brown; synandria 1–1.5 \times 1.1–2.5 mm, coherent, truncate, deeply (2)3- to 4-lobed, (2)3- to 4-androus, drying dark red-brown; sterile flowers less than 1 mm long, usually 1 mm \times 1.5–3 mm diam. and \pm elongated in direction of axis (rarely ca. 1 mm diam. and not elongated), coherent, truncate, subprismatic, laxly arranged in 5 to 7 whorls. INFRUCTESCENCE drying 6.7 \times 1.1 cm, weakly glossy, dark reddish brown on both surfaces; berries drying 2.5–3 mm diam., pale to medium tan.

Phenology. Flowering in *Chlorospatha litensis* is only known to occur during the months of July and December. Inflorescences emerge in slow progression, with several days between anthesis of one inflorescence and emergence of the next inflorescence at the apex of the petiole sheath.

Etymology. *Chlorospatha litensis* is named for the town of Lita, in Esmeraldas Province, Ecuador, near

the type locality and the border of Carchi and Imbabura provinces.

Discussion. *Chlorospatha litensis* is known from premontane wet forest and lower montane rainforest in the Lita–San Lorenzo region of Esmeraldas Province in northwestern Ecuador, at 350–425 m elevation, and from premontane wet forest and premontane rainforest in Nariño Department in southern Colombia, at 1100–1325 m elevation. All collections were made in the frontier region on the Pacific slopes, along the border between the two countries. The species is a member of *Chlorospatha* sect. *Occidentales* and is distinguished by its usually corrugate, hastate leaf blades and finely ribbed, long-sheathed petiole with the sheath free-ending at the apex and the free portion usually sharply D-shaped, with erect, acute margins. The petiole is sheathed three fourths to almost its entire length, commensurate with its unusually long peduncle that is usually nearly as long as or longer than the petiole, an unusual condition in *Chlorospatha*. The midrib and major veins on the lower surface are finely ribbed and usually darker than the surface. *Chlorospatha litensis* is one of only five species in the genus with bright orange synandria, all of which occur in the frontier region and are possibly closely related. The sterile staminate portion of the spadix of *C. litensis* is unusually long relative to total spadix length, frequently nearly as long as the pistillate portion.

Chlorospatha litensis would be most easily confused with *C. dodsonii*, with which it is sympatric in the Lita–San Lorenzo region of Esmeraldas Province (see discussion under *C. dodsonii*).

In one collection from Esmeraldas, *Madison 6947*, the style is reported as white, differing from the characteristic orange color observed in *Chlorospatha litensis*. *Croat et al. 82512* (its fertile habit seen in Fig. 30A) records the style as pink prior to anthesis. It is common for style color to intensify as it develops toward anthesis, and this possibly explains the discrepancy noted here. The floral characters are otherwise identical. With so few collections available, it is impossible to draw a definite conclusion in this regard. *Croat et al. 82512* also reports the petiole as terete rather than typically D-shaped. The fertile staminate portion of the spadix is reported as whitish in *Croat 87549*, but its dried color is identical to that of the type.

Tipaz et al. 2110 (MO, QCNE), from the Reserva Indígena Awá in Esmeraldas Province in northwestern Ecuador, is possibly this species. It differs in having a purple peduncle and grayish green-drying leaf blades. The small infructescence (5 cm long) would accord with the small inflorescence of

Chlorospatha litensis, but the synandria are reported as cream-colored, differing from the bright orange color found in *C. litensis*. Only berries were available for examination; therefore, a complete assessment of the stylar morphology was not possible.

Paratypes. COLOMBIA. **Nariño:** vic. Palmar, valley of Río Imbí, 3 km NW of Ricaurte (along Pasto–Tumaco rd.), ca. 1 km E of Texas Gulf Pipeline Maintenance Station, along slopes above Río Imbí, 1100 m, 1°08'N, 77°56'W, 14 Mar. 1990, *Croat 71456* (K, MO); Mpio. Barbacoas, Altaquer region, vic. El Barro, Res. Nat. Río Nambí, lt. bank of Río Nambí, 1325 m, 1°18'N, 78°08'W, 9 Dec. 1993, *P. Franco 5097* (COL), 11 Dec. 1993, *P. Franco 5148* (COL). ECUADOR. **Esmeraldas:** Lita–San Lorenzo rd., 0.9 km E of El Durango, 19.8 km W of Alto Tambo, 350 m, 0°52'N, 78°27'06''W, July 1998, *Croat, R. Mansell, L. P. Hannon & J. Whitehill 82512* (CAS, MO, QCNE); along Río Bogotá, Awá Comm., Bogotá, 3 km SW of main Lita–San Lorenzo Hwy., 11.5 km NW of Alto Tambo, 0°58'57''N, 78°35'58''W, 16 Sep. 2002, *Croat 87549* (B, K, MO, QCNE, US).

Cultivated specimen examined. ECUADOR. **Esmeraldas:** vic. Lita, *M. Madison 6947* (SEL).

40. *Chlorospatha longiloba* Croat & L. P. Hannon, sp. nov. TYPE: Ecuador. Esmeraldas: Lita–San Lorenzo rd., 14.2 km W of old Río Lita bridge (below Lita, prior to 1999), 425 m, 0°52'11''N, 78°27'16''W, July 1998, *Croat, L. P. Hannon, D. Mansell & J. Whitehill 82326* (holotype, MO-04889288!; isotypes, AAU!, B!, CAS!, CM!, CUVC!, F!, GB!, K!, MEXU!, NY!, QCNE!, S!, SEL!, TEX!, US!). Figures 29C, 31A–D.

Herba terrestris minus quam 1 m, vel saepe hemiepiphytica et 1–4 m; internodia 1–6 × 0.6–2.5 cm; cataphylla 12–24 cm longa. Petiolus 20–57 cm longus, vaginatus per 6–23 cm; lamina foliaris oblongo-elliptica, sagittata, interdum subsagittata, 20–40 × 6.3–16 cm, lobis posterioribus 3.2–13.5 × 2.3–5.5 cm, nervis basalibus utroque (2)3 ad 5, nervis primariis lateralibus utroque 5 vel 6. Inflorescentiae 2 ad 5 in quaque axilla; pedunculus 12–25 cm × 2–4 mm; spatha erecta, 5–8 cm × 4–5 mm; spadix 3.2–5.7 cm longus.

Terrestrial herb, less than 1 m tall, or frequently hemiepiphytic and 1–4 m tall; stem decumbent, remnants of old leaf bases and cataphylls persisting ± intact along its length; internodes 1–6 × 0.6–2.5 cm, glossy, medium green, drying matte to weakly glossy, dark brown; sap milky (all measurements made from dried material); cataphylls 12–24 cm long, obtuse with acumen at apex, 1-ribbed abaxially, green, drying semiglossy to glossy, medium to dark reddish brown on outer surface, weakly glossy on inner surface. LEAVES 2 to 5, erect-spreading, occasionally ± spreading; **petioles** 20–57 cm long, glabrous, weakly glossy to semiglossy, dark green,



Figure 31. *Chlorospatha longiloba* Croat & L. P. Hannon. —A. Leaf blade adaxial surfaces. —B. Fertile habit, with inflorescence visible at image bottom. —C. Stem bases with persistent cataphylls and petioles. —D. Anthesal inflorescence with erect, funnel-shaped spathe. Photos of the holotype *Croat et al.* 82326 (MO).

drying matte to weakly glossy, medium-dark to dark reddish brown, frequently with the epidermis in part separated and semiglossy to glossy, sheathed 6–23 cm, slightly less than 1/2 of total length; sheath decurrent at apex; free portion 3–5 mm diam. midway, terete or subterete; **blades** oblong-elliptic, sagittate, occasionally subsagittate, 20–40 × 6.3–16 cm, (2.4 to)2.6 to 3.4(to 4) times longer than wide, gradually acuminate at apex, rarely abruptly acuminate, weakly broadest at base, occasionally 2.2 to 2.5 times wider across anterior lobe than at base (measured tip to tip across posterior lobes), weakly or not at all constricted in area of petiole attachment, thinly coriaceous, rarely thin, weakly to moderately bicolorous; upper surface weakly glossy, dark green, drying weakly glossy to semiglossy, dark green to olive-green, rarely brownish yellow-green; lower surface weakly glossy to semiglossy, drying weakly glossy to semiglossy, weakly to moderately paler; anterior lobe 17.5–31 × 6.3–14.5 cm, (2.1 to)2.6 to 3.3 times longer than wide, (2 to)2.3 to 5.4(to 6.4) times longer than posterior lobes, broadest at or below middle, ± symmetrical to weakly inequilateral; posterior lobes directed toward the base, 3.2–13.5 × 2.3–5.5 cm, (1.4 to)2 to 3 times longer than wide, narrowly rounded to bluntly rounded at apex, rarely bluntly acute, broadest at base, moderately to markedly inequilateral, the inner side narrower, ± rounded toward the base, briefly attenuate and weakly confluent with opposite lobe, the confluent portion obscuring petiole apex; outer side 1.5 to 3 times wider than inner side midway, weakly convex to ± straight toward the base, occasionally weakly concave; midrib deeply and narrowly sunken on upper surface, narrowly raised or round-raised on lower surface, paler than surface, drying ± raised, weakly to moderately darker than surface, occasionally concolorous; **basal veins** (2)3 to 5 pairs, coalesced into prominent posterior rib; primary lateral veins 5 to 6 pairs, arising at 45°–65°(–70°), most acutely toward apex, weakly to moderately arcuate, occasionally strongly arcuate, etched to obtusely sunken on upper surface, acutely raised to convex on lower surface, paler than surface, drying ± flattened, concolorous to weakly darker than surface; secondary veins etched on upper surface, weakly raised on lower surface, drying weakly raised, ± concolorous; tertiary veins distinct, in part prominulous, otherwise flat on lower surface, drying visible, distinct, in part weakly prominulous, ± concolorous; reticulate veins obscure; collective veins 3, arising from one of the lowermost lateral veins on inner side of posterior lobe, loop-connected with all preceding lateral veins, ± parallel to and 2–7 mm from margin.

INFLORESCENCES erect to erect-spreading, 2 to 5 per axil, emitting a sweet fragrance at anthesis; sympodium held within a sympodial cataphyll; sympodial cataphyll 11–19.5 × 1–1.5 cm, pale to medium green, drying weakly glossy to semiglossy, pale to medium reddish brown; peduncle 12–25 cm × 2–4 mm, cylindroid, thicker than broad, broadest toward base, glossy, medium green, drying weakly glossy to semiglossy, medium to medium-dark reddish brown; **spathe** erect, 5–8 cm long, lanceolate, acute to acuminate at apex, opening narrowly most of its length and ± funnel-shaped at anthesis, more broadly on blade, the margins directed forward; spathe tube weakly glossy, medium green and prominently dark purple-tinged, or narrowly dark purple on outer margin of outer surface, dark purple on inner surface, 2–3.5 cm × 4–5 mm, drying matte to weakly glossy or semiglossy, dark reddish brown (rarely dark green), occasionally much paler near base on both surfaces, frequently weakly purplish on inner surface; spathe blade weakly glossy, pale green to greenish white on both surfaces and frequently narrowly dark purple on outer margin toward the base on outer surface, 3–4(–4.5) cm × 4–6 mm, to 3.5 cm wide (flattened), opening ± broadly at anthesis, drying matte to weakly glossy, medium-dark reddish brown on outer surface, rarely brownish cream, weakly to moderately paler on inner surface, marcescent, erect after anthesis; **spadix** ± erect, curved weakly forward, 3.2–5.7 cm long, sessile, adnate to spathe 0.7–1.8 cm at base, ca. 1/2 or slightly more of the length of pistillate portion; pistillate portion creamy white to pale green or pale yellow-green, 1.5–3 cm × 3–5 mm, broadest toward apex; fertile staminate portion white to creamy white or greenish white, 1.3–2.5 cm × 3–6 mm, ± cylindrical to weakly tapering, narrowly to bluntly rounded at apex, drying medium reddish brown, rarely brownish cream; sterile staminate portion pink or bright orange, 6–9 × 3–5 mm, ± cylindrical, drying medium orangish brown or medium to dark purplish brown; (floral characters from living and pickled material) pistils weakly coherent, 3 to 4 across the axis (viewed from above), 1.5–2 mm long; ovaries ± cylindrical, obtusely truncate at apex, ca. 1 × 1.8–2 mm, drying cream-colored with prominently darker veins, 2- to 3-locular, with axile placentation; ovules 8 to 14 per locule, small, hemianatropous, biseriate; funicles longer than ovules; style Type 5 (Fig. 1), 0.5–1 × 2–2.6 mm, comprising ca. 1/2 of the length of pistil, the margins usually coherent with those of adjacent styles, drying dark purplish brown, rarely pale tan; **stigma** disklike, ca. 0.3 × ca. 0.5–0.7 mm, elevated on and as wide as or weakly wider than

narrowed portion of style, drying weakly paler than style; synandria 1.5–2 × 1.5–2 mm, coherent, truncate, 3- to 4-lobed, 3- to 4-androus (mostly 3), drying medium to dark reddish brown, rarely brownish cream; sterile flowers ca. 1.5 × 1.5–2.4 mm, weakly elongated in direction of axis, coherent in apical whorls, weakly coherent to laxly arranged in basal whorls, ± fungiform (like toadstools), sub-prismatic when viewed from above, broadest and weakly convex at apex, abruptly narrowed below, the narrowed portion ca. 0.8 mm diam., in 6 to 8 whorls. INFRUCTESCENCE (immature) 3.5–5.5 cm × ca. 7 mm, drying matte to weakly glossy, dark reddish brown; berries not known. JUVENILE plants with leaf blades ± lanceolate and weakly cordulate at base, 14.5 × 4 cm; anterior lobe 13.5 × 4 cm; posterior lobes 9 × 10 mm, with inner margin possibly decurrent onto petiole; primary lateral veins 4 pairs.

Phenology. Flowering in *Chlorospatha longiloba* is only known to occur during the months of July, October, and November. Inflorescences are fragrant and emerge in quick succession, with each reaching anthesis approximately one to three days after anthesis of the preceding inflorescence.

Etymology. The epithet is taken from the Latin “longus,” meaning “long,” and “lobus,” meaning “lobed,” referring to the long anterior lobe of the leaf of the new species.

Discussion. *Chlorospatha longiloba* is known only from premontane wet forest on the western slopes of the Andes, at 300–800 m elevation in Carchi and Esmeraldas provinces in northwestern Ecuador, part of the frontier region along the Colombian border. The species would be expected to occur in Pichincha to the south and northward into Nariño Department in southern Colombia.

Chlorospatha longiloba is a member of *Chlorospatha* sect. *Occidentales* and is distinguished by its green-drying, sagittate, oblong-elliptic leaf blades with relatively short, narrow posterior lobes and by its small inflorescence with a more or less purple spathe tube. *Chlorospatha longiloba* can be terrestrial or hemiepiphytic. The authors have observed the species growing on the moss-covered trunks of trees and palms, with the apex of the stem 4 m above the ground. Also unusual is the flowering habit of this species in which the petiole is sheathed approximately one half of its length, but the sympodium is subtended by a sympodial cataphyll that emerges near the base of the sheath. The species is one of only two species in *Chlorospatha* sect. *Occidentales* with a

cataphyll for the sympodial leaf, and it is also distinguished by its pink or bright orange sterile flowers (see discussion under *C. grayumii*).

The leaf blades of *Chlorospatha longiloba* are somewhat variable even within single populations, and can be either sagittate and weakly widest at the base or subsagittate, widest across the anterior lobe and cordulate at the base, with the posterior lobes much shorter and rounded at the apex.

Paratypes. ECUADOR. **Carchi:** San Marcos Valley, 600 m, 1°07'N, 78°22'W, 20–24 Nov. 1983, *A. Barford et al.* 48823 (AAU, MO, QCA). **Esmeraldas:** Lita–San Lorenzo rd., 15.8 km W of new Río Lita bridge (after 1998), 800 m, 0°53'45"N, 78°31'57"W, 9 Oct. 1999, *Croat, R. Mansell, L. P. Hannon & B. Owen* 83174 (K, MO, US); Km. 8 on Lita–Alto Tambo rd., 749 m, 19 July 1988, *C. Dodson & A. Gentry* 17519 (MO, QCNE).

41. *Chlorospatha longipoda* (K. Krause) Madison, Selbyana 5(3–4): 353. 1981. Basionym: *Caladium longipodum* K. Krause, Notizbl. Bot. Gart. Berlin-Dahlem 15: 43. 1940. TYPE: Ecuador. Pastaza: Río Topo, 1200 m, 4 July 1938, *A. Schultze-Rhonhof* 2591 (holotype, B!). Figures 4B, 32A–D, 33A.

Chlorospatha madisonii J. Haager & J. Jeník, Preslia, Praha, 56: 165–167. 1984. TYPE: Ecuador. Napo: Río Borja, vic. San Francisco de Borja, 15 km NNE of Baeza, near Baeza–Lago Agrio rd., ca. 1200 m, 0°25'N, 77°50'W (est.), Dec. 1981, *J. Haager & J. Jeník* s.n. (holotype, PR).

Terrestrial or occasionally hemiepiphytic herb, to 40 cm tall, usually in small colonies; stem fleshy, decumbent, 20–40 cm long, erect to 15 cm at apex, remnants of old cataphylls and leaf bases persisting ± intact to semi-intact along its length; sap milky or transparent; internodes usually short, (0.5–)1–2(–4–6) cm × 6–13 mm, matte to weakly glossy (rarely semiglossy), dark green, occasionally weakly purplish, rarely pale brownish green, drying medium greenish brown; cataphylls 6–15 cm long, inequilateral, acuminate or obtuse with acumen (rarely apiculum) at apex, acutely or obtusely 1- to 2-ribbed abaxially, pale to medium green, rarely purple-mottled in transverse bands, drying matte, medium to medium-dark reddish brown. LEAVES 3 to 5, erect to erect-spreading; **petioles** (10–)13.5–29 cm long, glabrous, matte, medium to dark green, occasionally purple-mottled in narrow transverse bands in basal 2/3, drying matte to weakly glossy, dark brown or greenish brown, sheathed 8–14 cm, 1/3 to 1/2 of total length (rarely 1/4); sheath in-rolled or erect with margins in-rolled, decurrent or free ending at apex; free portion 2–3 mm diam. midway, terete, or terete midway and subterete toward apex,



Figure 32. *Chlorospatha longipoda* (K. Krause) Madison. —A. Plant habit, showing adaxial blade surfaces. —B. Habit, showing adaxial leaf blade surfaces. —C. Leaves with abaxial blade surfaces visible at top as well as remnants of the several persistent cataphylls and leaf bases. —D. Close-up of the post-anthesal inflorescence with the spathe blade erect and cucullate. A photographed from the collection Croat *et al.* 86584 (MO). B, C photographed from the collection Croat 87303 (MO). D photographed from the collection Croat & L. P. Hannon 86644 (MO).

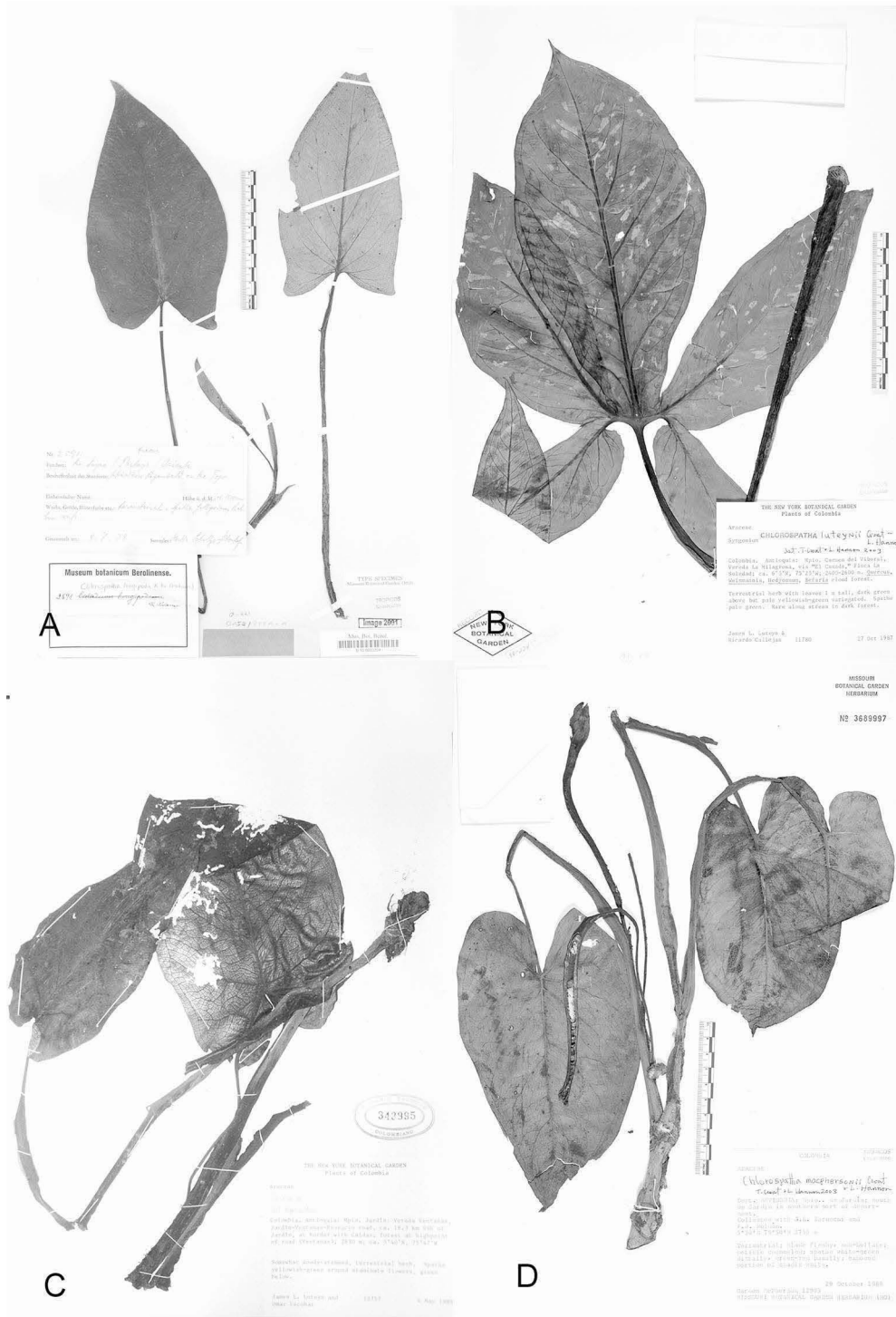


Figure 33. —A. *Chlorospatha longipoda* (K. Krause) Madison, photographed from *Schultze-Rhohof* 2591 (from holotype at B). —B. *Chlorospatha luteynii* Croat & L. P. Hannon, *Luteyn & Callejas 11780* (NY holotype). C, D. *Chlorospatha macphersonii* Croat & L. P. Hannon. —C. Isotype specimen, *Luteyn & O. Escobar 12757* (COL-343995). —D. Paratype specimen, *McPherson et al. 12903* (MO-3689997).

obscurely sulcate, bluntly V-sulcate to bluntly and narrowly sulcate or entirely sharply C-shaped and deeply narrowly sulcate, rarely sparsely and weakly granular-puberulent; **blades** narrowly ovate or ovate-elliptic, subcordate to subsagittate at base, (10–)15.5–21.5 × (3.5–)5–13 cm, 1.6 to 2 times longer than wide, usually broadest across anterior lobe, 1.1 to 2 times wider across anterior lobe than at base (measured tip to tip across posterior lobes), occasionally as broad as or weakly wider at base on drying, weakly or not at all constricted in area of petiole attachment, thin to thinly coriaceous, prominently bicolorous, rarely moderately so; upper surface broadly quilted, matte, matte-subvelvety, velvety or semiglossy, medium to dark green, drying matte to weakly glossy, medium to dark green or brownish to yellow-brown; lower surface reticulate, narrowly colliculate along all venation, matte, drying weakly glossy, moderately paler; anterior lobe (8.8–)14–18 × (3.5–)5–10(–13) cm, 1.4 to 2.3 times longer than wide, (3 to)3.5 to 10(to 11.6) times longer than posterior lobes, weakly to moderately acuminate to bluntly acute or apiculate at apex, broadest below middle; posterior lobes directed toward the base, occasionally weakly outward, 1.5–4(–6) × 1.5–4(–5) cm, usually as long as wide, rarely 1.2 times longer than wide, broadly to occasionally narrowly rounded at apex, broadest at base, occasionally markedly inequilateral, the inner side narrower, weakly rounded to acute at base and decurrent onto petiole; outer side 5 to 6 times wider than inner side midway; midrib and major venation occasionally in part weakly granular-puberulent on lower surface, matte, concolorous or weakly to moderately darker than surface; midrib deeply sunken on upper surface, convex or moderately to narrowly round-raised on lower surface, matte, drying raised, moderately darker than surface; **basal veins** 1 to 3 pairs, coalesced into a prominent posterior rib, or with 3 to 4 branching off, 2 to 3 acroscopic, 2 to 3 basiscopic, with first and second or also the third fused, forming a short posterior rib 5–10 mm long; primary lateral veins 4 to 6 pairs, arising at 17°–45°, most acutely toward apex, ± arcuate, quilted-sunken on upper surface, convex to narrowly round-raised on lower surface, drying weakly raised, darker than surface; secondary veins in part weakly sunken on upper surface, raised on lower surface, occasionally in part sparsely granular-puberulent, darker than surface, drying raised, weakly to moderately darker than surface; tertiary veins bluntly to acutely raised or prominulous on lower surface, darker than surface, drying entirely or in part weakly darker than surface; reticulate veins weakly raised or prominulous on lower surface,

concolorous to weakly darker than surface, drying entirely prominulous or weakly raised, or in part weakly raised and otherwise prominulous, weakly darker than surface; collective veins 2 to 3(4), the innermost arising from one of the lowermost lateral veins on inner side of posterior lobe, moderately scalloped, 3–9 mm from margin. INFLORESCENCES erect, 1 to 6 per axil, emitting a weak fruity fragrance at anthesis; sympodium held within a sympodial cataphyll; sympodial cataphyll 6.5–8.5 × 1–2 cm, acuminate at apex, 1-ribbed abaxially, medium green, occasionally weakly purple-speckled (*Croat & L. P. Hannon 86941*); peduncle terete, 4–10 cm × 1–2 mm (to 13 cm long in fruit), weakly glossy, pale to pale-medium green, occasionally purple-tinged, drying ca. 1 mm diam., dark brown; **spathe** erect and weakly cucullate, 4–8 cm long (1–3.5 cm longer than spadix), oblanceolate, briefly acuminate or cuspidate at apex, opening narrowly most of its length at anthesis, with margins directed forward; spathe tube matte to weakly glossy, entirely pale to dark green or weakly to heavily purple-tinged on outer surface, weakly glossy to semiglossy, green on inner surface, 1–2.5 cm long, drying 3–5 mm diam., matte, dark brown; spathe blade weakly glossy, entirely pale to dark green or dark purple, or weakly to strongly purple-tinged to purple-mottled on outer surface, weakly glossy to semiglossy or matte, pale to dark green on inner surface, 2.5–6 cm long, 1.2–2 cm wide (flattened), drying matte, dark brown to purplish, occasionally moderately paler than tube, marcescent, erect after anthesis; **spadix** erect, occasionally curving forward at anthesis, (3.3–)4.3–5.3 cm long, sessile, ± cylindrical, adnate to spathe 6–8 mm at base, ca. 1/2 of the length of pistillate portion; pistillate portion whitish, pale yellow or pale green to yellow-green, (0.7–)1–1.8 cm × 2–3.5 mm, broadest midway; fertile staminate portion white or whitish to whitish green or pale yellow, 2–3 cm × 2–3 mm, bluntly acute at apex, ± cylindrical, drying yellow to yellow-tan; sterile staminate portion whitish (rarely violet-red), 4–8 × ca. 2 mm, weakly narrower than pistillate and fertile staminate portions; pistils weakly coherent, 2 to 3 across the axis (viewed from above), ca. 1 mm long, rarely in whorls instead of spirals (one inflorescence of *Croat et al. 86561*); ovaries whitish, cream or pale green, 1.2–2 mm diam., ± cylindrical to obtusely obconical, usually broadly depressed medially, 2- to 3-locular, with pseudoaxile placentation, the placentae fused at base, or rarely 1-locular with basal placentation and vestigial septa present (*Croat et al. 86607*); ovules 8 to 12 per locule, anatropous, biseriate or occasionally 1-seriate; funicle shorter than ovule; style Type 1

(Fig. 1), 1.2–1.3 mm diam., as broad as ovary apex, occasionally obscurely attenuate medially, the margin obscure or distinct, not coherent with those of adjacent styles; red chromoplasts present; **stigma** white to cream, sessile, occasionally obscurely elevated on style, 0.2–0.3 mm diam., obpyramidal or cylindrical; synandria ca. 1 mm long, 1.3–1.5 × 1.1–1.2 mm diam. and ± elongated in direction of axis, occasionally highly bilaterally symmetrical, coherent, weakly or prominently deeply (2)3- to 4(5)-lobed (occasionally almost to center), broadly concave medially, with lobes thickened, occasionally subrounded, the margins sinuate-undulate and interlocking with those of adjacent flowers, (2)3- to 4(5)-androus, the thecae each with a terminal pore; sterile flowers occasionally purple-tinged in basal 2 whorls, rarely violet-red, less than 1 mm long, 1.3–2 × 1–1.3 mm diam. and ± elongated in direction of axis, coherent, truncate, subprismatic to irregularly prismatic, in 3 to 5 whorls. INFRUCTESCENCE pendent, entirely green or occasionally purple-tinged, (2.5–)3–4 cm × (6–)7–10 mm, drying matte to weakly glossy, dark brown; berries cream-colored or pale green and weakly violet-tinged apically, 4–5 mm diam., drying yellowish brown; seeds 7 to 8 per berry, 1.2–2 × 0.8–1 mm, obtusely 3-sided, rounded at base, acute at apex, finely costate, drying cream-colored.

Phenology. Flowering is known to occur in *Chlorospatha longipoda* during the months of January, April, May, July, August, September, and December, and probably occurs throughout the year. Inflorescences are fragrant and emerge in quick succession, each reaching anthesis approximately one to three days after anthesis of the preceding inflorescence. Fruiting is recorded for the months of April, August, and November.

Discussion. *Chlorospatha longipoda* is widespread on the eastern slopes of the Andes in Ecuador, at (265–)470–1700 m elevation, occurring in Morona-Santiago, Napo, Pastaza, Sucumbíos, Tungurahua, and Zamora-Chinchiipe provinces. The species probably occurs also in Chimborazo Province. As is true of other wide-ranging species from the eastern slopes, *C. longipoda* occurs in a wide variety of life zones: tropical wet forest, premontane wet forest, lower montane wet forest, premontane rain-forest, premontane moist forest, and montane moist forest. Although the notation of the localities is imprecise, it appears that *C. longipoda* occurs on the eastern slopes of the Cordillera de Cutucú in Morona-Santiago and, therefore, is likely to occur also in Peru. The species is found in deep shade, frequently

in small colonies, and can be common and widespread in the dark understory in some areas, such as the collection sites of *Croat & L. P. Hannon 87003*, off of the Macas–Puyo road, on the road to Palora, and *Croat & L. P. Hannon 86607*, near the town of Shell, on the Puyo–Baños road. In the original publication of the type, “Río Topo” is possibly a misprint. No record of this river could be located. However, there is a Río Toro at approximately the same GPS coordinates as those for Hacienda Topo and the town of Topo, at this elevation.

Chlorospatha longipoda, the type species for *Chlorospatha* sect. *Orietales*, is distinguished by its usually narrowly ovate-elliptic leaf blades that are subcordate to subsagittate at the base, with the posterior lobes short and usually rounded at the apex, and the inner margins decurrent onto the petiole. The upper surface is broadly quilted, frequently velvety, and the lower surface is matte and conspicuously reticulate. The species is also characterized by the presence of a sympodial cataphyll, its matte, medium to dark green petiole, sheathed one third to one half of its length, short peduncle (4–10 cm long) and small inflorescence, 4–8 cm long, with the spadix adnate to the spathe ca. one half of the length of the pistillate portion. The spathe can be entirely green or the tube can be weakly to moderately purple-tinged, or the blade can be partially purple-tinged to entirely dark purple and the tube green. *Chlorospatha longipoda* has been observed as a hemiepiphyte growing low on the bases of trees, a habit observed in no other species from the eastern slopes, although it is likely that it occurs in other species.

Chlorospatha longipoda exhibits considerable variation in the texture of the upper surface of the leaf blade, ranging from velvety to semiglossy, and some variation in blade shape, some blades having extremely short posterior lobes (less than 2 cm long), others having longer lobes with more well-developed posterior ribs. *Croat 59100* differs in having a more broadly sagittate blade that dries yellow-brown, with longer posterior lobes and the abaxial venation more conspicuously raised than is typical. *Croat & L. P. Hannon 86607* has leaf blades both narrowly triangular and narrowly ovate-elliptic on single plants, with some posterior lobes directed slightly outward and narrowly rounded at the apex. Considering the amount of variation in *C. longipoda* and the fact that many of the collections cited here are sterile, it is possible that more than one taxon or species is represented; however, the variation in blade shape occurs within single populations as well as between different populations, though the variation in the texture of the upper blade surface apparently occurs

only in different populations. The distinguishing characters of the species are otherwise consistent. Small, juvenile plants of several species from the eastern slopes are nearly identical to juvenile or even in some cases, adult plants of *C. longipoda*: *C. boosii*, *C. engleri*, *C. hannoniae*, *C. limonensis*, *C. plowmanii*, and *C. pubescens*. In these six species, the shape of the juvenile blade is similar to that of the juvenile and mature blades of *C. longipoda*. This, combined with a consideration of the variability of blade shape in most species in section *Orientalis*, would suggest a close relationship between these species. In the past, there has been some confusion regarding determinations of *C. longipoda*, and, because of this, its in-depth discussion seems appropriate.

Madison (1981) combined *Caladium plowmanii* (Madison, 1976) with *Chlorospatha longipoda* without examining the type of *C. longipoda*. *Caladium plowmanii* differs from *C. longipoda* in significant ways and is better combined in a new species, *Chlorospatha plowmanii* (Madison) Croat & L. P. Hannon. *Chlorospatha plowmanii* is also widespread on the eastern slopes of the Andes in Ecuador. To date, the two species have not been observed together, but are probably sympatric in Morona-Santiago and Napo provinces. The remnants of old cataphylls and leaf bases persist more or less intact along the stem of *C. longipoda*, but only as semi-intact fragments or short fibers in *C. plowmanii*. Throughout its range, *C. longipoda* has narrowly oblong-elliptic leaf blades, subcordate or subsagittate at the base, with the posterior lobes short, broad, and usually rounded at the apex and the anterior lobe (3.1 to)3.5 to 10 times longer than the posterior lobes. The blades of *C. plowmanii* are subhastate to hastate, conspicuously broadest at the base, frequently as wide as long, with the posterior lobes long, narrow, and usually acute at the apex (rarely narrowly rounded), and the anterior lobe only 1.5 to 2 times longer than the posterior lobes. The posterior rib is naked 3–5(–10) mm on each side in *C. plowmanii*, but not naked in *C. longipoda*. There are four to six pairs of primary lateral veins in the latter species and three or four pairs in *C. plowmanii*. The spathe of *C. longipoda* is weakly to moderately cucullate, with the blade erect after anthesis. In *C. plowmanii* the blade is erect to erect-spreading at anthesis, but reflexes after anthesis and is quickly deciduous, a presumably unique condition in *Chlorospatha*. The ovaries of the latter species are 1- or 2-locular versus 2- or 3-locular in *C. longipoda*. The synandria of *C. plowmanii* are 2- or 3(4)-androus, differing from those of *C. longipoda*, which are (2)3- or 4(5)-

androus. The inflorescence of the latter species is fragrant, whereas that of *C. plowmanii* is odorless.

Chlorospatha longipoda could possibly be confused with two species from Morona-Santiago Province, both of which occur in the Limón-Méndez region, at about 900 m elevation, *C. boosii* and *C. hannoniae*, and are probably sympatric with *C. longipoda* (see discussions under *C. boosii* and *C. longipoda*).

Krause (1940: 43) described the lower surface of the leaf blade of the type (*Schultze-Rhnhof 2591*) as having "sparse, short, prominent, white hairs." When the authors examined the type, no hairs were observed on the blade surface, but some sparse, random granular-puberulence was observed on the secondary venation, occasionally on the midrib, major, and secondary venation of other collections.

Chlorospatha madisonii J. Haager & J. Jeník was deemed to be the same species as *C. longipoda*.

Additional specimens examined. ECUADOR. **Morona-Santiago:** Laguna Sardina & Volcán al Upano, Parque Nac. Sangay, 1750 m, *C. Cerón et al. 48784* (QAP); vic. Río Furubumbo, Parque Nac. Sangay, 1450 m, *C. Cerón et al. 48890* (QAP); Macas–Riobamba, 17.3 km N of Macas, 1015 m, *Croat et al. 86561* (AAU, B, CAS, COL, F, GH, HUA, INB, K, M, MEXU, MO, MY, QCA, QCNE, RSA, S, SEL, UB, US, VEN); vic. Humboya, 10.5 km W of Puyo–Macas rd. (Hwy. 45), 6.6 km N of Río Chiguaza, *Croat & L. P. Hannon 86917* (CM, CUV, JBCP, MO, QCNE, U); along Palora–Río Amundalo rd., 5.3 km NW of Palora, at Río Amundalo, 0.3 km N of San Vicente at Tarquí, 932 m, *Croat & L. P. Hannon 86941* (MO, QCNE); Puyo–Macas rd. to Palora, 9.8 km from main rd., *Croat & L. P. Hannon 87003* (KRAM, L, MO, QCNE); along Gualaquiza–Indanza rd., 12 km S of Indanza, along river, 1336 m, *Croat 87303* (K, MO, QCNE, US); Cord. de Cutucú, ca. 25 km SE of Logroño on footpath to Yaupi, 900 m, *Madison & Coleman 2520* (SEL), 800 m, *Madison & Coleman 2567* (QCA, SEL); along Logroño–Yaupi trail, 1500 m, *Madison et al. 3357* (QCA, SEL, US); 20 km S of San Juan Bosco, 1300 m, *Madison & Besse 7557* (SEL). **Napo:** along rd. betw. Baeza & Tena, 37.7 km S of Baeza, 59 km N of Archidona, 1700 m, *Croat 58780* (MO); Archidona–Baeza, vic. Jondachi, 20.1 km N of Baeza, 5 km S of turn-off to Loreto, 1033 m, *Croat et al. 87777* (MO); Río Borja, vic. San Francisco de Borja, 15 km NNE of Baeza, near Baeza–Lago Agrio rd., 1981, 1200 m, *Haager & Jeník s.n.* (PR); Res. Prod. Faun. Cuyabeno, N of Laguna Grande, 1265 m, *A. D. Poulsen 80065* (AAU, MO). **Pastaza:** Mera, forest near Mangayacu, 1100 m, *E. Asplund 19095* (S); along Puyo–Baños rd., second bridge W of Mera, ca. 3 km W of Mera, 1165 m, *Croat 49715* (MO); along Puyo–Macas rd., Km. 19 (S of Puyo), 1200 m, *Croat 50570* (MO); along rd. betw. Puyo & Diez de Agosto & Arajuno, 18 km NE of main Puyo–Macas rd. (beginning 3.7 km from center of Puyo, at Hotel Europa), 8.2 km NE of Diez de Agosto, 970 m, *Croat 59062* (MO, QCNE); along Puyo–Baños rd., 11.9 km W of Shell, 3.9 km W of Mera, 1100 m, *Croat 59100* (CM, MO, QCA, QCNE); Macas–Puyo, 1.2 km S of Yantana, 38.4 km S of Veracruz, 951 m, *Croat et al. 86584* (K, MO, QCNE); vic. Shell, to N, off of main Puyo–Baños rd., 1096 m, *Croat & L. P. Hannon*

86607 (AAU, B, CAS, F, MEXU, MO, NY, QCNE, SEL, US); vic. Shell, along rd. N to Río Alpayacu 0.8 km, 1121 m, *Croat & L. P. Hannon 88917* (CM, CUVC, JBGP, MO, QCNE, U); along Puyo-Macas rd., 3 km SE of Veracruz, 900 m, *G. Harling & L. Anderson 16816* (MO). **Sucumbíos:** along Lumbaquí-La Bonita rd., departing main Baeza-Lago Agrio rd. just E of Río Aguarico bridge E of Lumbaquí, 5.8 km NW of jct. with main hwy., 400 m, *Croat et al. 93580* (MO, QCNE). **Tungurahua:** Río Negro to Parque Nac. Sangay, 4.9 km S of Río Negro, on rd. departing main Puyo-Baños rd., 1520 m, *Croat & L. P. Hannon 86644* (AAU, GB, K, MO, NY, QCNE, S, SEL, US); 1.8 km S of Río Negro, on rd. departing main Puyo-Baños rd., 1338 m, *Croat & L. P. Hannon 86662* (BR, GB, INB, M, MO, GH, P, QCNE, RSA, U, UB, USM, WU); along rd. from Río Negro to La Estancia & Parque Nac. Sangay, 1.8 km S of bridge over Río Pastaza, 1335 m, *Croat & L. P. Hannon 88495* (ENCB, MO, QCNE); *88514* (GB, MO, QCNE, TEX, WU). **Zamora-Chinchipec:** Paquisha S to Las Orquídeas, at end of Río Nangaritza rd. via Guayzimi, beginning at 15.9 km E of Zumbi & Río Nangaritza, then 46 km S of intersection near Paquisha, 875 m, *Croat et al. 91356* (MO, QCNE).

42. *Chlorospatha luteynii* Croat & L. P. Hannon, *Aroideana* 27: 24. 2004. TYPE: Colombia. Antioquia: Mpio. Carmen del Viboral, vic. La Milagrosa, vía “El Canada,” Finca La Soledad, 2400–2600 m, ca. 6°05'N, 75°25'W, 27 Oct. 1987, *J. Luteyn & R. Callejas 11780* (holotype, NY!; isotypes, HUA!, NY!). Figures 28D, 33B.

Terrestrial herb, to 1 m tall; stem not known; internodes not known (all measurements made from dried material); cataphylls not known. LEAVES 2 to 3, erect-spreading; **petioles** 40–90 cm long, glabrous, drying glossy, dark blackish brown, with epidermis in part separated \pm intact and semi-transparent, sheathed 20–55 cm, 1/2 or slightly more of total length; sheath decurrent at apex; free portion 4–6 mm diam. midway; **blades** deeply 5-lobed, occasionally weakly auriculate on outermost segments, ca. 35 \times ca. 31–40 cm, almost as wide as long, drying thin, weakly bicolorous; upper surface dark green, irregularly pale yellow-green maculate (maculations 7–30 \times 3–12 mm), drying weakly glossy to semiglossy (matte), dark green to olive-green, maculations paler; lower surface drying semiglossy to glossy, maculations weakly paler or not visible; **medial lobe** 24–31 \times 12–16 cm, 1.8 to 2.5 times longer than wide, abruptly acuminate at apex, broadest at or slightly above middle, cuneate toward and narrowly attached at base, 3–4 cm wide at point of attachment, \pm symmetrical; **lateral lobes** confluent with all adjacent lobes, the confluent portion 1.5–4 cm wide; innermost segment 20–27 \times 8–10.5 cm, 2.3 to 2.8 times longer than wide, acuminate at apex (rarely acute), broadest at or above middle, narrowly attached at base, 3–3.5 cm wide at point of attachment, moderately inequilateral, the inner side narrower, \pm

straight to weakly convex toward base, occasionally weakly attenuate; outer side to 1.9 times wider than inner side midway, weakly convex toward base; outermost segment 15–18.5 \times 5–7 cm, 2.6 to 3 times longer than wide, acuminate at apex, broadest midway, narrowly to broadly attached at base, 2–3.5 cm wide at point of attachment, moderately inequilateral, the inner side narrower, \pm straight toward base; outer side 1.3 to 1.5 times wider than inner side midway, weakly to broadly rounded toward the base or forming an auricle 5.5 \times 2 cm; midrib and major venation round-raised on lower surface, drying much darker than both surfaces, almost black, \pm flattened on lower surface; posterior rib naked 2–3.5 cm per side; primary lateral veins (on medial lobe) 5 to 6 pairs, arising at 25°–40°, \pm straight; primary lateral veins (on lateral lobes) 4 to 5 pairs, arising at 25°–35°, weakly arcuate; secondary veins drying in part raised on lower surface, otherwise prominulous, occasionally flattened, moderately darker than surface; tertiary and reticulate veins drying in part prominulous on lower surface, otherwise visibly distinct, usually moderately darker than surface; collective veins 3, the innermost arising from lowermost lateral vein at base, loop-connected with all preceding lateral veins, moderately scalloped, 0.4–1.2 cm from margin. INFLORESCENCES erect, to 3 per axil; peduncle held within the sheath, 20–43 cm \times ca. 2 mm, drying weakly glossy, dark blackish brown; **spathe** pale green, erect, 9–12 cm long; spathe tube 4.3–5 cm \times 5–6 mm, drying matte, dark brown on outer surface, weakly glossy, paler and densely tan, punctiform on inner surface (speckles regularly rounded, appearing as subepidermal cellular inclusions); spathe blade 5.5–7 cm \times 7–8 mm, acuminate at apex, drying matte, dark reddish brown (paler than tube), marcescent, erect after anthesis; **spadix** erect, weakly stipitate 1–2 mm (stipe emerging from a small sheath in spathe), 8.5–9.5 cm long, adnate to spathe 2.7–3.6 cm at base, most of the length of pistillate portion; pistillate portion 2.9–3.7 cm \times ca. 4 mm, broadest midway, drying brownish; fertile staminate portion white, 5–6 cm \times ca. 3–6 mm, bluntly acute at apex, narrowed at base, tapering, drying medium-dark brown to reddish brown; sterile staminate portion 1.4–1.6 cm \times 1.5–2.2 mm, narrowest midway, drying dark tan; pistils weakly coherent, ca. 4 to 5 across the axis (viewed from above), ca. 1.2 mm long; ovaries subglobose, 1.5–2 mm diam., drying cream to tan; style Type 3 (Fig. 1), 1–2 mm diam., weakly broader than ovary apex, the margins not coherent with those of adjacent styles; **stigma** 0.3–0.5 mm diam., sessile; synandria ca. 1–1.5 \times 1–2 mm, coherent, truncate, deeply (2)3-

to 4-lobed, (2)3- to 4-androus (either mostly 3- or mostly 4-androus on different specimens); sterile flowers ca. 1 mm long, 1.3–3 × 1 mm diam. and ± elongated in direction of axis, coherent, truncate, subprismatic, in 6 to 7 whorls. Berries not known.

Phenology. Flowering is only known to occur in *Chlorospatha luteynii* during the months of April and October, with fruiting reported for October.

Discussion. *Chlorospatha luteynii* is known only from lower montane wet forest in the northern portion of the Cordillera Central in Antioquia Department, Colombia, at 2440–2800 m elevation and would be expected to occur elsewhere in the department on both sides of the Cordillera Central, possibly to the south into Caldas and on the eastern slopes of the Cordillera Occidental in Risaralda. *Chlorospatha luteynii* is a member of *Chlorospatha* sect. *Chlorospatha* and is distinguished by its deeply 5-lobed, dark green, conspicuously pale yellow-green maculate leaf blades that dry dark green to olive-green on both surfaces and more or less glossy on the lower surface, with the midrib and major venation almost black on both surfaces. The species is also distinguished by its petiole, which dries semiglossy, almost black, with the epidermis partially separated intact, and by its entirely pale green spathe. The spadix is noteworthy in having the fertile staminate portion much longer than the pistillate portion, almost twice as long. In *Chlorospatha*, the fertile staminate portion is usually shorter, weakly longer than or equal in length to the pistillate portion. The sterile staminate portion is also relatively long (1.4–1.6 cm) and densely flowered, with the sterile flowers markedly elongated in the direction of the axis to 3 mm long (as viewed from above).

Chlorospatha luteynii could be confused with *C. caldasensis*, which occurs to the south on the western slopes of the Cordillera Central in Caldas Department at similar elevations. Grayum (1986) predicted that *C. croatiana* subsp. *croatiana*, known only from Central America at 200–1173(–1400) m elevation, would ultimately be found in Colombia, and although that species and *C. luteynii* have 5-lobed leaf blades in common, *C. luteynii* should be considered distinct (see discussions under *C. caldasensis* and *C. croatiana* subsp. *croatiana*).

Additional specimens examined. COLOMBIA. **Antioquia:** Mpio. Sonsón, vía Sonsón–La Soledad, 1.1 km E of the branch in rd. leading N to La Morelia, vic. Manzanares, 2800 m, 8 Apr. 1988, *Callejas 6361* (HUA); Mpio. Caldas, vic. La Corrala, Finca La Zarza, 2440 m, 1 June 1988, *L. Escobar et al. 8482* (HUA).

43. *Chlorospatha macphersonii* Croat & L. P. Hannon, *Aroidiana* 27: 27. 2004. TYPE: Colombia. Antioquia: Mpio Jardín, vic. Ventanas, Jardín–Ventanas–Riosucio rd., ca. 19.3 km SSE of Jardín, at border with Caldas, forest at high point of rd. (Ventanas), 2830 m, 5°40'N, 75°47'W, 4 May 1989, *J. Luteyn & O. Escobar 12757* (holotype, NY!; isotypes, COL-343995!, HUA!). Figures 33C, D, 36C.

Terrestrial herb, 50–60 cm tall (all measurements made from dried material); stem occasionally weakly woody, decumbent, with remnants of old cataphylls persisting semi-intact at upper nodes; internodes 2–6 × 0.6–2 cm, drying finely wrinkled, matte to weakly glossy, pale-medium brown, occasionally weakly gray-tinged; cataphylls 12–18 cm long, acuminate at apex, drying matte to weakly glossy, medium reddish brown. LEAVES 3, erect-spreading; **petioles** 25–34 cm long, drying glabrous, matte, dark brown, frequently blackish toward apex, sheathed 21–26.5 cm, slightly more than 3/4 of total length; sheath free-ending at apex; free portion 2.5–4 mm diam. midway, sulcate; **blades** ovate-cordate, 17–25 × 9–12.5 cm, 1.7 to 2 times longer than wide, gradually or abruptly acuminate at apex, broadest at or slightly below middle, weakly broader across anterior lobe than at base (measured tip to tip across posterior lobes), rarely much broader, fleshy; upper surface weakly bullate, drying matte to weakly glossy, dark yellow-brown; lower surface reticulate, drying semiglossy, yellow-brown to yellow-green, weakly to moderately paler; anterior lobe 13–19 × 9–12.5 cm, 1.3 to 1.6 times longer than wide, (2.8 to)3.8 to 4.8 times longer than posterior lobes, broadest at or below middle, ± symmetrical to weakly inequilateral; posterior lobes directed toward the base, 3–5 × 3.5–5 cm, usually as wide as long, occasionally wider than long, bluntly to narrowly rounded at apex, broadest at base, the sinus oblong to narrowly V-shaped or closed with the lobes overlapping; sides ± symmetrical, the inner side acute to weakly rounded toward base, briefly attenuate and weakly confluent with opposite lobe, obscuring petiole apex; outer side weakly convex; all orders of venation ± sunken on upper surface, moderately to prominently raised, ± granular-puberulent on lower surface, drying ± raised, concolorous or weakly paler to weakly darker than surface, frequently tan-colored; midrib round-raised on lower surface; **basal veins** 4 to 5 branching off, 3 to 4 acroscopic, 1 to 2 basiscopic, the first usually free to the base, second and/or third fused, forming a short posterior rib 0.5–2 cm long; primary lateral veins 4 to 5 pairs, arising at 40°–60°, weakly arcuate; collective veins 3, the innermost arising from one of

the lowermost basal veins, loop-connected with all preceding lateral veins, moderately scalloped, 3–11 mm from margin. INFLORESCENCES erect, 2 to 3 per axil; peduncle held within the sheath, 17–20 cm \times 1–3 mm, drying matte, dark blackish brown; **spathe** erect, ca. 15 cm long, acuminate at apex; spathe tube green or greenish red on outer surface, 8–8.5 cm \times 6–7 mm, drying matte, dark blackish brown on outer surface, weakly glossy and red-tinged on inner surface; spathe blade whitish green to yellowish green on outer surface, ca. 6.3 cm \times 7–7.5 mm, drying weakly glossy, dark blackish brown on outer surface, weakly glossier on inner surface; **spadix** erect, ca. 12.2 cm long, sessile, adnate to spathe ca. 7.5 cm at base, the entire length of pistillate portion and onto sterile staminate portion ca. 7 mm; pistillate portion ca. 6.7 cm \times ca. 4 mm, weakly broadest midway; fertile staminate portion white, ca. 4.7 cm \times 3–4.5 mm, narrowly rounded at apex, clavate, drying medium-dark orangish brown; sterile staminate portion ca. 1.5 cm \times 2–3 mm, broadest at apex, with axis naked in basal 3 mm, drying medium-dark orangish brown; pistils \pm laxly arranged, ca. 3 across the axis (viewed from above), ca. 2 mm long; ovaries subglobose to \pm cylindrical, ca. 1–1.5 \times 1.5–2 mm, drying dark reddish brown; style Type 10 (Fig. 1), ca. 0.5 \times 1.5–1.8 mm, comprising 1/4 to 1/3 of the length of pistil, the margins not coherent with those of adjacent styles; **stigma** ca. 0.5 mm diam., weakly elevated on and weakly broader than narrowed portion of style; synandria 1–1.5 \times ca. 2 mm, coherent, truncate, (2)3- to 4-lobed, (2)3- to 4-androus (mostly 4); sterile flowers 1–1.5 \times 1.5–2 mm, weakly coherent, in 6 whorls, 2- to 5-branched, the branches truncate and broadest at apex, weakly narrower below. INFRUCTESCENCES 11–12.5 \times ca. 1 cm, drying matte, dark reddish brown (almost black) on outer surface; berries ca. 5 \times 5 mm, drying dark reddish brown.

Phenology. Flowering is only known to occur in *Chlorospatha macphersonii* during the months of May and October, with fruiting reported in October.

Discussion. *Chlorospatha macphersonii* is known only from the eastern slopes of the Cordillera Occidental, in the vicinity of Jardín, at the southern end of Antioquia Department, Colombia, near the borders with Caldas and Risaralda departments, at almost 3000 m elevation. The species occurs in premontane wet forest and premontane moist forest, possibly also in lower montane wet forest, and would be expected to occur elsewhere in Antioquia and in the adjoining departments to the south, possibly also on the western slopes.

Chlorospatha macphersonii is a member of *Chlorospatha* sect. *Occidentales* and is distinguished by its long internodes (2–6 cm long), long-sheathed petiole (more than three fourths of its length), with the sheath free-ending at the apex and ovate-cordate leaf blades that are weakly bullate on the upper surface and reticulate on the lower surface. Also noteworthy is the extraordinarily large inflorescence (ca. 15 cm long), although the plant is relatively small (50 cm tall). The inflorescences are half as long to nearly as long as the peduncles and some petioles. The species is also distinguished by its green to greenish red spathe tube and whitish to yellowish green spathe blade. The spadix is adnate to the spathe the entire length of the pistillate portion and half of the length of the sterile staminate portion, with briefly attenuated styles and 2- to 5-branched sterile flowers.

Chlorospatha macphersonii could possibly be confused with *C. munchiquensis* from the Parque Nacional Munchique on the western slopes in Cauca Department, at 2580 m elevation. Both species have long internodes, more or less bullate leaf blades, and large inflorescences. The petiole of *C. munchiquensis* is sheathed only one third of its length and the peduncle is short (13–15 cm long), thus differing from *C. macphersonii* in which the petiole is sheathed more than three fourths of its length and the peduncle is 17–20 cm long. The leaf blades of *C. munchiquensis* are ovate-sagittate, broadest at the base and dry dark brown, with the posterior lobes long, relative to the length of the anterior lobe (1.4 to 1.6 times longer than the posterior lobes), and six to eight pairs of primary lateral veins. The posterior lobes have straight, well-developed posterior ribs, with the inner margins decurrent onto the petiole (in mature plants). *Chlorospatha macphersonii* differs in having ovate-cordate blades that are broadest across the anterior lobe and dry yellow-brown, with short posterior lobes, the anterior lobe being 3.8 to 4.8 times longer, and four to five pairs of primary lateral veins. The posterior lobe has only a weak posterior rib and the inner margin is weakly confluent with the opposite lobe, thus obscuring the petiole apex. The lower surface of the blade dries semiglossy, with all orders of venation more or less raised, creating a distinct reticulate pattern. In *C. munchiquensis*, the lower surface dries weakly glossy and the reticulate venation is not prominent, thus the reticulate pattern is lacking. The inflorescence of *C. munchiquensis* is probably significantly smaller than that of *C. macphersonii*, the spathe tube of the flowering inflorescence of the latter species being 8–8.5 cm long, compared to the fully mature infructescence (spathe tube) of *C. munchiquensis*, which is only 6–8

cm long. The fruiting tube is typically twice the length of the pistillate portion of the flowering spadix in *C. macphersonii*. The spathe tube of the latter species is green and dark purple-tinged on the outer surface and entirely dark purple on the inner surface, whereas that of *C. macphersonii* is green or greenish red on the outer surface and the sterile staminate portion of the spadix is 1.5 cm long, with the sterile flowers 2- to 5-branched. The sterile staminate spadix of *C. munchiquensis* is half as long, with the sterile flowers subprismatic.

Additional specimen examined. COLOMBIA. **Antioquia:** Mpio. Jardín, S of Jardín, 2750 m, *McPherson et al. 12903* (HUA-58996, MO-3689997, see Figs. 36C and 33D, respectively).

44. *Chlorospatha maculata* Croat & L. P. Hannon, sp. nov. TYPE: Colombia. Chocó: along rd. betw. Pueblo Rico (Risaralda) & Istmina (Chocó), along Quebrada Antón, 15 km W of Santa Cecilia, 6 km W of Chocó-Risaralda border, ca. 20 km E of Playa del Oro, 240 m, 5°20'30"N, 76°13'45"W, 22 Feb. 1990, *Croat 70901* (holotype, MO-3780535!; isotypes, K!, US!). Figure 34A, B.

Herba usque ad ca. 1 m; internodia ca. 1.5 × 1–4 cm. Petiolus 35–90 cm long, vaginatus per (12–)23–43 cm; lamina foliaris profunde 3-loba, fere trisecta, 30–48 × 27–60 cm, lobo medio 25.5–40 × 11–19 cm, nervis primariis lateralibus utroque 7 ad 10 (in lobis lateralibus). Inflorescentiae 3 in quaque axilla; pedunculus usque ad ca. 43 cm × 1 mm; spatheae tubo 4.2–4.5 cm × ca. 5 mm.

Terrestrial herb, to ca. 1 m tall; stem erect, remnants of old cataphylls persisting semi-intact and ± fibrous at upper nodes; internodes ca. 1.5 × 1–4 cm, brown, scurfy (with old petiole bases), drying matte, dark brown (all measurements made from dried material); cataphylls (total length and apex not known) drying weakly glossy, medium-dark reddish brown, weakly fibrous. LEAVES 2 to 3, erect-spreading; **petioles** 35–90 cm long, brittle, glabrous, semiglossy, dark green, drying weakly glossy to semiglossy, dark reddish brown to almost black, rarely medium to dark greenish brown, sheathed (12–)23–43 cm, 1/2 to 2/3 of total length; sheath weakly free-ending at apex; free portion 4–6 mm diam. midway, terete, subterete, or convex on both surfaces with obtusely angular lateral margins toward apex; **blades** held spreading to erect-spreading, deeply 3-lobed, nearly trisect, 30–48 × 27–60 cm, 1.1 to 1.2 times wider than long, coriaceous, occasionally thinly coriaceous, moderately bicolorous; upper surface (of all lobes) broadly concave, matte, dark green, sparsely to moderately pale yellow-green maculate (macula-

tions small), drying matte to weakly glossy, dark brown, rarely pale olive-green, the maculations obscure; lower surface weakly glossy to semiglossy, drying weakly glossy to semiglossy, weakly to moderately paler, occasionally weakly gray-tinged; **medial lobe** 25.5–40 × 11–19 cm, 1.7 to 2.1 (to 2.6) times longer than wide, 1.1 to 1.3 times longer than lateral lobes, gradually or abruptly acuminate at apex, broadest midway, briefly attenuate (rarely long-attenuate) to cuneate toward base and narrowly attached, 1.5–2 cm wide at point of attachment, weakly inequilateral; **lateral lobes** oblique or directed weakly toward the apex, 22–33 × 7.3–12.5 cm, usually 2.5 to 3 times longer than wide, acuminate to occasionally acute at apex, broadest below middle, markedly inequilateral, the inner side always narrower, attenuate at base and confluent with medial lobe, the confluent portion 1–3 mm wide; outer side 4 to 7 times wider than inner side midway, weakly to broadly rounded toward base, rarely narrowly rounded, frequently overlapping opposite lobe, abruptly attenuate onto posterior rib; midrib and major venation narrowly sunken on upper surface, paler than surface, drying concolorous to weakly paler than surface, round-raised on lower surface, drying ± flattened, moderately to conspicuously darker than surface; posterior rib naked 1–2 cm per side, convex on lower surface; primary lateral veins (of medial lobe) 6 to 8 pairs, arising at 35°–48°, most acutely toward apex, straight to weakly arcuate, convex on lower surface; primary lateral veins (of lateral lobes) 7 to 10 pairs (lowermost 1 to 2 pairs occasionally fused at base), with most aggregated in basal 1/3, arising at 35°–90°(–110°), most acutely toward apex, weakly to moderately arcuate; secondary veins in part narrowly sunken on upper surface, drying entirely or in part weakly raised or prominulous on lower surface, otherwise flattened, weakly darker than surface; tertiary veins usually flat on lower surface, occasionally weakly raised, darker than surface, drying ± obscure, occasionally in part weakly prominulous; reticulate veins obscure; collective veins 3, the innermost arising from one of the lowermost lateral veins at base, loop-connected with all preceding lateral veins, moderately scalloped, 3–13 mm from margin. INFLORESCENCES erect, to 3 per axil; peduncle held within the sheath, to ca. 43 cm × 1 mm, drying weakly glossy, blackish brown; **spathe** total length and apex not known; spathe tube yellow-green to greenish yellow, 4.2–4.5 cm × ca. 5 mm; spathe blade not known; **spadix** in part known; fertile staminate portion white. INFRUCTESCENCES medium green, 6–10 × 1–1.5 cm; berries ca. 5 across



Figure 34. *Chlorospatha maculata* Croat & L. P. Hannon, photos of the holotype Croat 70901 (MO). —A. Fertile habit. Note inflorescence in foreground. —B. Leaf blade adaxial surface.

the axis (viewed from above), drying creamy white, 2–5 mm diam.; seeds drying pale tan.

Phenology. The only available fertile material of *Chlorospatha maculata* was a fruiting spadix collected in February.

Etymology. The epithet is taken from the Latin “maculatus,” meaning “spotted” or “blotched,” referring to the spotted blade of *Chlorospatha maculata*.

Discussion. *Chlorospatha maculata* is known only from Chocó Department, Colombia, at 240–825 m elevation, in tropical rainforest, premontane rainforest, premontane wet forest, and lower montane wet forest on the western slopes of the Cordillera Occidental. Entirely green leaves, brittle petioles, and subcoriaceous, 3-lobed blades that are matte, maculate, and not at all quilted on the upper surface distinguish the species, a member of *Chlorospatha* sect. *Chlorospatha*. All segments are broadly concave on the upper sides (observed in photographs), a condition not previously observed in the genus, possibly resulting from the considerable thickness of the blade. It is possible that the label notes are

incorrect in this regard and that the blade is coriaceous rather than subcoriaceous. The apex of all lobes is directed above the horizontal plane, relative to the base, and the major venation is paler than the upper surface and only narrowly sunken.

Chlorospatha maculata would be most easily confused with *C. mirabilis*, which differs in having the petiole spongy and purple, the blades more or less purple on the lower surface and somewhat glossy on the upper surface, and the segments convex and quilted. The leaves of *C. maculata* are either entirely green or maculate, with the petiole brittle, the blades matte on the upper surface, not at all quilted, and the segments broadly concave. The lateral lobes of *C. maculata* have more primary lateral veins (in mature specimens), seven to 10 pairs versus three to six pairs in *C. mirabilis*, with the veins aggregated in the basal one third in *C. maculata* and evenly distributed in *C. mirabilis*.

Chlorospatha maculata might also be confused with another species that occurs in Chocó, *C. chocoensis* (see discussion under *C. chocoensis*).

The two additional specimens cited are sterile and differ from the type. *M. Grayum et al.* 7634 dries gray-tinged green on both surfaces. The blades of

Croat 57304A are reported as thin and the petioles as soft. However, the leaves of both specimens are entirely green, with the blades matte on the upper surface and more primary lateral veins on all segments than are found in *C. mirabilis*, with those on the lateral lobes being aggregated in the basal one third.

In *Exotica 3* (Graf, 1963), a plant is pictured that is incorrectly identified as *Chlorospatha maculata*. The binomial, *C. maculata*, had not been published at that time and is being published here for the first time. The brief description of the plant indicates that the petiole and lower surface of the blade are purple, precluding the possibility that the pictured plant is *C. maculata*. The plant is of Colombian origin, according to the text, and is possibly *C. mirabilis*.

Paratypes. COLOMBIA. **Chocó:** Quibdó-Bolívar rd., 97 km E of Quibdó, near Km. 155, 500 m, 5°44'N, 76°27'W, 11 Mar. 1984, *Croat 57304A* (MO); Quebrada La Asquerosa, ca. 16 km beyond El Siete along Ciudad Bolívar-Quibdó rd., 825 m, 5°45'N, 76°22'W, 8 July 1986, *M. Grayum, B. Hammel, J. Kress & G. Brown 7634* (MO).

45. *Chlorospatha mansellii* Croat & L. P. Hannon, sp. nov. TYPE: Ecuador. Esmeraldas: Lita-San Lorenzo rd., 9.8 km W of old Río Lita bridge at Lita (prior to 1999), 701 m, 0°52'59"N, 78°30'49"W, 6 Mar. 1997, *L. P. Hannon 97-361* (holotype, MO-5291337!; isotypes, AAU!, B!, CAS!, COL!, CUV!, F!, HUA!, K!, MEXU!, NY!, RSA!, US!). Figures 35A–D, 36A, B.

Herba usque ad 60 cm; internodia 1–2.5 × 1.8–2.2 cm; cataphylla 12–26 cm longa. Petiolus 27–47 cm longus, vaginatus per 15–29 cm; lamina foliaris subhastata, 18.5–26 × 14–16 cm, lobis posterioribus 9–12 × 5.5–6.5 cm, nervis primariis lateralibus utroque 4 ad 6. Inflorescentiae 6 in quaque axilla; pedunculus 21–30 cm × 2–4(5) mm; spatha erecta, 9.5–12.2 cm × 7–10 mm; spadix 8.8–11 cm longus.

Terrestrial herb, to 60 cm tall; stem decumbent, erect 10–15 cm, remnants of old leaf bases persisting as a few short fibers at upper nodes; sap milky; internodes 1–2.5 × 1.8–2.2 cm, weakly glossy, pale to medium green, becoming brownish with age, drying matte, medium brown; cataphylls ultimately deciduous, 12–26 cm long, acuminate at apex, obtusely 1-ribbed and matte, medium green on outer surface, weakly glossy and conspicuously paler on inner surface, drying matte, medium brown. LEAVES 3 to 6, erect-spreading; **petioles** 27–47 cm long, glabrous, matte, medium to dark green, darkest and occasionally with a glaucous bloom toward base, drying matte to weakly glossy, medium to dark brown, rarely greenish, sheathed 15–29 cm, ca. 1/2 of total

length (rarely to 2/3); sheath decurrent at apex; free portion ca. 6 mm diam. midway, occasionally in part terete midway and otherwise in part or entirely obtusely D-shaped or U-shaped, broadly and obtusely sulcate, frequently with margins bluntly acute in apical 8–10 cm; **blades** held horizontally, weakly to moderately subhastate, usually hastate on drying, 18.5–26 × 14–16 cm, 1.2 to 1.8 times longer than wide, briefly acuminate to occasionally broadly acuminate at apex, broadest at base, 1 to 1.5 times wider at base than across anterior lobe (measured tip to tip across posterior lobes), frequently weakly to moderately constricted on one side in area of petiole attachment, thin, conspicuously bicolorous; upper surface weakly quilted, weakly glossy with a subvelvety sheen, medium to dark green, drying matte to weakly glossy, dark green or brownish green; lower surface reticulate, matte, and obscurely narrowly minutely colliculate along all orders of venation, otherwise weakly glossy to semiglossy, frequently yellowish, drying weakly glossy to semiglossy, moderately paler; anterior lobe 14–17.5 × 11.5–14.5 cm, 1.2 to 1.3 times longer than wide, 1.5 to 1.6 times longer than posterior lobes, broadest near base, ± symmetrical; posterior lobes directed somewhat outward, 9–12 × 5.5–6.5 cm, 1.6 to 2 times longer than wide, bluntly acute to narrowly rounded at apex, broadest at or near base, ± symmetrical, the inner side weakly to broadly rounded toward base, usually overlapping that of opposite lobe, obliquely attached or abruptly attenuate onto posterior rib, rarely decurrent onto petiole (on one side); outer side ± straight to weakly concave toward base; midrib and major veins weakly narrowly convex and weakly sunken on upper surface, weakly paler than surface, drying paler than surface, narrowly raised to round-raised on lower surface, matte, weakly paler than surface, drying weakly raised and ± flattened, concolorous to weakly darker than surface; **basal veins** 3 to 5 pairs, coalesced into a prominent posterior rib; posterior rib naked 3–10 mm per side (rarely not at all on one side); primary lateral veins 4 to 6 pairs, arising at 45°–55°, weakly to moderately arcuate; secondary veins in part obtusely sunken on upper surface, raised on lower surface, drying weakly raised, concolorous to weakly darker than surface; tertiary veins prominulous on lower surface, drying prominulous, concolorous to weakly darker than surface; reticulate veins entirely or in part prominulous and otherwise visible and distinct on lower surface, drying in part weakly prominulous, otherwise visible, distinct, concolorous to weakly darker than surface; collective veins 2 to 3, the innermost arising from one of the lowermost



Figure 35. *Chlorospatha mansellii* Croat & L. P. Hannon. —A. Paratype collection, *Croat et al.* 82143 (MO), plant removed from soil and leaning against roadside boulder. —B. Plant habit, showing adaxial blade surfaces. —C. Close-up of cultivated plant, with inflorescence at anthesis in frontal view at center. —D. Entire plant, with cultivar in flower. B–D photographed from the type collection *L. P. Hannon* 97-361 (MO).

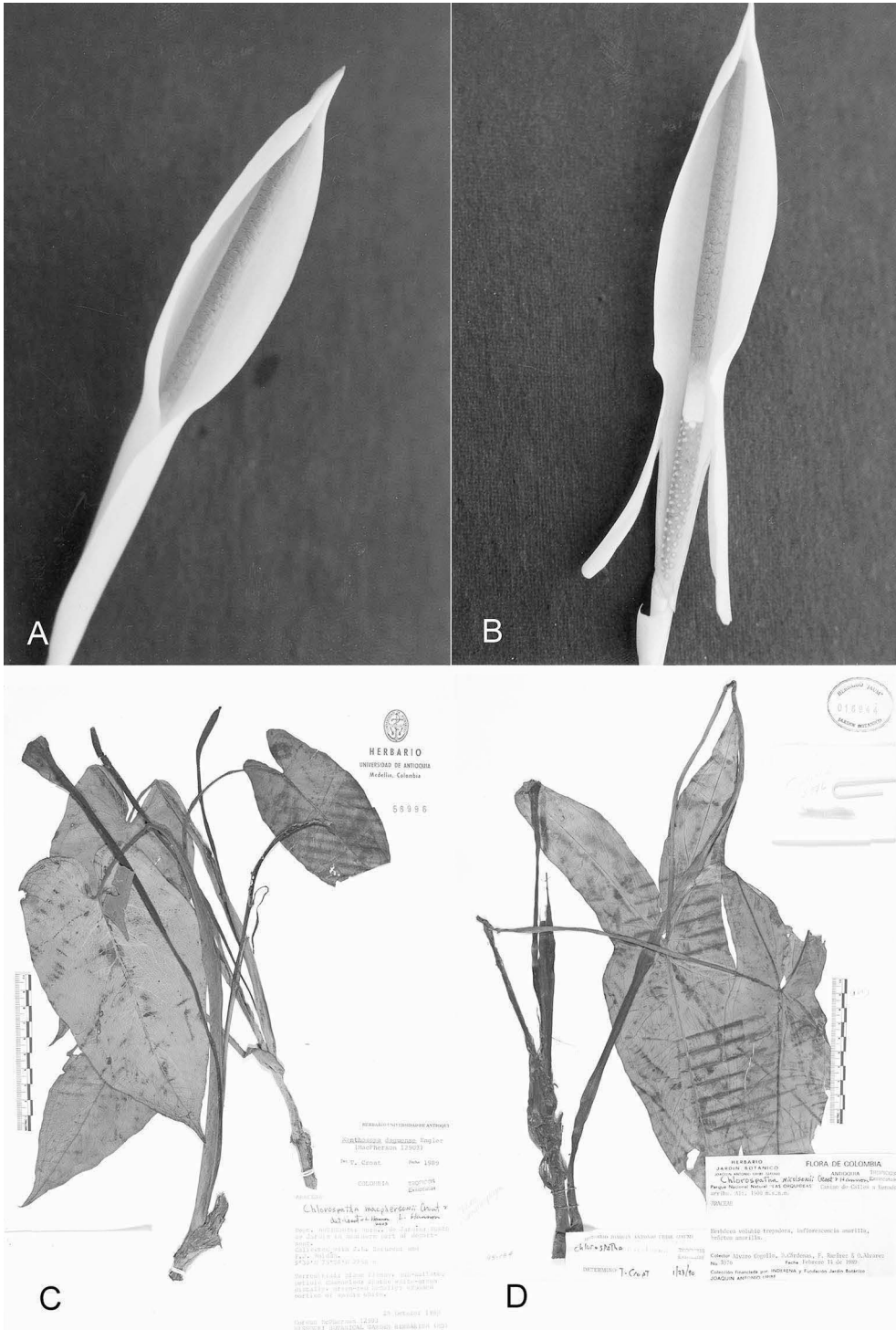


Figure 36. A, B. *Chlorospatha mansellii* Croat & L. P. Hannon, from the holotype L. P. Hannon 97-361 (MO). —A. Inflorescence near anthesis. —B. Inflorescence near anthesis, with spathe tube cut open. —C. *Chlorospatha macphersonii* Croat & L. P. Hannon, herbarium specimen McPherson et al. 12903 (HUA-58996). —D. *Chlorospatha nicolsonii* Croat & L. P. Hannon, herbarium specimen Cogollo et al. 3976 (JAUM-16944).

lateral veins on inner side of posterior lobe, loop-connected with all preceding lateral veins, weakly scalloped, 3–7 mm from margin. INFLORESCENCES erect, to 6 per axil, emitting a sweet or spicy-fruity fragrance at anthesis; peduncle held within the sheath, 21–30 cm \times 2–4(5) mm, thicker than broad, markedly so at apex (5 mm thick, 2 mm wide), occasionally broader than thick, narrowest toward base, matte to weakly glossy, pale green to pale yellow-green, drying matte to weakly glossy, medium-dark to dark green or brown; **spathe** erect, 9.5–12.2 cm long, lanceolate, \pm acute to weakly cuspidate at apex; spathe tube matte, greenish cream to pale yellowish green, narrowly paler at margins on outer surface, weakly glossy to glossy on inner surface, 4.2–6 cm \times 7–10 mm, thicker than broad, opening narrowly at apex at anthesis, drying matte, medium to dark (rarely pale) brown or greenish brown on outer surface, weakly glossy and weakly to moderately paler on inner surface; spathe blade weakly glossy to semiglossy, cream-colored, narrowly pale yellow-green medially on outer surface, matte on inner surface, 5.5–6.2 \times ca. 1 cm, to 3 cm wide at base (flattened), obtusely 1-ribbed abaxially (rib bluntly acute in apical 2 cm), drying matte to weakly glossy, occasionally in part semiglossy, brownish to greenish brown-cream on outer surface, matte on inner surface, opening broadly at anthesis, with margins narrowly out-rolled, marcescent, erect after anthesis; **spadix** erect, 8.8–11 cm long (slightly shorter than spathe), sessile, adnate to spathe ca. 2.6–4 cm at base, most or all of the length of pistillate portion; pistillate portion pinkish orange, 2.7–4 cm \times 3–4 mm, broadest toward apex, drying medium to dark pinkish to purplish brown; fertile staminate portion bright orange, 5–6 cm \times 4–5 mm, weakly thicker than broad, acute to bluntly acute at apex, broadest just above base, tapering, drying dark orangish brown; sterile staminate portion yellowish cream at base, yellowish orange toward apex, 5–10 \times 1.8–4 mm, cylindrical or weakly narrowest midway, drying cream to orangish brown; pistils weakly coherent, 4(5) across the axis (viewed from above), 1.2–1.6 mm long; ovaries white (drying creamy white), \pm subglobose, obtusely truncate at apex, 1.5–2 mm diam., 2(3)-locular, with axile placentation, 8 to 10 ovules per locule, hemianatropous, biseriolate; funicles shorter than ovules; style Type 9 (Fig. 1), ca. 0.5 \times 1.5–2 mm, comprising 1/3 or less of the length of pistil, moderately broader than ovary apex, the margins \pm coherent with those of adjacent styles; red chromoplasts present; **stigma** white or cream, 0.5–0.7 mm diam., elevated on and weakly broader than narrowed portion of style; synandria 1–1.2 \times ca.

2 mm, coherent, truncate, deeply 3- to 4-lobed, 3- to 4-androus, with most flowers in apical 2 to 3 whorls lacking microsporangia; sterile flowers ca. 1 mm long, 2 \times 1 mm diam. and \pm elongated in direction of axis, coherent, truncate, irregularly subprismatic, in 5 to 8 whorls. Berries not known.

Phenology. Flowering is only known to occur in *Chlorospatha mansellii* during October and November. The species is known from only two sterile collections made in March and June, one of which later flowered in cultivation. Inflorescences are fragrant and emerge in slow progression, with several days between anthesis of one inflorescence and emergence of the next inflorescence at the apex of the petiole sheath. The cultivated specimen, observed over a period of six years, consistently flowered only during those two months.

Etymology. *Chlorospatha mansellii* is named for Dr. Richard Mansell, participant in several expeditions to Ecuador with the authors, and collaborator on the Flora of Ecuador and the Flora of Lita–San Lorenzo.

Discussion. *Chlorospatha mansellii* is known only from premontane wet forest on the western slopes of the Andes, in the vicinity of Lita in Esmeraldas Province in northern Ecuador, at 647–701 m elevation. The species is a member of *Chlorospatha* sect. *Occidentales*.

Chlorospatha mansellii might be confused with *C. besseae*, a sympatric species, also with *C. dodsonii*, which is sympatric with *C. mansellii* and *C. besseae* in the Lita–San Lorenzo region, with *C. mansellii* appearing to be intermediate between the two species and possibly a primary hybrid, sharing some intact characters of each as well as characters that would appear to be intermediate between those of the other two species (see discussions under *C. mansellii* and *C. besseae*).

The vegetative morphology of *Chlorospatha mansellii* also appears to be intermediate. The leaf blades of *C. dodsonii* are prominently hastate in both living and dried material, with the anterior and posterior lobes usually markedly constricted at the base and the posterior lobes usually about as long as the anterior lobe and acute at the apex. The blades of *C. besseae* are cordate, with the posterior lobes directed toward the base, not constricted, much shorter than the anterior lobe and rounded at the apex. In *C. mansellii*, the blades are intermediate, being weakly to moderately subhastate, constricted on one side or not at all, with the posterior lobes somewhat shorter than the anterior lobe and more or less acute at the

apex. Both *C. mansellii* and *C. besseae* have blades with four to five pairs of primary lateral veins, whereas those of *C. dodsonii* usually have six to eight pairs. In *C. mansellii* and *C. besseae*, the lower surface of the blade is narrowly colliculate along all abaxial venation, with the condition less pronounced in *C. mansellii* and more or less lacking in *C. dodsonii*. Consideration of all of the above poses the interesting possibility of hybridization in *Chlorospatha*, a phenomenon not previously explored or encountered.

Paratype. ECUADOR. **Esmeraldas:** Lita–San Lorenzo rd., 3.7 km W of old Río Lita bridge (below Lita, prior to 1999), 647 m, 0°52'51"N, 78°28'30"W, 30 June 1998, Croat, R. Mansell, L. P. Hannon & J. Whitehill 82143 (MO, QCNE).

46. *Chlorospatha mirabilis* (Mast.) Madison, Selbyana 5(3–4): 351. 1981. Basionym: *Xanthosoma mirabile* Mast. Gard. Chron., n.s. 1874(2): 258, tab. 53, 54. 1874. TYPE: Colombia. Tab. 53 in Masters, 1874: 258–259. Tropical South America, s.d., *B. Roezl s.n.*, cultivated by nurserymen Carter & Bull, at Kew Gardens (type, tab. 53 in Masters, 1874). Figures 37A, B, 38A.

Terrestrial herb, to 1.5 m tall; stem erect, in part subterranean, elongate, with remnants of old cataphylls persisting \pm intact at a few upper nodes; sap milky; internodes 5–12 mm \times 1–3 cm, scurfy brown, drying ca. 2 cm diam.; cataphylls ultimately deciduous, 17–25 cm long, obtuse with acumen at apex, purplish, obtusely 1-ribbed abaxially in apical 1/4 to 1/2, drying weakly glossy to semiglossy, medium-dark to dark reddish brown. LEAVES 1 to 3, erect-spreading; **petioles** (23–)33–96(–125) cm long, moderately spongy, glabrous, matte to weakly glossy, entirely dark purple or purple-tinged, or in part medium to dark olive-green in apical 1/3 to 2/3, occasionally with a glaucous bloom toward base, drying weakly glossy to semiglossy, dark brown to occasionally blackish brown, sheathed 30–69 cm, (1/3 to)1/2 to 2/3 of total length; sheath decurrent or free-ending at apex, occasionally with sides minutely many-ribbed; free portion 6–12 mm diam. midway, subterete, obtusely or sharply flattened adaxially, with margins acute to acutely ribbed or obtuse throughout and acute toward apex, frequently 1-ribbed medially, rarely obtusely and shallowly sulcate in apical 1/3; **blades** deeply 3-lobed, rarely trisect, 30–54 \times 30–75 cm, 1 to 1.4 times wider than long, thinly coriaceous to subcoriaceous, moderately bicolorous; upper surface semiglossy to glossy, dark green, with or without irregular white, cream, yellowish, or pale green

maculations, drying weakly glossy to semiglossy, dark green or olive-green to brownish green or weakly reddish brown, the maculations weakly to moderately paler; lower surface weakly glossy to semiglossy, entirely purple to purple-violet, or green to yellow-green and entirely irregularly or moderately to heavily purple-tinged medially, drying semiglossy to glossy, weakly to moderately paler; **medial lobe** ovate to elliptic, (20–)27–44.5 \times 11–24 cm, 1.9 to 2.9 times longer than wide, (1 to)1.2 to 1.5 times longer than lateral lobes, acute to weakly acuminate at apex, broadest at or below middle, cuneate (rarely weakly attenuate) toward and narrowly attached at base, 1.2–4.5 cm wide at point of attachment, \pm symmetrical, the margins rarely weakly sinuate; **lateral lobes** oblique or directed toward apex, (15.5–)22–42 \times (3.5–)6.5–20 cm, 1.7 to 3.6(to 4.3) times longer than wide, acute to weakly acuminate at apex, rarely bluntly acute, broadest at or below middle, usually markedly inequilateral, the inner side always narrower, long-attenuate (rarely straight) toward base, moderately to markedly narrowly confluent with medial lobe, confluent portion 2–5(–10) mm wide, rarely free to the base and not at all confluent; outer side 3 to 9 times wider than inner side midway, broadly rounded at base, occasionally weakly rounded, obliquely attached or abruptly attenuate onto posterior rib, rarely with a weakly developed auricle 7 \times 7 cm and narrowly rounded at apex; midrib and major veins usually purple on lower surface, drying \pm flattened; midrib obtusely to deeply sunken on upper surface, concolorous to weakly paler than surface, round-raised to narrowly rounded on lower surface, occasionally acutely angular on lateral lobes, drying moderately to prominently darker than surface; posterior rib naked 0.5–1.5(–2) cm per side; primary lateral veins (of all lobes) 3 to 6(7) pairs, arising at 30°–45°, weakly to moderately arcuate, occasionally straight, weakly to deeply sunken on upper surface, convex to round-raised on lower surface, occasionally purple-striped, drying weakly to prominently darker than surface; secondary veins obtusely sunken on upper surface, raised on lower surface, purple or green, drying \pm flattened, concolorous to weakly darker than surface, or entirely green and paler than surface; tertiary veins entirely prominulous or in part moderately or weakly raised and otherwise prominulous on lower surface, purple or green, drying in part weakly prominulous, otherwise flat, brownish and weakly darker than surface, or green and weakly paler than surface; reticulate veins obscure; collective veins 3, the innermost arising from one of the lowermost lateral veins at base, loop-connected with all preceding lateral veins, markedly scalloped (in mature specimens), 3–



Figure 37. *Chlorospatha mirabilis* (Mast.) Madison, cultivated accession at Munich, *E. Spear s.n.* (M). —A. Cultivated plant showing the maculation present on the adaxial leaf blade surface. —B. Cultivar, with the erect anthesal inflorescence emerging from the terminal axil below the trilobed, maculate blade. Photos by J. Bogner.

25 mm from margin. INFLORESCENCES erect, 3 or 4 per axil, emitting a weak, fruity fragrance at anthesis; peduncle held within the sheath, 30–59 cm × 2–4 mm, trigonous or cylindroid and broader than thick, glossy, medium yellow-green most of length, matte to weakly glossy in apical 2.5 cm, drying matte to weakly glossy, dark brown to blackish brown; **spathe** erect, curved forward, (7–)8–15.5 cm long, acuminate or cuspidate at apex, cucullate at anthesis, acutely 1-ribbed in apical 1.5 cm abaxially, ± tubular or narrowly funnel-shaped at anthesis and opening 2/3 to nearly 3/4 of its length, curved prominently forward post-anthesis; spathe tube matte or weakly glossy to glossy, medium green to yellow-green on outer surface, glossy to semiglossy on inner surface, moderately to prominently paler, rarely dark purple, (3.5–4)4.5–7.5 cm × 6–10 mm, drying weakly glossy, medium green or dark brown to reddish brown on outer surface, usually weakly paler on inner surface, rarely dark purplish; spathe blade broadly elliptical (flattened), matte or weakly glossy to glossy, yellow, medium green to yellow-green, or whitish green on outer surface, matte and weakly paler on inner surface, (3–)4–7 × ca. 1 cm, drying 6–7 mm diam., matte to weakly glossy,

tan to dark brown, opening ± broadly at anthesis, with margins directed forward, in-rolled in apical 2.5 cm, marcescent, erect after anthesis; **spadix** erect, curved forward with spathe, (5.5–)6.5–10.1 cm long, sessile, adnate to spathe (1.2–)1.7–3.7 cm at base, ca. 1/2 to 3/4 of the length of pistillate portion; pistillate portion ± ellipsoid, pink, pale yellow, cream, or pale orange, (2–)3–5 cm long, 3–6 mm diam. (dry), broadest at or just above middle, drying pink to orangish tan; fertile staminate portion white, greenish white, creamy tan or cream and weakly pink-tinged at anthesis (*Croat & Mora 83686*), (1.8–)2.6–3.6 cm × 4–5 mm, ± cylindrical, narrowly rounded at apex, weakly narrowed at base, drying pale yellow-tan to medium-dark or dark brown; sterile staminate portion greenish cream, (1.5–)1.7–2.4 cm × 2–5 mm, ± cylindrical or weakly broadest at base, drying creamy tan, rarely dark tan; pistils weakly coherent to ± laxly arranged, or ± densely arranged (*Croat & Mora 83686*), 4 to 6 across the axis (viewed from above), ca. 1.8–2.3 mm long; ovaries irregularly subcuboidal or cylindrical, (1–)1.5–2 mm diam., weakly narrower and truncate at apex, drying ± white, dark purple at apex and irregularly purple along the sides, or frequently

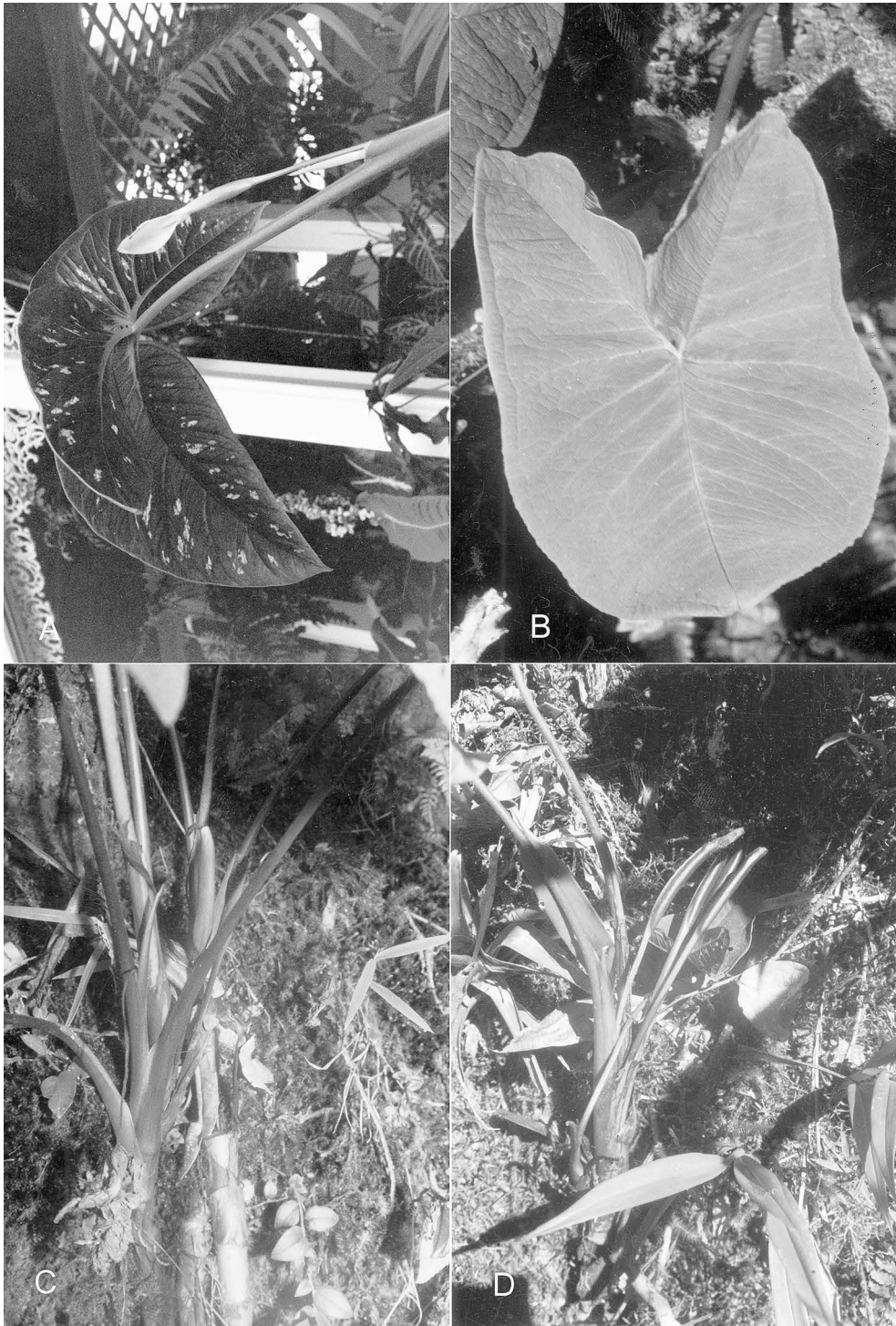


Figure 38. —A. *Chlorospatha mirabilis* (Mast.) Madison, *E. Spear s.n.* (M). Cultivated plant with inflorescence at anthesis. Photo by J. Bogner. B–D. *Chlorospatha munchiquensis* Croat & L. P. Hannon, from the holotype *Croat & Gaskin 80042* (MO). — B. Leaf blade adaxial surface. —C. Stems with pre-anthesis inflorescence. —D. Stem with four infructescences from the same axil.

entirely creamy white to creamy tan, with or without darker reddish veins, 3- to 4(5 to 6)-locular, with axile placentation (mainly in basal 2/3, *Croat & Mora 83686*); ovules numerous or 8 to 12 per locule (*Croat & Mora 83686*), biseriate, hemianatropous, micropyle superior; funicles longer than ovules; style Type 3 (Fig. 1), (1-)1.5-2 mm diam., weakly broader than ovary apex, rarely weakly narrower (*Croat & Mora 83686*), the margins irregularly weakly sinuate and weakly or not at all coherent with those of adjacent styles; **stigma** purplish or pink (*Croat & Mora 83686*), disklike, 0.5-1 mm diam., ca. 1/2 as wide as style, sessile, obtusely truncate, drying orangish tan; synandria, ca. 1-1.8 × 1-1.8 mm diam., frequently ± elongated in direction of axis in basal 2 to 4 whorls, coherent, truncate, deeply (2)3- to 4(5)-lobed, 3- to 4(5)-androus (mostly 3 or mostly 4 on different plants); pollen cream-colored; sterile flowers 0.2-0.5 mm long, (1-)2-3 × 1-1.5 mm diam. and ± elongated in direction of axis, laxly arranged (rarely weakly coherent), truncate, subprismatic, in 7 to 9(11) whorls, frequently drying with weakly darker brownish speckles. INFRUCTESCENCE dark green on outer surface, pale green on inner surface; berries pale green. JUVENILE plants with leaf blades entire, elliptical or frequently with small lobes at the base of medial lobe, or with well-developed lateral lobes weakly confluent with medial lobe.

Phenology. Flowering is only known to occur in *Chlorospatha mirabilis* during the months of February, April, June, July, and August.

Discussion. Prior to this treatment, *Chlorospatha mirabilis* was known only from the type, an illustration in *Gardeners' Chronicle*, and two herbarium specimens, none of which indicated a specific locality within tropical South America or Colombia. *Chlorospatha mirabilis* is known only from sea level to 900 m elevation in tropical rainforest and premontane rainforest on the western slopes of the Andes in Antioquia and Chocó departments, Colombia, and in transitional forest between tropical wet forest and premontane rainforest in Valle Department. The species also presumably occurs in southern Panama, in Darién Province, at 550-1400 m elevation, in tropical wet forest and premontane rainforest. As Madison (1981) rightly noted, the *Forget s.n.* collection sent from Peru was probably not collected in Peru, no collections of *C. mirabilis* having been made south of the aforementioned localities in Colombia. The collections from Panama are somewhat problematic, all being sterile and somewhat geographically isolated from the Colombian collections, with some from well above the elevations

recorded for most of the Colombian collections, however, and all appear to accord with *C. mirabilis*.

Chlorospatha mirabilis, a member of *Chlorospatha* sect. *Chlorospatha*, is a robust plant (to 1.5 m tall) distinguished by its deeply 3-lobed to nearly trisect and usually maculate leaf blades that are semiglossy to glossy on the upper surface and purple or purplish on the lower surface, with the petiole also purple. The species is also distinguished by its large inflorescence (to 15 cm long in mature specimens) with the sterile staminate portion of the spadix comprising about one third of the total length, an uncommon condition in *Chlorospatha*. The most densely arranged pistils in the genus were observed in one collection of the species, *Croat & Mora 83686*, wherein the ovaries of all flowers except those in a few apical and basal whorls were coherent most of their lengths, similar to those of *Xanthosoma*.

Chlorospatha mirabilis would be most easily confused with two species that also occur at low elevations in Chocó, *C. chocoensis* and *C. maculata*, and might eventually prove to be conspecific with one or both (see discussions under *C. chocoensis* and *C. maculata*). *Chlorospatha chocoensis* differs in having the petiole sheathed one third of its length, with the free portion terete; in *C. mirabilis*, the petiole is sheathed for a longer length, one half to two thirds, with its free portion sharply or obtusely flattened adaxially and the blades nearly almost trisect (rarely trisect). The posterior rib is naked 0.5-2 cm per side in *C. mirabilis*, but is not naked in *C. chocoensis*. The posterior rib is not naked and the blades in *C. mirabilis* are 3-lobed to nearly trisect (rarely trisect) and broadly confluent between segments (confluent portion 3.5-4 cm wide vs. less than 1 cm) in *C. mirabilis*, with the lateral segments only moderately inequilateral. The inflorescence of *C. chocoensis* is smaller, with the peduncles shorter (16-18 cm long vs. 30-59 cm in *C. mirabilis*). The spathe and spadix of *C. mirabilis* are longer, with the sterile staminate portion of the spadix comprising about one third of the total length (vs. one fourth in *C. chocoensis*), and the sterile flowers subprismatic. In *C. chocoensis*, the sterile flowers are fungiform and resemble toadstools (vs. cylindrical or weakly broadest at base in *C. mirabilis*), broadest at the apex and broadly concave medially, with deeply sinuate margins.

Chlorospatha mirabilis might be confused with *C. cogolloi* (see discussion under the latter Colombian species). The single collection of *C. mirabilis* cited from Antioquia, *Callejas et al. 6742*, appears to be somewhat intermediate between *C. mirabilis* and *C. cogolloi*. It was collected at higher elevations (approx. 900 m) north of the type locality of *C. cogolloi*, which

occurs only above 1200 m. All other Colombian collections of *C. mirabilis* were made at or below 150 m. *Callejas et al.* 6742 differs from the typical form of *C. mirabilis* in having the sterile staminate portion of the spadix comprising only one fourth of the total length, with the sterile flowers coherent, and therefore, possibly represents another taxon or an atypical specimen of *C. cogolloi*.

Chlorospatha maculata differs from *C. mirabilis* in having entirely green leaves, a brittle petiole, and subcoriaceous blades that are matte and not at all quilted on the upper surface, with the midrib and major veins only narrowly sunken. All segments are broadly concave on the upper surface (observed in photographs), a condition not previously observed in the genus, possibly resulting from the considerable thickness of the blade. The lateral lobes of *C. maculata* have more primary lateral veins (in mature specimens), seven to 10 pairs versus three to six pairs in *C. mirabilis*, with the veins aggregated in the basal one third in *C. maculata*, but evenly distributed in *C. mirabilis*.

It is noteworthy that all species with which *Chlorospatha mirabilis* might be confused are members of *Chlorospatha* sect. *Chlorospatha*. Among these is *C. ilensis*, known only from the western slopes of the Andes in Ecuador. There are no collections of either species, intermediate forms, or other species in section *Chlorospatha* in Ecuador.

The leaf blades of *Croat & Bay* 75777 and *Croat & Watt* 71002 differ from those of the other collections in lacking maculations. It is possibly significant that these and all other collections except *Hort. Veitch s.n.* have no purple in the spathe tube. *Croat & Watt* 71002 is distinctive in having the secondary and tertiary venation green on the lower surface, in both living and dried material, contrasting with the purple laminar surface. The blades of this collection dry only weakly bicolorous and the medial lobe is unusually narrow.

Additional specimens examined. COLOMBIA. S. loc., sent by Kalbreyer to Hort. Veitch, 17 Apr. 1882, s. coll. (K). **Antióquia:** Mpio. Frontino, La Blanquita distr., Murri region, 14.5 km W of Nutibara on Nutibara-La Blanquita rd., 890–900 m, *R. Callejas et al.* 6742 (HUA). **Chocó:** Serranía de Baudó, along Las Ánimas–Pató rd., on Río Pató, ca. 4 km SW of Pató, on property of Sr. Gutiérrez, 150 m, *Croat* 56133 (MO); vic. El Amargal, vic. Nuquí, 20–50 m, *Croat & Mora* 83686 (COL, MO, US) (= *Mora* 304 [COL, MO]); near jct. of Río Condoto & Río San Juan, 100–150 m, *E. Killip* 35091 (COL, US); Cabo Corrientes, Est. Biol. El Amargal, near sea level, *Mora* 161 (KKK, MO). **Valle:** Mpio. Buenaventura, Bajo Calima region, along Buenaventura–Málaga rd., Km. 51.3, less than 100 m, *Croat & Watt* 70380 (MO), 100 m, *Croat & Watt* 71002 (HUA, MO), Km. 51.7, 100 m, *Croat & Bay* 75777 (CUVC, MO); vic. of Bahía Málaga, Málaga Naval Base, Río Bongito, 40 m, *Croat &*

Watt 80503 (K, MO, US). PANAMA. **Darién:** middle slopes of W side of Cerro Pirre, 550–760 m, *Croat* 68888 (MO); Parque Nac. Darién, slopes of Cerro Mali, 22 km E of Púculo, 1300–1400 m, *H. Cuadros et al.* 3930 (MO); Parque Nac. Darién, near N & S branches of Río Púculo, N of Tacarcuna, 18 km E of Púculo, 600–800 m, *Hammel et al.* 16472 (MO). PERU.

Cultivated specimens examined. COLOMBIA. 1980, *E. Spear s.n.* (M).

47. *Chlorospatha morae* Croat & L. P. Hannon, sp. nov. TYPE: Colombia. Chocó: Mpio. Tadó, vic. Gingaraba, 26 Oct. 1991, *G. Lozano-C. & students* 6291 (holotype, COL-378032!). Figures 27D, 29D.

Herba ca. 1 m; internodia ca. 1 × 0.8–2.5 cm. Petiolus (20–)32–47 cm longus, vaginatus per 15–25 cm; lamina foliaris 5- ad 9-pedatisecta, 20–40 × 27–48 cm, lobo medio ± elliptico, 18–25 × 7–12 cm, nervis primariis lateralis utroque 6 vel 7(8, 9). Inflorescentiae usque ad 4 in quaque axilla; pedunculus ca. 25 cm × 1–3 mm; spatha erecta ca. 3–7 cm longa, tubo 5–7 mm diam.; spadix ca. 5.5 cm longus.

Terrestrial herb, ca. 1 m tall (est.); stem erect, 15–50 cm tall, with remnants of old cataphylls persisting semi-intact and ± fibrous at upper nodes, otherwise as loosely held, pale linear fibers (all measurements made from dried material); internodes ca. 1 × 0.8–2.5 cm, brown, drying matte, dark brown; cataphylls at least 19 cm long, apex not known, drying weakly glossy, dark reddish brown. LEAVES 2, erect-spreading; **petioles** (20–)32–47 cm long, glabrous, moderately to prominently minutely striate-ridged throughout, drying weakly glossy, dark brown to reddish brown, sheathed 15–25 cm, ca. 1/2 of total length; sheath decurrent at apex; free portion 3–5 mm diam. midway, entirely terete, or in part obtusely angular toward apex; **blades** 5- to 9-pedatisect, occasionally weakly alate between some segments, 20–40 × 27–48 cm, 1.2 to 1.3 times wider than long, thin to thinly coriaceous, moderately to prominently bicolorous; upper surface ± bullate, matte to weakly glossy, dark green, drying weakly glossy, medium to dark brownish green, occasionally greenish brown; lower surface reticulate, matte to weakly glossy, drying semiglossy, occasionally weakly glossy, green, occasionally weakly gray-tinged, moderately to conspicuously paler; all segments ± acute at base; **medial lobe** ± elliptical, 18–25 × 7–12 cm, (2 to)2.3 to 2.9 times longer than wide, 1.1 to 3.5 times longer than lateral lobes, frequently weakly shorter than innermost lateral lobes, gradually or abruptly acuminate at apex, broadest midway, ± symmetrical; **lateral lobes** 4.5–24.5 × 1.5–12.5 cm, 1.1 to 3.5 times longer than wide, gradually or abruptly

acuminate at apex, rarely acute, usually broadest at or below middle, occasionally above middle, progressively shorter and narrower toward outermost segments, with outermost segments usually much shorter and narrower than all other segments, progressively weakly to moderately inequilateral, most prominently so on outermost segments, the inner side always narrower; outer side 1.1 to 2.2 times wider than inner side midway, weakly to broadly rounded at base on outermost segments, rarely narrowly rounded, briefly attenuate onto posterior rib; all orders of venation sunken on upper surface, rarely with only the midrib and major veins sunken, usually prominently raised on lower surface; midrib occasionally paler than upper surface, round-raised and striate-ridged on lower surface, drying \pm raised, concolorous to moderately darker than surface; posterior rib naked 1.5–3.5 cm per side, round-raised on lower surface; primary lateral veins on all segments 6 to 7(8, 9) pairs (4 to 5 pairs on outermost segments), arising at 25° – 45° , moderately to markedly arcuate, prominently so toward apex, round-raised on lower surface, drying weakly raised to weakly flattened on lower surface, weakly to moderately darker than surface; secondary veins drying \pm raised on lower surface, weakly darker than surface; tertiary veins darker than lower surface, drying entirely \pm raised or in part prominulous, concolorous to weakly darker than surface; reticulate veins drying entirely weakly raised to prominulous on lower surface, or occasionally in part only visible and distinct, concolorous or weakly to moderately darker than surface; collective veins 2 to 3, the innermost arising from the lowermost lateral vein at the base, loop-connected with all preceding lateral veins, weakly to moderately scalloped, 2–10 mm from margin. INFLORESCENCES erect, to 4 per axil; peduncle held within the sheath, ca. 25 cm \times 1–3 mm, narrowest toward base, glabrous, drying weakly glossy, dark blackish brown; **spathe** erect, ca. 3–7 cm long, cuspidate at apex; spathe tube green, 3.5–4 cm \times 5–7 mm (2 cm \times 4 mm in immature inflorescence), drying weakly glossy, dark blackish brown; spathe blade white, 3.2 cm \times 4 mm, drying weakly glossy, dark brown; **spadix** erect, ca. 5.5 cm long, sessile, adnate to spathe 1–2 cm at base, ca. 1/2 of the length of pistillate portion; pistillate portion ca. 2.5–3 cm \times 4–6 mm (1.9 cm \times 2 mm on immature inflorescence), broadest midway; fertile staminate portion white, 2.5 cm \times 2–4 mm, narrowly rounded at apex, \pm clavate, drying medium brown; sterile staminate portion ca. 9 \times 1.5 mm, \pm cylindrical, drying medium brown; pistils weakly coherent, 3 to 4 across the axis (viewed from above), 1–1.5 mm long; ovaries subglobose, 1–2 mm diam.,

drying brownish; style Type 3 (Fig. 1C), ca. 1–1.5 mm diam., as broad as ovary apex, drying paler than ovary, the margins not coherent with those of adjacent styles; **stigma** 0.2–0.3 mm diam., sessile, disklike, obtusely truncate at apex, drying dark reddish brown; synandria ca. 1 \times ca. 1.2 mm, elongated in direction of axis in basal 3 whorls, deeply 3- to 4-lobed, 3- to 4-androus, coherent, truncate; sterile flowers ca. 0.5 mm long, 1–1.2 \times 0.75 mm diam. and \pm elongated in direction of axis, coherent, truncate, subprismatic, in 7 whorls. Berries not known.

Phenology. Flowering is only known to occur in *Chlorospatha morae* during the month of October.

Etymology. *Chlorospatha morae* is named for Marcela Mora Ward (1977–), graduate of the Universidad Nacional de Colombia, Bogotá, and specialist on the aroid flora of lowland Chocó Department, whose collection of *C. kolbii* made possible our understanding of that pivotal species. This new species is named in her honor, in recognition of her work on the Araceae of the Flora of Cabo Corrientes.

Discussion. *Chlorospatha morae* is known only from Chocó Department, Colombia, in premontane rainforest or transitional forest between tropical rainforest and premontane rainforest on the western slopes of the Cordillera Occidental at 285–325 m elevation. Most of the collections were made along the Medellín–Quibdó road west of Bolívar, very near the border with Antióquia Department. One collection, *Croat 7088I*, was made on the border with Risaralda and the species would be expected to occur in that department and in Antióquia. Tadó, the type locality, is at approximately $5^{\circ}20'N$, $76^{\circ}40'W$ (est.), northeast of Istmina, on the road to Pueblo Rico.

Chlorospatha morae, a member of *Chlorospatha* sect. *Chlorospatha*, is an erect-growing species distinguished by its usually bullate, dark green, frequently prominently bicolorous, 5- to 9-pedatisect leaf blades with the segments relatively broad and elliptical, ovate or obovate, and acute and very narrowly attached at the base, with all venation usually sunken on the upper surface and raised or prominulous on the lower surface, with the lower surface reticulate. It is also distinguished by its small inflorescence with a green spathe tube and white blade.

Chlorospatha morae could be confused with only one species, *C. genyrii*, known only from the Parque Nacional Natural Las Orquídeas in Antióquia Department, Colombia, on the western slopes of the

Cordillera Occidental at higher elevations, 1200–1800 m (see discussion under *C. gentryi*).

Grayum (1986) originally filed *Croat 49311* and *Croat 55930*, sterile collections from Chocó Department, as *Chlorospatha croatiana* var. *enneaphylla*, possibly because of their 7-foliolate leaf blades and Colombian collection sites. Subsequent discovery of fertile material of *C. morae* indicates that these collections should be assigned to this species (cf. discussion under the latter species).

There is possibly more than one species involved in the collections cited here, all collections except the type being sterile. *Croat 49311* differs in drying with the minor venation more prominent. *Croat 70881* has only five segments, although it appears to be as mature as *Grayum et al. 7633*, which has nine segments. The type plant has seven segments. Both *Croat 70881* and *Grayum et al. 7633* dry paler, somewhat grayish green, whereas the type and other collections dry more brownish.

Paratypes. COLOMBIA. **Chocó:** along Medellín–Quibdó rd., 85 km W of Bolívar, 350 m, 11 Dec. 1979, *Croat 49311* (MO); along Quibdó–Medellín rd., Km. 159, 480 m, 13 Apr. 1983, *Croat 55930* (MO); along Quibdó–Medellín rd., at Km. 179, 20 km E of Tutunendo, 440 m, 5°44'N, 76°28'W, 22 Apr. 1983, *Croat 56303* (MO); Quibdó rd. from Bolívar, 97 km E of Quibdó, near Km. 155, 500 m, 5°44'N, 76°27'W, 11 Mar. 1984, *Croat 57286* (MO); along Pueblo Rico (Risaralda)–Istmina (Chocó) rd., 1 km W of Guarato & Río Guarato at Risaralda & Chocó border, 285 m, 5°21'N, 76°11'W, 22 Feb. 1990, *Croat 70881* (MO); along Quebrada La Asquerosa, along Bolívar–Quibdó rd., ca. 16 km beyond El Siete, 825 m, 5°45'N, 76°22'W, 8 July 1986, *M. Grayum, B. Hammel, J. Kress & G. Brown 7633* (MO).

48. *Chlorospatha munchiquensis* Croat & L. P. Hannon, sp. nov. TYPE: Colombia. Cauca: Parque Nac. Munchique, at Km. marker G1, 2 km W of summit, 2580 m, 2°30'38"N, 76°58'38"W, 19 July 1997, *Croat & J. Gaskin 80042* (holotype, MO-04940032!; isotype, CA-UP!). Figure 38B–D.

Herba minus quam 1 m; internodia 3–4 × usque ad 2.3 cm; cataphylla 9–18 cm longa. Petiolus 24–46 cm longus, vaginatus per 10.5–13.5 cm; lamina foliaris ovato-sagittata, 21–28 × 14–18 cm, lobis posterioribus 8.8–12 × (4–)4.5–9.5 cm, nervis basalibus utroque 4 ad 6, nervis primariis laterales utroque 6 ad 8. Inflorescentiae usque ad 4 in quaque axilla; pedunculus 13–15 cm × 2–3 mm; spatha erecta, longitudine ignota; spadix longitudine ignota, 6–8 mm diam.

Terrestrial herb, on steep bank, less than 1 m tall; stem decumbent, 40 cm long, with remnants of old cataphylls persisting ± intact along its length (usually entirely covering stem); internodes 3 to 4,

to 2.3 cm, semiglossy, olive-green, drying weakly glossy, dark reddish brown to blackish brown, occasionally irregularly finely transversely striate (all measurements made from dried material); cataphylls 9–18 cm long, obtuse with acumen at apex, 1-ribbed abaxially, green, drying weakly glossy to semiglossy, medium-dark reddish brown on outer surface, weakly paler on inner surface. LEAVES 3 to 5, erect-spreading; **petioles** 24–46 cm long, glabrous, semiglossy, brownish green, drying matte to weakly glossy, dark brown to blackish brown, sheathed 10.5–13.5 cm, ca. 1/3 or slightly more of total length; sheath free-ending at apex; free portion 3–5 mm diam. midway, terete; **blades** ovate-sagittate, subhastate in young plants, 21–28 × 14–18 cm, 1.5 to 1.6 times longer than wide, acuminate at apex, broadest at base, 1.1 to 1.5 times wider at base than across anterior lobe (measured tip to tip across posterior lobes), weakly to moderately constricted in area of petiole attachment, with one side ca. 2 cm wider than opposite side, subcoriaceous, weakly bicolorous; upper surface weakly bullate, velvety-matte, dark green, drying matte, dark brown; lower surface weakly glossy, drying weakly glossy to in part semiglossy, weakly paler; anterior lobe 14–19 × 9.3–17 cm, 1 to 1.7 times longer than wide, 1.4 to 1.6 times longer than posterior lobes, broadest at or below middle, weakly inequilateral, with one side 1–1.5 cm wider than opposite side midway; posterior lobes directed toward the base, somewhat outward in young plants, 8.8–12 × (4–) 4.5–9.5 cm, 1.3 to 2.3 (to 2.5) times longer than wide, narrowly rounded to bluntly rounded or bluntly acute at apex, broadest at base or weakly broadest below middle, weakly to moderately inequilateral, the inner side narrower, weakly to broadly rounded toward base, decurrent onto petiole (onto posterior rib in young plants, with rib naked 5 mm per side); outer side 1 to 1.4 times wider than inner side midway, ± straight to weakly concave toward base; sinus 7.5–10.5 cm deep, oblong to spatulate, or broadly V-shaped, occasionally with lobes overlapping; midrib and major venation deeply sunken on upper surface, round-raised on lower surface, drying raised to weakly flattened, weakly darker to weakly paler than surface; **basal veins** 4 to 6 pairs, coalesced into prominent posterior rib; primary lateral veins 6 to 8 pairs, arising at 50°–65° on broad side, 35°–45° on narrow side, weakly arcuate, rarely irregularly ascending; secondary and tertiary veins sunken on upper surface, prominently raised on lower surface, drying raised, occasionally in part prominulous, weakly or prominently darker than surface; reticulate veins drying in part distinct and flat on lower surface, rarely in part weakly prom-

inulous, concolorous to weakly darker than surface; collective veins 3, the innermost arising from one of the lowermost lateral veins on the inner side of the posterior lobe, loop-connected with all preceding lateral veins, \pm parallel to and 3–7 mm from margin. INFLORESCENCES erect, to 4 per axil; peduncle held within the sheath, 13–15 cm \times 2–3 mm, drying matte to weakly glossy, medium-dark to dark brown; **spathe** erect, total length and apex not known; spathe tube dark green and dark purple-tinged on outer surface, dark purple on inner surface; spathe blade not known; **spadix** total length not known, sessile, adnate to spathe 6–8 cm at base, the entire length of pistillate portion; pistillate portion not known; fertile staminate portion not known; sterile staminate portion ca. 7 \times 1.5–2 mm, drying dark reddish brown; pistils not known; style probably attenuate, with the stigma \pm elevated on narrowed portion; synandria ca. 1 \times ca. 1.5 mm, 4-lobed, 4-androus, coherent, truncate (2 flowers examined); sterile flowers ca. 0.8 mm long, 1.5–2 \times 1 mm diam. and \pm elongated in direction of axis, coherent, truncate, irregularly subprismatic, in 3 to 4 whorls. INFRUCTESCENCE 6.2–8.5 cm \times 6–9 mm, drying matte to weakly glossy, dark brown on outer surface, moderately paler on inner surface; berries 3–5 mm diam., drying tan.

Phenology. Flowering and fruiting are only known to occur in *Chlorospatha munchiquensis* during the month of July.

Etymology. *Chlorospatha munchiquensis* is named for the type locality, Parque Nacional Munchique, located along the crest of the Cordillera Occidental in Cauca Department of Colombia.

Discussion. *Chlorospatha munchiquensis* is known only from the type collection made in Parque Nacional Munchique on the western slopes of the Cordillera Occidental in Cauca Department, Colombia, 2 km west of the summit of the Continental Divide, at Km. marker G1, at 2580 m elevation. The species occurs in premontane wet forest and lower montane wet forest and would be expected to occur elsewhere within the department, in suitable habitat, possibly on the eastern slopes.

Chlorospatha munchiquensis is a member of *Chlorospatha* sect. *Occidentales* and is distinguished by its weakly bullate, broadly ovate-sagittate leaf blades that are weakly to moderately constricted in the area of petiole attachment, velvety-matte and dark green on the upper surface, only weakly bicolorous, and dry dark brown. All venation except the reticulate is prominently raised on the lower surface, and, in some specimens, the secondary and tertiary

veins dry conspicuously darker than the surface, giving the blades a distinctive appearance.

Chlorospatha munchiquensis could possibly be confused with *C. macphersonii* from the eastern slopes of the Cordillera Occidental, in the vicinity of Jardín at the southern end of Antióquia Department, near the border with Caldas and Risaralda departments, at almost 3000 m elevation (see discussion under *C. macphersonii*).

49. *Chlorospatha nambiensis* Croat & L. P. Hannon, sp. nov. TYPE: Colombia. Nariño: Mpio. Barbaças, Altaquér distr., vic. El Barro, Res. Nat. Río Nambí, rt. bank of Río Nambí, 1325 m, 1°18'N, 78°08'W, 8 Dec. 1993, P. Franco, D. Giraldo, W. Beltrán, A. Prieto & O. Rivera 5056 (holotype, COL-360481!). Figure 39A.

Herba 60–80 cm; internodia 1.2–2 \times 1.2–1.7 cm; cataphylla ultra 10 cm longa. Petiolus 34–48.5 cm longus, vaginatus per 8–12.5(–19.5) cm; lamina foliaris hastata, 18.5–27.5 \times 23–25 cm, lobis posterioribus 12.5–13.5 \times 3.5–5 cm, nervis basalibus utroque 6 ad 8, nervis primariis lateralibus utroque 3 vel 4(5). Inflorescentiae usque ad 3 in quaque axilla; pedunculus 10.2–13 cm \times 1–2 mm; spatha longitudine ignota sed existimata ca. 6–6.5 cm, ca. 5 mm diam., lamina ca. 3 cm \times 7 mm; spadix ca. 6.1 cm longus.

Terrestrial herb, 60–80 cm tall; stem with remnants of old leaf bases persisting semi-intact at some uppermost nodes (all measurements made from dried material); internodes 1.2–2 \times 1.2–1.7 cm, drying matte, dark brown; cataphylls ultimately deciduous, more than 10 cm long, total length and apex not known, drying weakly glossy, medium-dark reddish brown, \pm fibrous. LEAVES 2, erect-spreading; **petioles** 34–48.5 cm long, glabrous, pale green, drying matte, medium-dark to dark brown, sheathed 8–12.5(–19.5) cm, ca. 1/3 of total length; sheath maroon, decurrent at apex; free portion 2–3 mm diam. midway; **blades** hastate, 18.5–27.5 \times 23–25 cm, 1.1 times longer than wide, or frequently to 1.2 times wider than long, gradually to abruptly acuminate at apex, broadest at base, 2.7 to 3 times wider at base than across anterior lobe (measured tip to tip across posterior lobes), thin (dry), moderately bicolorous; upper surface green, drying matte, dark brown, with densely dispersed, pale, punctiform, and short, linear raphid cells; lower surface drying weakly glossy, occasionally in part semiglossy, weakly paler or concolorous; anterior lobe 12.7–20 \times 8–8.6 cm, 1.6 to 2.3 times longer than wide, 1 to 1.5 times longer than posterior lobes, broadest near base or midway, weakly to markedly constricted at base, occasionally not at all on one side, weakly inequilateral, with one side 1.1 to 1.5 times wider than

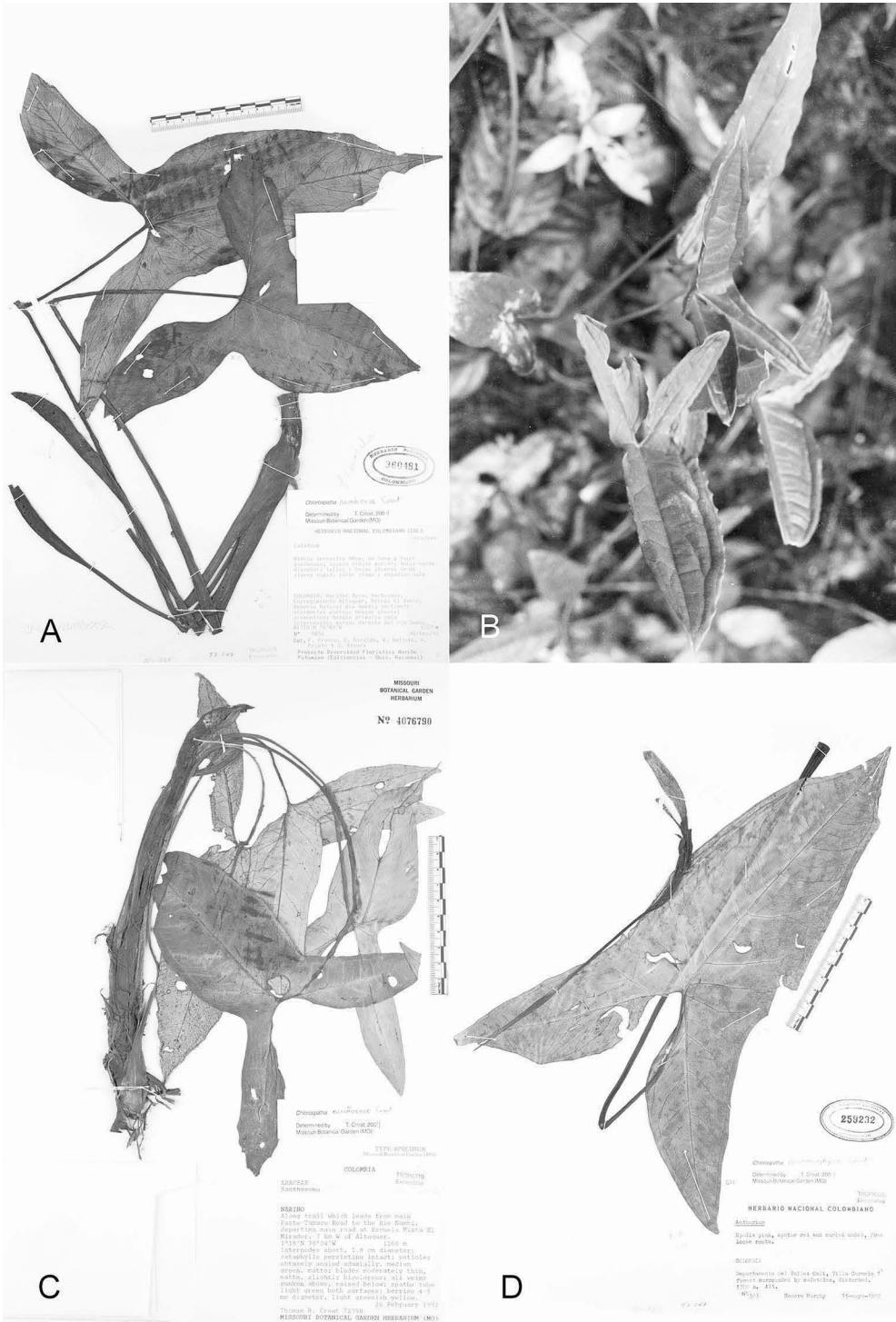


Figure 39. —A. *Chlorospatha nambiensis* Croat & L. P. Hannon, the holotype *Franco et al.* 5056 (COL-360481). B, C. *Chlorospatha nariñoensis* Croat & L. P. Hannon, the holotype *Franco et al.* 72398 (MO). —B. Plant habit, showing adaxial surfaces of blades. —C. Holotype specimen (MO-4076790). —D. *Chlorospatha noramurphyae* Croat & L. P. Hannon, the isotype *Murphy* 383 (COL-259232).

opposite side; posterior lobes directed prominently outward, 12.5–13.5 × 3.5–5 cm, 2.6 to 3.8 times longer than wide, narrowly rounded to bluntly acute at apex, broadest below middle, usually markedly constricted at base, 1.4 to 2.3 times wider at widest point than at point of constriction, ± symmetrical to weakly inequilateral, the inner side broadly rounded and markedly narrowly long-attenuate toward base, the attenuate portion less than 1 mm wide, decurrent onto posterior rib; outer side ± straight toward base; midrib, major and secondary venation drying moderately darker than lower surface; midrib round-raised on lower surface, drying raised; **basal veins** 6 to 8 pairs, coalesced into a prominent posterior rib; posterior rib naked 3–10(–12) mm per side; primary lateral veins 3 to 4(5) pairs, arising at 25°–50°, most acutely toward apex, straight, weakly to markedly arcuate or irregularly ascending, convex on lower surface, drying raised near base, otherwise ± flattened; secondary veins raised on lower surface, drying raised; tertiary veins drying prominulous on lower surface, darker than surface; reticulate veins drying obscure; collective veins 3, the innermost arising from one of the lowermost lateral veins on the inner side of the posterior lobe, loop-connected with all preceding lateral veins, moderately scalloped, 2–10 mm from margin. INFLORESCENCES erect, to 3 per axil; peduncle held within the sheath, 10.2–13 cm × 1–2 mm (ca. 18 cm × 3.5 mm when in fruit), pale green, drying matte, dark brown; **spathe** habit not known, ca. 6–6.5 cm long (est.), apex not known; spathe tube cream-colored, 3–4 cm × ca. 5 mm, drying matte, in part weakly glossy, dark brown on outer surface, matte to weakly glossy, and weakly paler on inner surface, with regularly rounded, pale cellular inclusions, the inclusions concentrated in medial 1/3; spathe blade cream or white, ca. 3 cm long, 7 mm wide (flattened), drying matte, dark brown on outer surface, weakly glossy on inner surface, marcescent, erect after anthesis; **spadix** erect, curved weakly forward, ca. 6.1 cm long, sessile, adnate to spathe ca. 3–3.5 cm at base, the entire length of pistillate portion and onto sterile staminate portion 1.5 mm; pistillate portion 2.8–3.5 cm × 2–3 mm, broadest midway, drying dark, reddish brown; fertile staminate portion brown, ca. 2.2 cm × ca. 3 mm, ± cylindrical, narrowly rounded at apex, drying dark reddish brown; sterile staminate portion ca. 1.2 cm × 2 mm, weakly broadest at apex, drying dark reddish brown; pistils weakly coherent, 3 to 4 across the axis (viewed from above), ca. 1.8 mm long; ovaries subglobose, ca. 2 mm diam.; style Type 8 (Fig. 1), 1 × 1.2–1.3 mm (attenuate portion ca. 0.7 mm long), comprising ca. 1/2 of the length of pistil, weakly

broader than ovary apex, the margins weakly coherent with those of adjacent styles; **stigma** 0.2–0.3 mm diam., markedly elevated on and weakly broader than narrowed portion of style; synandria ca. 1 × 0.8–1.4 mm, coherent, truncate, 3- to 4-lobed, 3- to 4-androus; sterile flowers 0.6–0.8 × 0.5–0.8 mm, or 0.4–0.8 × 1–1.8 mm diam. and ± elongated in direction of axis, fungiform (like toadstools) in basal 4 to 5 whorls and markedly laxly arranged (with only 5 to 6 flowers present), several-branched or markedly irregularly and deeply lobed in apical 2 to 4 whorls and weakly coherent, the branches truncate, broadest at and abruptly narrowing below apex. INFRUCTESCENCE cream-colored, 7–9.5 cm × 9–13 mm, drying matte, dark brown; berries (immature) 2–3 mm diam.

Phenology. Flowering and fruiting are only known to occur in *Chlorospatha nambiensis* during the month of December.

Etymology. *Chlorospatha nambiensis* is named for the Reserva Natural Río Nambí in Nariño Department of Colombia, where the type was collected.

Discussion. *Chlorospatha nambiensis* is known only from premontane wet forest on the western slopes of the Cordillera Occidental, in the Reserva Natural Río Nambí in Nariño Department, Colombia, at 1325 m elevation. The species would be expected to occur elsewhere in the department and southward into northern Ecuador, in suitable habitat.

Chlorospatha nambiensis is a member of *Chlorospatha* sect. *Occidentales* and is distinguished by its hastate, dark brown-drying leaf blades with all lobes usually prominently constricted at the base, the posterior lobes narrow and as long as or moderately shorter than the anterior lobe and the inner margins conspicuously long-attenuate toward the base. The lower surface of the blade dries concolorous to weakly paler than the upper surface, with the major and secondary venation darker than the surface. The petiole is pale green and sheathed one third of its length, with the sheath maroon. *Chlorospatha nambiensis* is also characterized by its short, pale green peduncle, one third as long as the petiole, and small inflorescence with the spathe less than 7 cm long and usually entirely cream-colored. The sterile staminate portion of the spadix comprises one fifth of the total length and is markedly laxly flowered in the basal one half, with only five to six flowers on the axis. The synandria are reported as brown.

Chlorospatha nambiensis would be most easily confused with *C. nariñoensis*, with which it is possibly sympatric in Nariño Department. Both species have

the petiole sheathed one third of its length, hastate leaf blades (on drying) with pale raphid cells on the upper surface, long posterior lobes, short peduncles, and small inflorescences.

Chlorospatha nambiensis differs in having the petiole sheath maroon and the leaf blades drying dark brown, not at all greenish, with the midrib, major, and minor venation drying darker than the lower surface and the major venation flattened. In *C. narinoensis*, the petiole sheath is green and the leaf blades dry green or greenish, with the venation concolorous to weakly paler than the lower surface and the major venation raised. In *C. nambiensis*, the fertile staminate portion of the spadix is brown; the style (Type 8, Fig. 1) is appressed to the ovary (not broadly spreading); and the sterile flowers are fungiform to branched and laxly arranged, markedly so in the basal half of the sterile portion. In *C. narinoensis*, the fertile staminate portion is cream-colored; the style (Type 5, Fig. 1) is broadly spreading; and the sterile flowers are subprismatic and densely arranged. The species are possibly closely related.

Chlorospatha nambiensis could possibly be confused with *C. carchiensis* from the western slopes of the Andes, in the vicinity of Maldonado in Carchi Province, Ecuador, at 1740–1800 m elevation. The species could ultimately prove to be sympatric, their type localities being in close proximity. The petiole is sheathed one half or slightly more of its length, the sheath is green and free-ending at the apex, and the leaf blades are sagittate with broad posterior lobes (see discussion under *C. carchiensis*).

Paratype. COLOMBIA. **Nariño:** Mpio. Barbacoas, Altaquer distr., vic. El Barro, Res. Nat. Río Nambí, lt. bank of Río Nambí, 1325 m, 1°18'N, 78°08'W, 10 Dec. 1993. *P. Franco et al.* 5132 (COL).

50. *Chlorospatha narinoensis* Croat & L. P. Hannon, sp. nov. TYPE: Colombia. Nariño: along trail leading from main Pasto–Tumaco rd. to Río Nambí, departing main rd. at Escuela Mixta El Mirador, 7 km W of Altaquer, 1100 m, 1°18'N, 78°04'W, 26 Feb. 1992, *Croat 72398* (holotype, MO-4076790!; isotypes, K!, PSO!). Figure 39B, C.

Herba 0.5–1.6 m; internodia 1–1.5 × 1.2–1.8 cm; cataphylla 11–16 cm longa. Petiolus 36–46 cm longus, vaginatus per 8–13.5 cm; lamina foliaris hastata, 15.5–27 × 14.5–27 cm, lobis posterioribus 10.2–16 × 2.2–3.7(–4.4) cm, nervis basalibus utroque (5)6 vel 7, nervis primariis lateralibus utroque 3–5. Inflorescentiae erectae, usque ad 3 in quaque axilla; pedunculus 12–14.5 cm × 1–3 mm; spatha erecta, 6–7.5 cm longa, tubo 4–5 mm diam., lamina 3–3.5 cm × ca. 5 mm; spadix 5–6 cm longus.

Terrestrial herb, 0.5–1.6 m tall; stem with remnants of old cataphylls persisting ± intact at upper nodes, weakly fibrous; sap milky; internodes 1–1.5 × 1.2–1.8 cm, green, drying matte, medium-dark brownish green (all measurements made from dried material); cataphylls 11–16 cm long, ± obtuse with acumen at apex, 1-ribbed abaxially, drying semiglossy to glossy, medium to dark reddish brown. LEAVES 1 to 4, erect-spreading; **petioles** 36–46 cm long, glabrous, matte, medium green, drying matte to weakly glossy, medium-dark to dark brown, sheathed 8–13.5 cm, ca. 1/3 or less of total length; sheath decurrent at apex; free portion 1.5–4 mm diam. midway, obtusely angular adaxially; **blades** held ± horizontally, the apices of all lobes directed ± upward, hastate (rarely subhastate on drying), 15.5–27 × 14.5–27 cm, 1 to 1.3(to 1.8) times longer than wide, acuminate at apex, broadest at base, (2.7 to)3.4 to 4.2 times wider at base than across anterior lobe (measured tip to tip across posterior lobes), moderately to markedly constricted in area of petiole attachment, thin, weakly to moderately bicolorous; upper surface quilted, matte, dark green, drying matte, medium-dark green to brownish green, with densely dispersed, pale, punctiform and short linear raphid cells; lower surface matte to weakly glossy, drying weakly glossy to semiglossy, weakly to moderately paler; anterior lobe 12.7–19 × 4.5–8(–9.5) cm, (1.8 to)2.4 to 2.8 times longer than wide, 1.2 to 1.3(to 1.5) times longer than posterior lobes, broadest near base, moderately to markedly constricted at base, ± symmetrical; posterior lobes directed prominently outward, 10.2–16 × 2.2–3.7(–4.4) cm, (2.6 to)4 to 4.6 times longer than wide, narrowly rounded to bluntly acute at apex, broadest midway, usually markedly constricted at base, (1.3 to)1.6 to 2.3 times broader midway than at point of constriction, ± symmetrical, the inner side weakly rounded and narrowly long-attenuate toward base, rarely abruptly attenuate; outer side ± straight toward base; major and secondary venation quilted-sunken on upper surface, raised on lower surface, drying raised, concolorous to weakly paler than surface; midrib deeply sunken on upper surface, round-raised on lower surface, weakly paler than surface; **basal veins** (5)6 to 7 pairs, coalesced into a prominent posterior rib, the first free to the base; posterior rib naked 3–8 mm per side, narrowly raised or round-raised on lower surface; primary lateral veins 3 to 5 pairs, arising at 35°–65°, weakly arcuate to irregularly ascending, convex on lower surface; secondary veins raised on lower surface; tertiary veins in part sunken on upper surface, raised on lower surface, drying entirely or in part prominulous

and otherwise distinct; reticulate veins drying obscure; collective veins 3, the innermost arising from one of the lateral veins on the inner side of the posterior lobe, loop-connected with all preceding lateral veins, weakly scalloped, 3–7 mm from margin. INFLORESCENCES erect, to 3 per axil; peduncle held within the sheath, 12–14.5 cm × 1–3 mm (to 16 cm long when in fruit), pale green, drying matte, medium to dark brown; **spathe** erect, 6–7.5 cm long, abruptly acuminate at apex; spathe tube pale green or white, 3–4 cm × 4–5 mm, drying matte, dark brown on both surfaces; spathe blade white, 3–3.5 cm × ca. 5 mm, ca. 1.5 cm wide (flattened), 1-ribbed abaxially, drying matte, dark reddish brown on both surfaces, weakly paler than tube, marcescent, erect after anthesis; **spadix** erect, 5–6 cm long, sessile, adnate to spathe 1.8–3.2 cm at base, most or all of the length of pistillate portion; pistillate portion 2.2–3.2 cm × ca. 2 mm, broadest toward apex, drying dark reddish brown; fertile staminate portion cream-colored, 1.6–2.3 cm × 2–3 mm, weakly clavate, narrowly rounded at apex, drying medium-dark yellowish brown, occasionally weakly gray-tinged; sterile staminate portion 5–8 × 1.5–2 mm, ± cylindrical, drying dark reddish brown; pistils weakly coherent, 2 to 4 across the axis (viewed from above), 1.7–2 mm long; ovaries subglobose, 1.5–1.7 mm diam.; style Type 5 (Fig. 1), 0.8–1.2 × 1–1.5 mm (attenuate portion ca. 1 mm long), comprising ca. 1/2 of the length of pistil, broader than ovary apex, the margins frequently ± coherent with those of adjacent styles; **stigma** 0.3–0.5 mm diam., markedly elevated on and broader than narrowed portion of style; synandria ca. 1 × ca. 1 mm, coherent, truncate, (2)3- to 4-lobed, (2)3- to 4-androus (mostly 3); sterile flowers ca. 0.5 mm long, 1–2 × 0.5–1 mm diam. and ± elongated in direction of axis, coherent to weakly coherent, truncate, subprismatic to irregularly lobed, in 4 to 5 whorls. INFRUCTESCENCE ca. 7.5 × 1.2 cm; berries pale greenish yellow, 4–5 mm diam.

Phenology. Flowering is only known to occur in *Chlorospatha narinoensis* during the months of February and December, with fruiting reported for February.

Etymology. *Chlorospatha narinoensis* is named for Nariño Department of Colombia, where the species is endemic.

Discussion. *Chlorospatha narinoensis* is known only from premontane wet forest on the western slopes of the Cordillera Occidental, near the Reserva Natural Río Ñambí in Nariño Department, Colombia, at 1100–1325 m elevation. The species would be

expected to occur elsewhere within the department, also southward into Carchi Province in northern Ecuador and possibly to the north in Cauca Department.

Chlorospatha narinoensis is a member of *Chlorospatha* sect. *Occidentales* and is distinguished by its hastate, matte, dark green leaf blades with the anterior and posterior lobes moderately to markedly constricted at the base, and the posterior lobes narrow and almost as long as the anterior lobe. The species is also distinguished by its petiole, which is obtusely angular in the free portion and sheathed one third of its length, with the peduncle accordingly short (12–14.5 cm long) and the inflorescence small, 6–7.5 cm long. The style comprises one half or more of the length of the pistil, with the attenuate portion markedly long (1 mm long) and the mantle much broader than the ovary apex.

Chlorospatha narinoensis could be most easily confused with *C. nambiensis*, with which it is possibly sympatric in Nariño Department. Both species have the petiole sheathed one third of its length, hastate leaf blades (on drying) with pale raphid cells on the upper surface, long posterior lobes, short peduncles, and small inflorescences (see discussion under *C. nambiensis*).

Chlorospatha narinoensis could possibly be confused with *C. carchiensis* from the western slopes of the Andes, in the vicinity of Maldonado in Carchi Province, Ecuador, at 1740–1800 m elevation. The species could ultimately prove to be sympatric; their type localities being in close proximity (see discussion under *C. carchiensis*).

Betancur et al. 4872 is possibly a different species. It differs vegetatively from the other collections in having sagittate, brown-drying leaf blades with the posterior lobes proportionally broader and less constricted at the base. The anterior lobe is also broader relative to its length. The spathe is reported as entirely white, thus differing from the other collections in which the spathe tube is pale green and the blade white. However, the percentage of sheathing on the petiole, the peduncle length, and floral morphology appear to accord with the type, and the collection was made at the type locality.

Paratypes. COLOMBIA. **Nariño:** Mpio. Barbacoas, Altaquer distr., vic. El Barro, Res. Nat. Río Ñambí, on lt. side of Río Ñambí, 1325 m, 1°18'N, 78°08'W, 11 Dec. 1993, *J. Betancur 4816* (COL), *Betancur, A. Guzman, R. Lopez & S. Vargas 4872* (COL).

51. *Chlorospatha nicolsonii* Croat & L. P. Hannon, *Aroideana* 27: 34. 2004. TYPE: Colombia. Antioquia: trail from Encarnación to Parque Nac. Nat. Las Orquídeas, 1600–1800 m, 27 Jan.

1979, *A. Gentry & E. Rentería 24590* (holotype, MO-2715459!; isotype, COL!). Figure 36D.

Terrestrial or hemiepiphytic herb, to ca. 1 m tall; stem decumbent, with remnants of old leaf bases and cataphylls persisting \pm intact and weakly fibrous at upper nodes (all measurements made from dried material); internodes 2–4 cm \times 8–10 mm, drying weakly glossy, dark brown, occasionally finely irregularly transversely ridged, ridges darker than surface; cataphylls ca. 16–19 cm long, apex not known, drying weakly glossy to semiglossy, dark reddish brown, weakly fibrous. LEAVES 2 to 3, erect-spreading; **petioles** 38–60 cm long, drying glabrous, semiglossy, dark reddish brown, sheathed 15–22 cm, ca. 1/3 of total length; sheath decurrent at apex; free portion 3–5 mm diam. midway; **blades** subhastate, 28–35 \times 18–22 cm, 1.7 to 2.2 times longer than wide, acute to acuminate at apex, broadest at base, 1.9 to 2.8 times wider at base than across anterior lobe (measured tip to tip across posterior lobes), weakly to moderately constricted in area of petiole attachment, drying thinly coriaceous, concolorous to moderately bicolorous; upper surface drying matte to weakly glossy, occasionally in part semiglossy, dark brown to greenish brown; lower surface drying weakly glossy to semiglossy; anterior lobe 18–20.5 \times 9–9.5 cm, 2 to 2.2 times longer than wide, 1.2 to 1.3 times longer than posterior lobes, broadest below middle, usually near base, \pm symmetrical; posterior lobes directed outward, 13.5–17.5 \times 4–5.5 cm, 3.4 to 3.8 times longer than wide, narrowly rounded to bluntly acute at apex, broadest below middle, \pm symmetrical to weakly inequilateral, the inner side occasionally weakly narrower, \pm rounded toward base, briefly attenuate and decurrent onto petiole; outer side \pm straight toward base; all venation (except reticulate) drying weakly to moderately darker than surface; midrib round-raised on lower surface, drying \pm raised; **basal veins** 4 to 6 pairs, coalesced into prominent posterior rib; primary lateral veins 3 to 4 pairs, arising at 30°–60°, most acutely toward apex, weakly to moderately arcuate, occasionally strongly arcuate or irregularly ascending, convex on lower surface, drying \pm flattened to weakly raised; secondary veins raised on lower surface, drying \pm flattened to weakly raised; tertiary veins drying entirely or in part prominulous and otherwise distinct on lower surface; reticulate veins drying obscure; collective veins 3, the innermost arising from one of the lowermost lateral veins on inner side of posterior lobe, loop-connected with all preceding lateral veins, parallel to margin or moderately scalloped, 3–7 mm from margin. INFLORESCENCES erect, to 3 per axil; peduncle held within the sheath, 11–15 cm \times 1.5–3.5 mm, drying weakly glossy

to semiglossy, dark brown; **spathe** erect, cream-colored or yellow, 7–8.5 cm long, acuminate at apex; spathe tube 3.2–4.4 cm \times 3–4 mm, drying matte, dark reddish brown on outer surface, weakly glossy on inner surface; spathe blade 4–4.5 cm \times 5–6 mm, drying weakly glossy to semiglossy, pale-medium to medium-dark reddish brown on both surfaces, marcescent, erect after anthesis; **spadix** erect, 6–8 cm long, sessile, adnate to spathe 2.7–3.8 cm at base, the entire length of pistillate portion and occasionally narrowly onto sterile staminate portion; pistillate portion 2.7–3.8 cm \times 2–3 mm, wider than thick, drying cream to tan; fertile staminate portion cream or yellow, 2.5–3.5 cm \times 3–4 mm, \pm cylindrical, narrowly rounded at apex, drying medium to medium-dark yellowish brown; sterile staminate portion 3–8 \times 2–3 mm, cylindrical or weakly broadest at apex, drying medium to medium-dark yellowish brown, minutely darker red-brown-speckled; pistils weakly coherent to laxly arranged, ca. 3 across the axis (viewed from above), ca. 1.5 mm long; ovaries subglobose, ca. 1 \times 1.5–2 mm, drying dark brown; style Type 10 (Fig. 1), ca. 0.5 \times 1–1.5 mm (attenuate portion ca. 0.4 mm long), comprising 1/4 to 1/3 of the length of pistil, as broad as to weakly narrower than ovary apex, the margins weakly or not at all coherent with those of adjacent styles; **stigma** ca. 0.5 mm diam., weakly elevated on and weakly broader than narrowed portion of style, drying yellowish tan; synandria 1–1.3 \times 1.8–2 mm, coherent, truncate, (2)3- to 4(5)-lobed, (2)3- to 4(5)- (mostly 4); sterile flowers 0.5–1 mm long, 1 \times 2 mm diam. and elongated in direction of axis, coherent, truncate, irregularly subprismatic, in 3 to 5 whorls. Berries not known.

Phenology. Flowering is only known to occur in *Chlorospatha nicolsonii* during the months of January and February.

Discussion. *Chlorospatha nicolsonii* is known only from the Parque Nacional Natural Las Orquídeas on the western slopes of the Cordillera Occidental in Antioquia Department, Colombia, at 1500–1800 m elevation. The park area exhibits a high level of endemism in *Chlorospatha*. The species occurs in premontane wet forest, possibly also in tropical wet forest.

Chlorospatha nicolsonii is a member of *Chlorospatha* sect. *Occidentales* and is distinguished by its subhastate, triangular leaf blades with narrow posterior lobes nearly as long as the anterior lobe. The posterior rib is not naked, the inner margins of the posterior lobes being decurrent onto the petiole. The species is also characterized by its petiole, which is sheathed only one third of its length, short peduncle (11–15 cm long), entirely yellow or

cream-colored, and cream or yellow synandria. The spadix is adnate to the spathe the entire length of the pistillate portion and onto half or the entire length of the sterile staminate portion. The species has relatively long internodes, 2–4 cm, and is occasionally hemiepiphytic.

Chlorospatha nicolsonii would be most easily confused with *C. tokioensis* from Valle Department, at Estación Microndas Tokio near Queremal, on the western slopes at 2000–2100 m elevation. Both species have the petiole sheathed one third of its length, subhastate leaf blades with long, narrow posterior lobes, and short peduncles. *Chlorospatha nicolsonii* is occasionally hemiepiphytic, with longer internodes, 2–4 cm long versus 1–1.5 cm long in *C. tokioensis*, which is consistently terrestrial. The leaf blades of *C. tokioensis* have five to six pairs of primary lateral veins and dry green, with the anterior lobe narrower and longer relative to the length of the posterior lobes. The leaf blades of *C. nicolsonii* have three to four pairs of primary lateral veins and dry brown to greenish brown, with the anterior lobe broad, and the inner margin of the posterior lobe decurrent onto the petiole. The posterior lobe is decurrent onto the posterior rib, which is naked 3–12 mm on each side in *C. tokioensis*. Pale raphid cells are visible on the upper blade surface in the latter species, but do not occur on the blades of *C. nicolsonii*. *Chlorospatha tokioensis* has a larger inflorescence, with the spathe 8.8–9.5 cm long, the tube green, the blade white, and the sterile staminate portion of the spadix uncommonly short, less than 2 mm long, with the sterile flowers laxly arranged and fungiform or deeply lobed. *Chlorospatha nicolsonii* differs in having the spathe 7–8.5 cm long, entirely yellow or cream-colored, and the sterile staminate portion of the spadix 3–8 mm long, with the flowers subprismatic and densely arranged. The style of the latter species is only as broad as the ovary apex and very briefly attenuated, whereas that of *C. tokioensis* is broader than the ovary apex and long-attenuated.

Chlorospatha nicolsonii could possibly be confused with *C. noramurphyae* from Valle Department, in the vicinity of Cali on the eastern slopes of the Cordillera Occidental at 1700 m elevation. Both species have subhastate leaf blades with long, narrow posterior lobes, but in *C. noramurphyae*, the posterior rib is naked and there are five to seven pairs of primary lateral veins versus three or four pairs in *C. nicolsonii* in which the posterior rib is not naked. The latter species further differs in having the petiole sheathed one third of its length, the peduncle short (11–15 cm long), and the inflorescence smaller, to 8.5 cm long. The petiole of *C. noramurphyae* is sheathed three

fourths of its length; the peduncle is 32 cm long; and the inflorescence is 12.5 cm long. The spathe is red in the latter species, and the sterile staminate portion of the spadix is 1.8–2.5 cm long, with the flowers branched and laxly arranged, thus differing from *C. nicolsonii* in which the spathe is entirely cream or yellow and the sterile staminate portion is less than 1 cm long, with the flowers densely arranged and subprismatic. The style of *C. nicolsonii* is briefly attenuated, whereas that of *C. noramurphyae* is long-attenuated.

Additional specimen examined. COLOMBIA. **Antioquia:** Parque Nac. Nat. Las Orquídeas, Calles–Venados rd., 1500 m, *Cogollo et al.* 3976 (JAUM-016944).

52. *Chlorospatha noramurphyae* Croat & L. P. Hannon, sp. nov. TYPE: Colombia. Valle: Cali, Villa Carmelo, 1700 m, 15 May 1982, *H. Murphy* 383 (holotype, MO-3046149!; isotype, COL-259232!). Figure 39D.

Herba minus quam 1 m. Petiolus 36–41 cm longus, vaginatus per usque ad 30 cm; lamina foliaris subhastata, 29–35 × 23–28 cm, lobis posterioribus 16–16.5 × 5.5–6 cm, nervis basalibus utroque 5 ad 7, nervis primariis lateralibus utroque 5 ad 7. Inflorescentia 1 in quaque axilla; pedunculus ca. 32 cm × 2–4 mm; spathe rubra, ca. 12.5 cm longa, tubo 5.5–6 mm diam., lamina complanata ca. 6 cm × 9 mm; spadix ca. 10.5 cm longus.

Terrestrial herb, less than 1 m tall; stem, internodes, and cataphylls not known (all measurements made from dried material). LEAVES 1 to 2; **petioles** 36–41 cm long, drying glabrous, matte to weakly glossy, medium-dark to dark or blackish brown, sheathed to 30 cm, ca. 3/4 of total length; sheath decurrent at apex; free portion 2.5–3 mm diam. midway; **blades** subhastate, 29–35 × 23–28 cm, 1 to 1.5 times longer than wide, acuminate at apex, broadest at base, 2 to 2.5 times wider at base than across anterior lobe (measured tip to tip across posterior lobes), occasionally weakly constricted in area of petiole attachment, drying thinly coriaceous, moderately bicolorous; upper surface drying matte, dark brown; lower surface drying weakly glossy to semiglossy, olive-brown; anterior lobe 21–22 × 11–11.5 cm, 1.9 times longer than wide, 1.3 to 1.4 times longer than posterior lobes, broadest below middle, ± symmetrical; posterior lobes directed outward, 16–16.5 × 5.5–6 cm, 2.6 to 3.2 times longer than wide, bluntly acute to narrowly rounded at apex, broadest below middle, ± symmetrical, the inner side weakly to broadly rounded toward base and briefly attenuate onto posterior rib; outer side straight to weakly concave toward base; midrib narrowly raised on lower surface, drying ± flattened, weakly paler to weakly

darker than surface; **basal veins** 5 to 7 pairs, coalesced into a prominent posterior rib; posterior rib naked ca. 1 cm per side; primary lateral veins 5 to 7 pairs, arising at 50°–60°, weakly arcuate, occasionally straight, convex on lower surface, drying entirely \pm flattened or in part weakly raised toward base, concolorous to weakly darker than surface; secondary veins drying weakly raised on lower surface, \pm concolorous to weakly darker than surface; tertiary veins drying distinct on lower surface, in part weakly prominulous, otherwise flat, \pm concolorous to weakly darker than surface; reticulate veins drying in part visible on lower surface; collective veins 3, the innermost arising from one of the lowermost lateral veins on inner side of posterior lobe, loop-connected with all preceding lateral veins, parallel to and 4–6 mm from margin. INFLORESCENCE erect, 1 per axil; peduncle held within the sheath, ca. 32 cm \times 2–4 mm, drying weakly glossy, medium-dark to dark brown; **spathe** red, weakly cucullate, ca. 12.5 cm long, apex not known; spathe tube 6.5–7 cm \times 5.5–6 mm, drying matte, dark brown on outer surface, weakly glossy, reddish brown on inner surface; spathe blade ca. 6 cm long, 9 mm wide (flattened), drying matte, medium-dark tan; **spadix** curved forward, ca. 10.5 cm long (est.), sessile, adnate to spathe 5.2–5.5 cm at base, the entire length of pistillate portion, occasionally onto sterile staminate portion 2–3 mm; pistillate portion 5.2–5.5 cm \times ca. 3 mm, drying medium-dark to dark reddish brown; fertile staminate portion pink, total length not known, 2–3 mm diam., narrowed toward base, drying pale grayish brown; sterile staminate portion 1.8–2.5 cm \times 1.5–3 mm, drying dark reddish brown; pistils weakly coherent, ca. 4 across the axis (viewed from above), 2–2.5 mm long; ovaries subglobose, 2.5–3 mm diam., drying cream to brownish cream, with or without moderately darker veins; style Type 8 (Fig. 1), 0.8–1 \times 1.5–2.2 mm, comprising ca. 1/2 of the length of pistil, broader than ovary apex, the margins not coherent with those of adjacent styles; **stigma** ca. 0.2 mm diam., elevated on and wider than narrowed portion of style, drying yellowish to amber; synandria ca. 1 \times 1–1.2 mm, coherent, truncate, deeply 3- to 4-lobed, 3- to 4- androus; sterile flowers 0.5–0.8 \times ca. 1 mm, mostly 1-branched and subrounded in basal 10 whorls (some 2- to 3-branched), markedly laxly arranged, most conspicuously so toward base (axis mostly bare and few flowered), the branches convex at apex, abruptly narrowed below, otherwise 0.2–0.5 mm diam. and deeply irregularly lobed in apical 1 to 2 whorls, in 12 or more whorls. Berries not known.

Phenology. Flowering is only known to occur in *Chlorospatha noramurphyae* during the month of May.

Etymology. The epithet is named for Honora Murphy, formerly of Duke University and the Missouri Botanical Garden, former assistant of the senior author and the collector of the type of *Chlorospatha noramurphyae*.

Discussion. *Chlorospatha noramurphyae* is known only from the type collection made in Valle Department, Colombia, in the vicinity of Cali, near Villa Carmelo, in premontane wet forest on the eastern slopes of the Cordillera Occidental at 1700 m elevation. The species would be expected to occur elsewhere in the department, possibly also on the western slopes. When the collection was made, the type locality was in primary forest surrounded by coffee farms and was being rapidly cut. It is likely that the only known population has been destroyed. The species was found growing on steep slopes in red clay soil subsided by shale, with a thick layer of humus. The label notes report 1000 mm of annual rainfall for the area.

Chlorospatha noramurphyae is a member of *Chlorospatha* sect. *Occidentales* and is distinguished by its petiole, which is sheathed ca. three fourths of its length, and subhastate leaf blades, with the posterior lobes narrow and long relative to the length of the anterior lobe. The species is also distinguished by its long, weakly cucullate, red spathe (ca. 12.5 cm long) and its spadix, with the fertile staminate portion pink and the sterile staminate portion unusually long, 1.8–2.5 cm long. The sterile flowers are noteworthy, being in ca. 12 whorls, with most 1-branched and laxly arranged, and the axis almost bare in the basal one third of the sterile staminate portion.

Chlorospatha noramurphyae could be easily confused with *C. giraldoi*, also from Valle, near Cali, on the eastern and western slopes of the Cordillera Occidental, and is possibly sympatric with that species (see discussion under *C. giraldoi*).

Chlorospatha noramurphyae could possibly be confused with *C. ricautensis* from Reserva La Planada on the western slopes of the Cordillera Occidental in Nariño Department, Colombia, at 1800 m elevation. *Chlorospatha ricautensis* has sagittate leaf blades that dry semiglossy on both surfaces, with three pairs of primary lateral veins, and the posterior lobes directed toward the base. *Chlorospatha noramurphyae* differs in having subhastate leaf blades that dry matte on the upper surface and weakly glossy on the lower surface, with five to seven pairs of primary lateral veins. The spathe of the latter species is entirely red, differing from that of *C. ricautensis*, which has a purple tube and weakly purple-tinged, greenish cream blade. The pistils of *C. ricautensis* are densely arranged, with the style

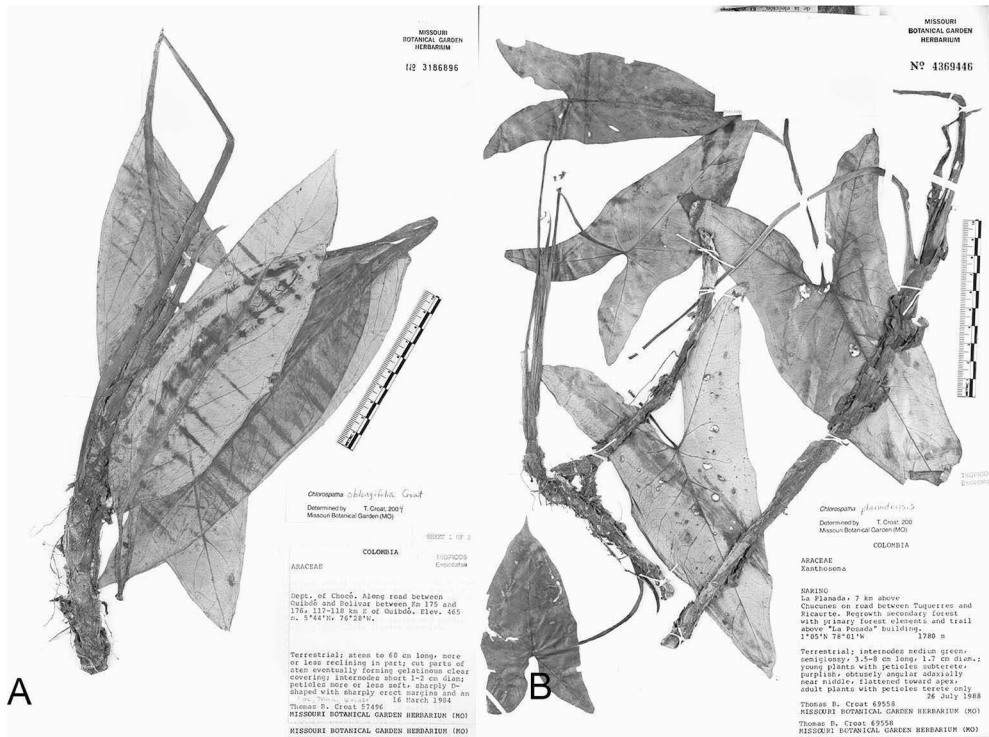


Figure 40. —A. *Chlorospatha oblongifolia* Croat & L. P. Hannon, the paratype specimen Croat 57496 (MO-3186896). —B. *Chlorospatha planadensis* Croat & L. P. Hannon, the paratype specimen Croat 69588 (MO-4369446).

(Type 9, Fig. 1) comprising ca. one third of the length of the pistil, whereas those of *C. noramurphyae* are laxly arranged, with the style (Type 8, Fig. 1) comprising one half of the length of the pistil. The synandria of *C. ricautensis* are 5- to 6-androus, a rare condition in the genus, thus differing from those of *C. noramurphyae*, which are 3- to 4-androus. In *C. noramurphyae*, the sterile staminate portion of the spadix is longer, 1.8-2.5 cm long, although the spadix is shorter than that of *C. ricautensis* in which the sterile portion is 1.5-1.8 cm long. The sterile flowers are similar in both species, but are laxly arranged in *C. noramurphyae* and densely arranged in *C. ricautensis*.

53. *Chlorospatha oblongifolia* Croat & L. P. Hannon, sp. nov. TYPE: Colombia. Chocó: vic. El Viente, 410 m, 5°45'N, 76°30'W, 16 Aug. 1997, Croat & J. Gaskin 80957 (holotype, MO-5796074!; isotypes, F!, HUAL, K!, NY!, US!). Figures 3A-F, 40A.

Herba ca. 50 cm; internodia ca. 1 × 0.8-2 cm; cataphylla 9-18 cm longa. Petiolus (12-)14.5-34 cm longus, vaginatus per 6-10.5 cm; lamina foliaris oblonga vel ovato-elliptica, (15-)18-33 × (2.7-)3.5-13.5 cm, nervis primariis later-

alibus utroque (6)7-10. Inflorescentiae 6 in quaque axilla; pedunculus 5-6 cm × 3-4 mm; spatha erecta, 3-5.3 cm longa, tubo 3-6 mm diam.; spadix erectus, 2.2-3.9 cm longus.

Terrestrial herb, ca. 50 cm tall; stem decumbent, to 60 cm long, erect, ca. 15 cm, with remnants of old leaf bases and cataphylls persisting ± intact or semi-intact along its length, eventually ± fibrous; sap ± transparent, becoming gelatinous; internodes ca. 1 × 0.8-2 cm, semiglossy, dark green, quickly becoming gray-green, drying weakly glossy, medium to dark brownish gray; cataphylls 9-18 cm long, obtuse with acumen at apex, obtusely 1-ribbed toward apex or entirely acutely 2-ribbed, thin, semiglossy, pale-medium green, drying weakly glossy to semiglossy, medium-dark reddish brown. LEAVES 3 to 4, erect-spreading; petioles (12-)14.5-34 cm long, moderately firm or soft, glabrous, weakly glossy, medium to dark green, drying weakly glossy to semiglossy, dark reddish brown, sheathed 6-10.5 cm, ca. 1/4 to 1/3 of total length; sheath decurrent at apex; free portion 4-8 mm diam. midway, frequently thicker than broad, obtusely 1-ribbed medially, sharply D- or C-shaped, the margins bluntly acute, frequently becoming acute and alate toward apex (to 1.5 mm wide near apex); blades oblong to ovate-elliptic, (15-)18-33 × (2.7-)3.5-13.5 cm, nervis primariis later-

3.5–13.5 cm, briefly narrowly acuminate at apex, (2.4 to)3.5 to 5.6 times longer than wide, broadest at or below middle, \pm acute at base and usually inequilateral at point of attachment, occasionally weakly cordulate, decurrent onto petiole, \pm symmetrical, thin to thinly coriaceous, weakly to conspicuously bicolorous; upper surface quilted, semiglossy to glossy, medium-dark to dark green, drying weakly glossy to semiglossy, dark yellowish brown; lower surface weakly glossy to semiglossy, drying semiglossy to glossy, weakly to moderately paler; midrib deeply sunken on upper surface, round-raised on lower surface, weakly paler than surface, drying \pm flattened, moderately darker than surface; primary lateral veins (6)7 to 10 pairs, arising at 27° – 40° (– 45°), \pm straight to weakly arcuate, occasionally moderately arcuate, quilted-sunken on upper surface, convex on lower surface, concolorous, drying flattened, weakly to moderately darker than surface; secondary veins sunken on upper surface, raised on lower surface, drying weakly raised, concolorous to weakly darker than surface; tertiary veins entirely raised or in part raised and otherwise prominulous on lower surface, drying in part weakly prominulous, otherwise flat, concolorous to weakly darker than surface; reticulate veins obscure, drying obscure; collective veins 3, the innermost arising from the base, loop-connected with all preceding lateral veins, \pm parallel to and 3–8 mm from margin. INFLORESCENCES erect, to 6 per axil, emitting a spicy-sweet fragrance at anthesis; peduncle held within the sheath, 5–6 cm \times 3–4 mm, weakly broader than thick, obtusely triangular and flattened adaxially, weakly sulcate at apex, weakly glossy, pale to pale-medium green, drying weakly glossy, dark reddish brown; **spathe** erect, 3–5.3 cm long, ovate, cuspidate at apex; spathe tube matte, white to pale green on outer surface, weakly glossy to semiglossy on inner surface, 1.2–2.3 cm \times 3–6 mm, weakly thicker than broad, drying matte, medium-dark reddish brown on outer surface, matte to weakly glossy on inner surface; spathe blade weakly glossy, white to greenish cream on outer surface, semiglossy on inner surface, 1.8–3 cm \times 3–5 mm, drying weakly glossy, pale-medium reddish brown on both surfaces, opening broadly at anthesis, marcescent, erect after anthesis; **spadix** erect, 2.2–3.9 cm long, sessile, adnate to spathe 5–9 mm at base, ca. 1/2 to 3/4 of the length of pistillate portion; pistillate portion greenish cream to pale green, 0.7–1.5 cm \times 2–4 mm, broadest midway, drying dark reddish brown; fertile staminate portion white to weakly green-tinged cream, 1.1–1.9 cm \times 2–4 mm, weakly cylindrical, thicker than broad, \pm clavate, bluntly acute at apex, drying medium

yellowish brown; sterile staminate portion white or cream, 3–10 \times 1.5–3 mm, broadest at base, drying medium to medium-dark yellowish brown; pistils weakly coherent, ca. 3 to 4 across the axis (viewed from above), 1.2–1.5 mm long; ovaries \pm cylindrical, greenish cream to pale green, ca. 1 \times 1–1.8 mm, drying pale tan, 3-locular, with axile placentation; ovules 8 to 10 per locule, anatropous, 2- to 3-seriate; funicle longer than ovule; style Type 10 (Fig. 1), 0.3–0.5 \times 0.7–1.2 mm (attenuate portion ca. 0.3 mm long), comprising 1/4 to 1/3 of the length of pistil, narrower to weakly broader than ovary apex, with red chromoplasts, the margins not coherent with those of adjacent styles; **stigma** greenish cream, ca. 0.2–0.25 mm diam., weakly elevated on narrowed portion of style, drying medium to dark reddish brown; synandria 1–1.1 \times 1.5–1.7 mm, coherent, truncate, 2- to 3-lobed, 2- to 3-androus (mostly 3); pollen exine smooth (Fig. 3A–F); sterile flowers 0.5–0.7 \times 1.2–2 mm, weakly elongated in direction of axis, \pm coherent, truncate, subprismatic or prismatic (in apical 1 to 3 whorls), in 3 to 7 whorls. Berries not known.

Phenology. Flowering is only known to occur in *Chlorospatha oblongifolia* in the months of March, April, and July through November. Inflorescences are fragrant and emerge in slow progression, with several days between anthesis of one inflorescence and emergence of the next inflorescence at the apex of the petiole sheath.

Etymology. The epithet is taken from the Latin “oblongus,” meaning “oblong,” referring to the unusual leaf blade shape of *Chlorospatha oblongifolia*.

Discussion. *Chlorospatha oblongifolia* is known from a relatively small area to the east of Quibdó, just east of Tutunendo in Chocó Department, Colombia, in tropical rainforest at 410–465 m elevation on the western slopes of the Cordillera Occidental. The species would be expected to occur elsewhere within the department.

Chlorospatha oblongifolia is a member of *Chlorospatha* sect. *Occidentales* and is distinguished by its semiglossy to glossy, dark green, narrowly oblong to ovate-elliptic leaf blades that are much longer than wide, more or less acute at the base and usually inequilateral at the point of petiole attachment. This mature blade shape is found in only one other species, *C. portillae*, and only rarely in juvenile specimens of a few additional species. The species is also distinguished by its petiole, which is sheathed one fourth to one third of its length, with the free portion obtusely 1-ribbed medially and sharply D- or

C-shaped, with the margins bluntly acute midway, becoming acute and occasionally alate near the apex, with the alate portion to 1.5 mm wide. The peduncle is unusually thick for its length (5–6 cm long), being ca. 4 mm diameter. Such large diameter is usually observed only in much larger species with long peduncles. The inflorescence is also unusually small, 3–5.3 cm long. The style is narrowly attenuated, thus elevating the stigma.

Chlorospatha oblongifolia could not be confused with any known species of *Chlorospatha*. Vegetatively, it most closely resembles *C. portillae*, which occurs only on the eastern slopes of the Andes in Zamora-Chinchipe Province in southeastern Ecuador. *Chlorospatha oblongifolia* has petioles that are sharply C- or D-shaped, with raised or alate margins and a medial rib, whereas the petiole of *C. portillae* is terete and lacks a medial rib. Both species have relatively short peduncles and small inflorescences, but *C. oblongifolia* differs in having no more than six inflorescences in a sympodium, with the peduncle held within the petiole sheath and the spathe entirely green. The peduncle and spathe are purple or purplish in *C. portillae*, which has 10 inflorescences per sympodium, with the sympodium held within a sympodial cataphyll. The most notable differences are in the pistils. The style of *C. portillae* lacks a mantle, whereas that of *C. oblongifolia* is expanded into a prominent mantle.

Paratype. COLOMBIA. **Chocó:** along Quibdó–Bolívar rd., betw. Km. 175 & Km. 176, 117–118 km E of Quibdó, 465 m, 5°44'N, 76°28'W, 16 Mar. 1984, *Croat 57496* (CHOCO, COL, HUA, JAUM, MO-3186896, MO [2]-3186897).

54. *Chlorospatha planadensis* Croat & L. P. Hannon, *Aroideana* 33: 81–84. 2010. TYPE: Colombia. Nariño: Res. Nat. La Planada, 7 km from Chucunés, 1800 m, 1°10'N, 77°58'W, 1 Nov. 1987, *O. Benavides 8686* (holotype, MO-3656423!; isotype, PSO not seen). Figure 40B.

Terrestrial or hemiepiphytic herb, to ca. 1 m tall; stem decumbent, with remnants of old cataphylls persisting \pm intact along its length; sap milky; internodes (2–)3.5–8 \times 1.7 cm, semiglossy, medium green, occasionally weakly violet-tinged, drying matte to weakly glossy, dark green to blackish green (all measurements made from dried material); cataphylls 10–33 cm long, obtuse with subapical apiculum at apex, 1-ribbed abaxially, drying weakly glossy to semiglossy, medium-dark reddish brown. LEAVES 1 to 3, erect-spreading; **petioles** 66–77 cm long, glabrous, green, drying weakly glossy to semiglossy, dark brown, sheathed 28–29 cm, slightly more than

1/3 of total length; sheath decurrent at apex; free portion 4–7 mm diam. midway, terete, obtusely angular at apex; **blades** subhastate, broadly triangular, 31–33.5 \times 23–27 cm, 1.2 to 1.3 times longer than wide, weakly acuminate at apex, broadest at base, ca. 1.5 times wider at base than across anterior lobe (measured tip to tip across posterior lobes), thinly coriaceous, moderately to prominently bicolorous; upper surface broadly quilted, semiglossy, dark green, drying weakly glossy to semiglossy, brownish green; lower surface semiglossy, drying semiglossy to glossy, weakly to moderately paler; anterior lobe 21–23 \times 17.5–18 cm, 1.2 to 1.3 times longer than wide, 1.4 to 1.6 times longer than posterior lobes, broadest at or near base, \pm symmetrical to weakly inequilateral, occasionally with one side ca. 1 cm wider than opposite side; posterior lobes directed somewhat outward, 14–16 \times 8.5–10 cm, 1.4 to 1.7 times longer than wide, narrowly rounded at apex, broadest at base, weakly inequilateral, the inner side narrower, weakly to broadly rounded toward base, moderately attenuate and decurrent onto petiole or possibly occasionally onto posterior rib; outer side 1.3 to 1.4 times wider than inner side midway, \pm straight to weakly concave or weakly convex toward base; midrib and major venation deeply sunken on upper surface, round-raised on lower surface, drying weakly raised to weakly flattened, weakly darker than surface; **basal veins** 5 pairs, coalesced into a prominent posterior rib; primary lateral veins 5 pairs, arising at 40°–60°, most acutely toward apex, weakly to moderately arcuate; secondary veins sunken on upper surface, raised on lower surface, drying weakly raised, weakly darker than surface; tertiary veins in part sunken on upper surface, raised on lower surface, darker than surface, drying weakly prominulous, weakly darker than surface; reticulate veins visible, flat on lower surface, darker than surface, drying in part visible, distinct, \pm concolorous; collective veins 3, the innermost arising from one of the lateral veins on inner side of posterior lobe, loop-connected with all preceding lateral veins, weakly scalloped, usually moderately remote from margin, 5–12 mm from margin. INFLORESCENCE erect, 1 per axil; peduncle held within the sheath, 49 cm \times 3–5 mm, drying semiglossy, dark reddish brown; **spathe** length not known; spathe tube dark violet or purple, ca. 5.2 cm \times ca. 5 mm, drying matte to weakly glossy, dark reddish brown on both surfaces; spathe blade not known, possibly dark purple; **spadix** total length not known, sessile, adnate to spathe ca. 4 cm at base, the entire length of pistillate portion; pistillate portion ca. 4 cm \times ca. 5 mm, drying dark reddish brown; fertile staminate portion cream-colored or white, length not

known, 2–4 mm diam., narrowed at base, drying dark reddish brown; sterile staminate portion ca. 1 cm \times 2.5–3.5 mm, broadest near apex, drying medium-dark to dark reddish brown; pistils weakly coherent, ca. 4 across the axis (viewed from above), ca. 2 mm long; ovaries subglobose, ca. 1 \times ca. 2–2.2 mm; style Type 5 (Fig. 1), ca. 0.8–1 \times 2 mm, comprising ca. 1/2 of the length of pistil, much broader than ovary apex, the margins \pm coherent with those of adjacent styles; **stigma** ca. 0.3–0.8 mm diam., prominent, elevated on and broader than narrowed portion of style, drying dark reddish brown, occasionally paler; synandria 1–1.3 \times 1.5 mm, or 2 \times 1 mm diam. and \pm elongated in direction of axis, coherent, truncate, 3- to 4-lobed, 3- to 4-androus; sterile flowers ca. 1 \times ca. 1 mm in basal whorl, otherwise 1.5–2 \times 3 mm diam. and elongated in direction of axis, coherent, truncate, subprismatic, in 3 to 5 whorls. Berries not known. JUVENILE plants with internodes 1.5–3 \times ca. 1 cm; petioles 17–22 cm long, purplish, sheathed ca. 1/3 of total length; free portion subterete, obtusely angular midway, flattened toward apex; blades sagittate, narrowly triangular, 16–21.5 \times 8–13 cm, frequently weakly to moderately constricted in area of petiole attachment, drying moderately bicolorous.

Phenology. Flowering is only known to occur in *Chlorospatha planadensis* during the months of January and November.

Discussion. *Chlorospatha planadensis* is known only from the western slopes of the Cordillera Occidental, at La Planada Reserve in Nariño Department in southern Colombia, at 1780–1800 m elevation. The area is north of Ricaurte, near Chucunés, in an area of regrowth secondary forest that includes primary forest elements. The species was collected in premontane wet forest, possibly also in an area of either premontane wet forest or lower montane wet forest, and would be expected to occur elsewhere in the department and southward into northern Ecuador.

Chlorospatha planadensis is a member of *Chlorospatha* sect. *Occidentales* and is distinguished by its terrestrial or hemiepiphytic habit and markedly long internodes, the longest in the genus, which are semiglossy, medium green, and occasionally violettinged. The species is also distinguished by its semiglossy, dark green, subhastate, and broadly triangular leaf blades with broad posterior lobes. *Chlorospatha planadensis* is unusual in the genus in having the petiole sheathed only one third of its length, but with the peduncle much longer than the sheath. The peduncle is usually only slightly longer or shorter than the petiole sheath in *Chlorospatha*.

The inflorescence of *C. planadensis* is presumably large, the spathe tube being 5.2 cm long and dark violet to purple on both surfaces. The spathe blade was not examined, but label notes indicate that it too is possibly dark purple.

Chlorospatha planadensis could be most easily confused with *C. ricautensis*, with which it is sympatric at La Planada Reserve. Both species have semiglossy leaf blades, semiglossy, medium green internodes, and purple spathe tubes. *Chlorospatha ricautensis* is terrestrial, having been collected in a pasture, with short internodes and sagittate leaf blades with three pairs of primary lateral veins and narrow posterior lobes. *Chlorospatha planadensis* differs in being frequently hemiepiphytic and having long internodes, subhastate blades with five pairs of primary lateral veins, and broad posterior lobes. The petiole of *C. ricautensis* is sheathed two thirds of its length, with the sheath free-ending at the apex, and the peduncle is 23–31 cm long. In *C. planadensis*, the petiole is sheathed one third of its length, with the sheath decurrent, and the peduncle is much longer, 49 cm long. The inflorescence of *C. planadensis* is probably significantly smaller, with the tube 5.2 cm long versus 6.5–7 cm long in *C. ricautensis*. The sterile staminate portion of the spadix of *C. ricautensis* is unusually long (1.5–1.8 cm), with most flowers branched, whereas that portion is short in *C. planadensis* (1 cm long), with the flowers subprismatic. The style of *C. ricautensis* (Type 9, Fig. 1) comprises ca. one third of the length of the pistil, whereas that of *C. planadensis* (Type 5, Fig. 1) comprises ca. one half of the length. The synandria of *C. ricautensis* are 5- or 6-androus, a rare condition in the genus, whereas those of *C. planadensis* are 3- or 4-androus.

Only the type specimen is fertile, with only a partial inflorescence available for examination. *O. Benavides 11253* is a sterile collection, but the label notes indicate that the spathe is purple and the spadix white; therefore, it would appear to accord with this species, in most respects.

Additional specimens examined. COLOMBIA. **Nariño:** La Planada Reserve, 1°10'N, 77°58'W, 17 Jan. 1990, *O. Benavides 11253* (MO, PSO); La Planada Res., 7 km above Chucunés on Túquerres–Ricaurte rd., trail above La Posada bldg., 1780 m, 1°05'N, 78°01'W, 26 July 1988, *Croat 69558* (B, K, MO-4369446, US); Res. Nat. La Planada, Mpio. Ricaurte, Border Pialapi, 1800 m, 12 Nov. 1993, *C. Restrepo CR 667* (MO).

55. *Chlorospatha plowmanii* (Madison) Croat & L. P. Hannon, comb. nov. Basionym: *Caladium plowmanii* Madison, Phytologia 35: 104. 1976. TYPE: Ecuador. Sucumbíos: 31 mi. W of Lago

Agrio on rd. to Baeza, 700 m, *T. Plowman*, *C. Sheviak* & *E. W. Davis* 3979 (holotype, GH!; isotypes, M!, MO!, P not seen, SEL!). Figures 3G–L, 41A–D.

Terrestrial herb, 30–50 cm tall, in small colonies; stem decumbent, with remnants of old cataphylls persisting as a few short, brown fibers, occasionally in part semi-intact, occasionally producing bulbils randomly along its length; bulbils solitary, 1–3 × 1–3 mm, subglobose; sap milky; internodes 1–3 × 0.8–1.5 cm, semiglossy, medium to dark green, becoming matte to weakly glossy with age, drying matte, dark brown or greenish brown; cataphylls 6–11 cm long, obtuse and inequilateral with acumen at apex (acumen 0.5–1.5 cm long), obtusely 1(2)-ribbed abaxially, matte to weakly glossy, pale to medium green, rarely purple-mottled in narrow transverse bands (*Croat et al. 88008A*), drying matte, medium to dark brown. LEAVES 5 to 10, erect, erect-spreading, spreading and reflexed-spreading; **petioles** 13–26 cm long, glabrous, matte, medium to medium-dark green, rarely dark purple (*Croat et al. 96410*), drying matte, medium to dark brown or greenish brown, sheathed 4–7.5 cm, ca. 1/4 of total length, occasionally 1/3, rarely 1/2 (in Zamora-Chinchi); sheath decurrent at apex, or frequently with one side wider and free-ending, the sides ± erect; free portion 2.5–4 mm diam. midway (drying 2–3.5 mm diam.), terete or subterete, obtusely to weakly acutely sulcate in apical 5 cm, rarely sharply D-shaped and obtusely sulcate throughout (*Croat et al. 88008A*); **blades** held ± horizontally, hastate to subhastate, occasionally subsagittate (in young blades), 12.5–25 × 12.5–21 cm, 1 to 1.3(to 1.5) times longer than wide, acute to acuminate or apiculate at apex, frequently as wide as long, broadest at base, (1.5 to)1.7 to 2.8 times wider at base than across anterior lobe (measured tip to tip across posterior lobes), occasionally weakly constricted in area of petiole attachment, thin, moderately bicolorous, the margins frequently narrowly undulate; upper surface broadly quilted, velvety, dark green to yellowish green, drying matte to velvety-matte or weakly glossy, dark green; lower surface reticulate, weakly glossy, narrowly colliculate along all venation, drying weakly glossy to semiglossy, weakly to moderately paler; anterior lobe 11–20 × 6.5–10.5 cm, 1.4 to 2 times longer than wide, 1.5 to 2 times longer than posterior lobes, broadest at or near base; posterior lobes directed prominently outward, (5.5–)6.5–12.5 × (2–)2.8–5.5 cm, 1.9 to 3.6 times longer than wide, acute to bluntly acute at apex, rarely narrowly rounded, broadest at base or below middle, symmetrical or moderately inequilateral, the inner side narrower, weakly to broadly rounded toward base,

briefly to moderately attenuate onto posterior rib; outer side 1.3 to 1.5 times wider than inner side midway, weakly concave or occasionally weakly convex toward base; midrib and major venation deeply sunken on upper surface, round-raised on lower surface, green and weakly darker than surface, rarely moderately purple-tinged, drying raised, weakly to prominently darker than surface; **basal veins** 2 to 3 pairs, coalesced into prominent posterior rib; posterior rib naked 3–5(–10) mm per side; primary lateral veins 3 to 4 pairs, arising at 20°–50°, most acutely toward apex, moderately arcuate; secondary veins weakly quilted-sunken on upper surface, in part raised and otherwise prominulous on lower surface, concolorous, drying weakly raised, usually darker than surface; tertiary veins mostly weakly raised, otherwise prominulous on lower surface, drying entirely or in part raised or prominulous, usually darker than surface; reticulate veins prominulous on lower surface, concolorous, drying in part prominulous, otherwise flat, visible, distinct, concolorous to weakly darker than surface; collective veins 3, the innermost arising from apex of posterior rib or occasionally from one of the lateral veins on the inner side of the posterior lobe, moderately scalloped, 4–7 mm from margin. INFLORESCENCES erect, 3 to 5 per axil, odorless; sympodium held within sympodial cataphyll; sympodial cataphyll 5–8 × 1–1.5 cm, acuminate at apex, obtusely or acutely 1- to 2-ribbed abaxially, pale to medium green; peduncle 3–6.5 cm × ca. 1(–2.5) mm, terete to weakly cylindroid, narrowing toward base, matte, pale to pale-medium green, drying ca. 1 mm diam., matte, dark brown; **spathe** erect, 4–9.3 cm long (1–4 cm longer than spadix), oblanceolate, acute to weakly acuminate at apex, opening narrowly most of its length at anthesis (to within 1–2 mm of base); spathe tube matte to weakly glossy, medium green, occasionally purplish green on outer surface, weakly glossy to glossy and paler on inner surface, 1.5–2.4 cm × 3–5 mm (to 8 mm diam. at anthesis), drying 2–3 mm diam., matte, dark brown; spathe blade erect to erect-spreading, weakly glossy to semiglossy, pale to medium green or yellow, rarely weakly to prominently purple-tinged on outer surface, weakly glossy to semiglossy and weakly paler on inner surface, 4–7.3 cm × ca. 5 mm, 1.2–1.5 cm wide (flattened), drying matte to weakly glossy, dark brown or reddish brown on outer surface, weakly glossy to semiglossy and weakly paler on inner surface, reflexing after anthesis, frequently forming a coil or spiral with margins out-rolled, marcescent or ± caducous, quickly deciduous; **spadix** erect, curving forward at anthesis, 4.4–5.7 cm long, sessile, ± cylindrical, adnate to spathe ca. 6 mm at base, slightly

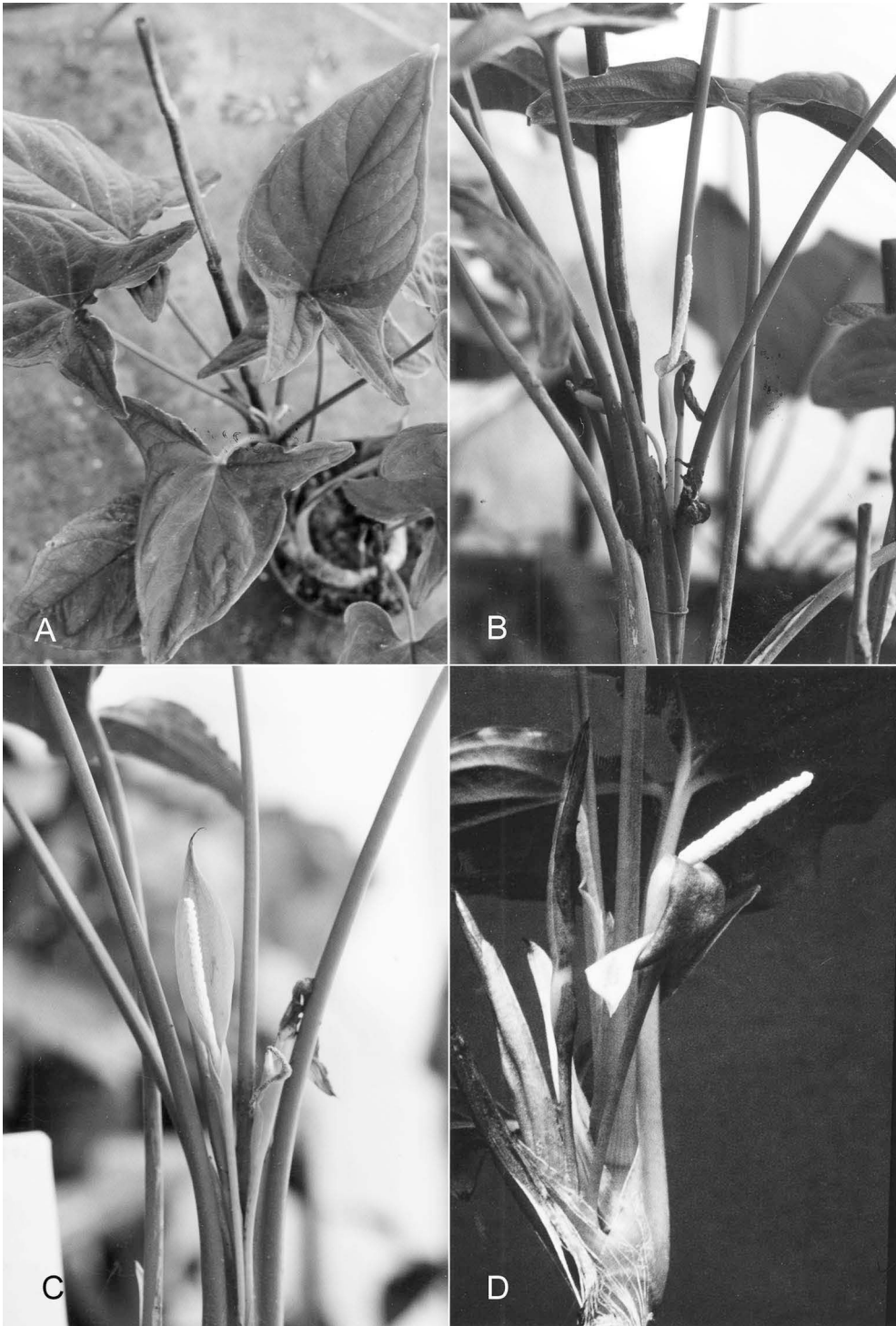


Figure 41. *Chlorospatha plowmanii* (Madison) Croat & L. P. Hannon. —A. Potted plant, showing the quilted leaf blades and inflorescences seen at center. —B. Stem with petioles visible and a post-anthesal inflorescence that shows the reflexed spathe blade (side view). The reflexed and deciduous spathe blade is only known in this species. —C. Stem with petioles and one inflorescence at anthesis with the spathe blade still erect (frontal view). —D. Axillary cluster of inflorescences, contrasting both pre-anthesal and post-anthesal spathe position with the blades erect and reflexed, respectively. A–C photographed from the cultivar Croat & L. P. Hannon 81475 (MO). D photographed from the SEL live accession of the type collection Plowman *et al.* 3979.

less than 1/2 of the length of pistillate portion; pistillate portion cream, 1–1.5(–2.2) cm × 2–3 mm, weakly broadest midway; fertile staminate portion cream-colored (rarely yellow), 2–3 cm × 2–2.5 mm, bluntly to narrowly rounded at apex, weakly tapering; sterile staminate portion white to creamy white (rarely purple-tinged basally), 5–8 × ca. 2 mm, weakly narrower than pistillate and fertile staminate portions; pistils weakly coherent to ± laxly arranged, 2 to 3 across the axis (viewed from above), ca. 1 mm long; ovaries cream-colored, 1–1.2 mm diam., ± cylindrical to obtusely obconical, broadly depressed medially, 2-locular, with pseudoaxile placentation and 6 to 10 ovules per locule, or rarely 1-locular, with basal placentation and 16 to 20 ovules, or with single deeply intrusive parietal placenta; ovules hemianatropous, biseriate, occasionally 3-seriate; funicles shorter than ovule; style Type 1 (Fig. 1), 1–1.2 mm diam., thin, as broad as ovary apex, the margins obscure, not coherent with those of adjacent styles; stigma white, ca. 0.2 mm diam., sessile, broadest and truncate at apex; synandria ca. 1 mm long, 1.5–2.5 × 1–1.5 mm diam. and ± elongated in direction of axis, coherent, sometimes highly bilaterally symmetrical, sometimes subrounded, prominently and deeply 2- to 3(4)-lobed (occasionally almost to middle), broadly concave medially, with lobes thickened, the margins sinuate-undulate and weakly interlocking with those of adjacent flowers, 2- to 3(4)-androus (mostly 3), the thecae each with a terminal pore; pollen cream-colored, in tetrahedral or linear tetrads, with exine reticulate (Fig. 3G–L); sterile flowers less than 1 mm long, 1.5–2 × 0.5–1.5 mm diam. and ± elongated in direction of axis, coherent, truncate, subprismatic to irregularly prismatic, in 3 to 5 whorls. INFRUCTESCENCE (Croat *et al.* 88008A) semiglossy, dark purple; berries medium green, purple-spotted at apex and exposed sides; seeds pale green, smooth.

Phenology. *Chlorospatha plowmanii* flowers freely, almost continuously, throughout the year. The species is unique in having a spathe blade that reflexes after anthesis and is then quickly deciduous. Spathe blades that reflex after anthesis have been observed in only two other species, *C. corrugata* and *C. limonensis*. Neither species could be confused with *C. plowmanii*. Inflorescences of *C. plowmanii* are odorless and emerge in quick succession, each reaching anthesis approximately one to three days after anthesis of the preceding inflorescence.

Etymology. *Chlorospatha plowmanii* is named for Timothy C. Plowman (1944–1989), formerly of the Field Museum in Chicago, a renowned Neotropical botanist and collector of many new taxa, including

the type of this species. Plowman was responsible for the successful introduction of countless ornamental plants from a wide variety of families.

Discussion. *Chlorospatha plowmanii* is widespread on the eastern slopes of the Andes in Ecuador, occurring in Morona-Santiago, Napo, Sucumbíos, and Zamora-Chinchiipe provinces at 250–1200(–1486) m elevation. Most collections were made in premontane wet forest, but some were made in tropical moist forest, premontane moist forest, or tropical wet forest. The species would be expected to occur northward into Colombia, many collections having been made near that border in the area to the south and north of Lumbaquí, near the type locality. It probably also occurs in Peru, *Jaramillo 14974* having been collected in easternmost Sucumbíos Province, near the Peruvian border.

Chlorospatha plowmanii, a member of *Chlorospatha* sect. *Orientalis*, is found in small colonies and is distinguished by its broadly quilted, subhastate to hastate leaf blades, with the posterior lobes long and narrow, the upper surface velvety, dark green and the lower surface conspicuously reticulate, with all venation glabrous. The petiole is usually sheathed only one fourth of its length. The species is also distinguished by its markedly short peduncle, 3–6.5 cm long and frequently shorter than the spathe. The spathe is usually green, occasionally with the tube purple-tinged, rarely the blade, and the blade yellow. The spadix is less than 6 cm long and usually entirely cream-colored. The morphology of some ovaries is unique in the genus. In several collections, one or two ovaries at the base of the pistillate portion were found to be unilocular with basal placentation, with all other ovaries bilocular with axile or subaxile placentation. The type plant (*Plowman et al.* 3979) is the exception, having most or possibly all ovaries unilocular with basal placentation. All ovaries of this collection were not dissected, but several were examined at different positions along the length of the pistillate portion and found to be unilocular with basal placentation. At present, *C. plowmanii* is the only species in which smooth seeds have been observed, but in only one collection (*Croat et al.* 88008A). This collection is atypical of the species in having more or less sagittate blades and sharply D-shaped petioles that are sulcate throughout and purple-mottled in transverse bands.

Chlorospatha plowmanii would be most easily confused with *C. pubescens*, which is also widespread on the eastern slopes of the Andes in Ecuador, at 400–1400 m elevation. The species appear to be sympatric in all provinces in which both occur. In both species, the leaf blades are broadly quilted,

velvety, dark green on the upper surface, and usually similarly shaped, with the length of the petiole sheath and the size and structure of the inflorescences also similar. The free portion of the petiole of *C. pubescens* is D-shaped, usually sharply so toward the apex, whereas that of *C. plowmanii* is usually terete or subterete. Old petiole bases and cataphylls persist only as short fibers or semi-intact remnants along the stem of *C. plowmanii*, but are more or less intact and cover the stem in *C. pubescens*. *Chlorospatha plowmanii* is entirely glabrous on all its parts, lacking any of the crispy-puberulent to granular-puberulent indumentum that is usually conspicuous in *C. pubescens*. The spathe blade of *C. plowmanii* reflexes after anthesis and is quickly deciduous. In *C. pubescens*, the spathe blade is usually erect after anthesis, only occasionally spreading, and abscises with the fertile staminate portion of the spadix. The syndria of *C. plowmanii* are 2- or 3(4)-androus, thus differing from those of *C. pubescens*, which are (2)3- or 4(5)-androus. The inflorescence of the latter species is sweetly fragrant, whereas that of *C. plowmanii* is odorless.

Madison (1976) published *Caladium plowmanii*, citing *Plowman et al. 3979* as the type, and in his 1981 treatment of *Chlorospatha*, combined *Caladium plowmanii* Madison and *Caladium longipodum* K. Krause in *Chlorospatha longipoda* (K. Krause) Madison. The type of *Caladium plowmanii* differs from that species in significant ways and is better combined in the new species, *Chlorospatha plowmanii* (see discussion under *C. longipoda*).

Additional specimens examined. ECUADOR. **Morona-Santiago:** Cordillera de Cutucú, Centro Shuar Uusuants/Transkutuku, 600 m, *W. Palacios et al. 15795* (MO, QCNE). **Napo:** Res. Biol. Jatún Sacha, 8 km from Puerto Misahuallí, rt. side of Río Napo, 450 m, *C. Cerón 1003* (MO, QAME, QCA, QCNE); *2111* (MO, QCA, QCNE); along Narupa-Coca rd., 4 km E of Narupa (jct. of Baeza-Tena rd.), 1312 m, *Croat et al. 87833* (AAU, B, BM, BR, CAS, COL, DUKE, F, GH, HUA, INB, JAUM, K, M, MEXU, MO, NY, P, PMA, QCA, QCNE, RSA, S, SEL, TEX, UB, US, VEN); Archidona-San Vicente Para rd., vic. San Pablo, 6.5 km E of Archidona, along Río Ollín, 543 m, *Croat et al. 88008A* (MO, QCNE); Archidona-Baeza rd., 39.9 km N of Archidona, 28.4 km S of Cosanga, 40.8 km S of jct. with Baeza-Papallacta-Lago Agrio rd., 1486 m, *Croat et al. 88036* (QCNE); along rd. to Mushullacta, 1–5 km S of main Narupa-Coca rd., vic. Parque Nac. Napo-Galeras, 1500 m, *Croat et al. 96410* (MO). **Sucumbios:** Zancudo Cocha, vic. of lake, S of & on trail to Río Aguarico, 220 m, *Jaramillo 14974* (QCA); Cantón Gonzalo Pizarro, Parroquia Gonzalo Pizarro, 8 km S of Recinto Amazonas, 800 m, *Yanez & Shuigra 846* (QCA). **Zamora-Chinchipec:** vic. El Panguí, hills W of town, 1200 m, *Croat 87190* (MO, QCNE); Podocarpus Nat. Park, study plot ca. 1 km SW of Bombuscaro Visitors Center, 6 km S of Zamora, 1050 m, *R. Leimbeck et al. 418* (AAU, QCA).

Cultivated specimens examined. ECUADOR. **Sucumbios:** along rd. to La Bonita, 6 km N from cut-off at Río Aguarico bridge on Lumbaquí-Lago Agrio rd., 472 m, *Croat & L. P. Hannon 81496* (MO); *81473* (MO); along rd. to La Bonita, 8 km N of cut-off at Río Aguarico bridge on Lumbaquí-Lago Agrio rd., 487 m, *Croat & L. P. Hannon 81475* (MO); 31 mi. W of Lago Agrio, *Madison 3747* (MO, NY, SEL); *4185* (SEL, ex. *Plowman et al. 3979*, GH, MO, P, SEL live acc. #75-0058-001).

56. *Chlorospatha portillae* Croat & L. P. Hannon, sp. nov. TYPE: Ecuador. Zamora-Chinchipec: along El Panguí-Zamora rd., vic. San Roque, 2 km S of San Roque, 10 km S of El Panguí, ca. 900 m, 3°42'11''S, 78°35'59''W, 7 Sep. 2002, *Croat 87201* (holotype, MO-5771767!; isotypes, AAU!, B!, CAS!, F!, GH!, HUA!, INB!, K!, M!, MEXU!, NY!, QCA!, QCNE!, S!, SEL!, UB!, US!, VEN!). Figure 42A–D.

Herba usque ad 50 cm; internodia 3–8(–10) mm × 1–2.7 cm; cataphylla 14–16.5 cm longa. Petiolus 20.5–42(–53) cm longus, vaginatus per 5–12 cm; lamina foliaris ovata, 20–34.5 × 6–20 cm, nervis primariis lateralibus utroque 5 vel 6. Inflorescentiae 10 in quaque axilla; pedunculus 9–17.5 cm × ca. 1 mm; spathe erecta, 3–5.4 cm longa, tubo 3–4.5 mm diam., lamina complanata 1.6–2.6 cm longa, 2.5–4 mm diam., 7–10 mm lata; spadix 2.3–3.5(–5) cm longus.

Terrestrial herb, to 50 cm tall; stem decumbent, with remnants of old cataphylls persisting ± intact to semi-intact and ± fibrous along its length, occasionally with few bulbils produced; bulbils ovoid, solitary, ca. 9 × 4 mm; sap milky; internodes 3–8(–10) mm × 1–2.7 cm, semiglossy, gray-green, drying matte to weakly glossy, dark brown (all measurements made from dried material); cataphylls 14–16.5 cm long, ± acuminate or obtuse with acumen at apex, 1-ribbed abaxially, pale-medium green, weakly darker maroon-speckled, dark maroon at apex and on abaxial rib, drying weakly glossy to semiglossy, dark reddish brown, weakly fibrous. LEAVES 2 to 4, erect-spreading; **petioles** 20.5–42(–53) cm long, glabrous, semiglossy, dark green, or weakly to prominently maroon-tinged, or entirely dark maroon, drying matte, dark reddish brown, sheathed 5–12 cm, ca. 1/4 of total length; sheath decurrent at apex; free portion 2–5(–9) mm diam. midway, terete or sharply flattened adaxially in apical 3–4 cm, with margins acutely raised and an obtuse medial rib; **blades** narrowly ovate, 20–34.5 × 6–20 cm, (1.3 to) 2.5 to 3.3 times longer than wide, acuminate at apex, broadest at or below middle, acute to rounded at base and frequently weakly inequilateral, occasionally cordulate, decurrent onto petiole, thinly coriaceous, moderately bicolorous, ± symmetrical or weakly to moderately inequilateral, with one side to 2.5 cm wider than opposite side; upper surface quilted,

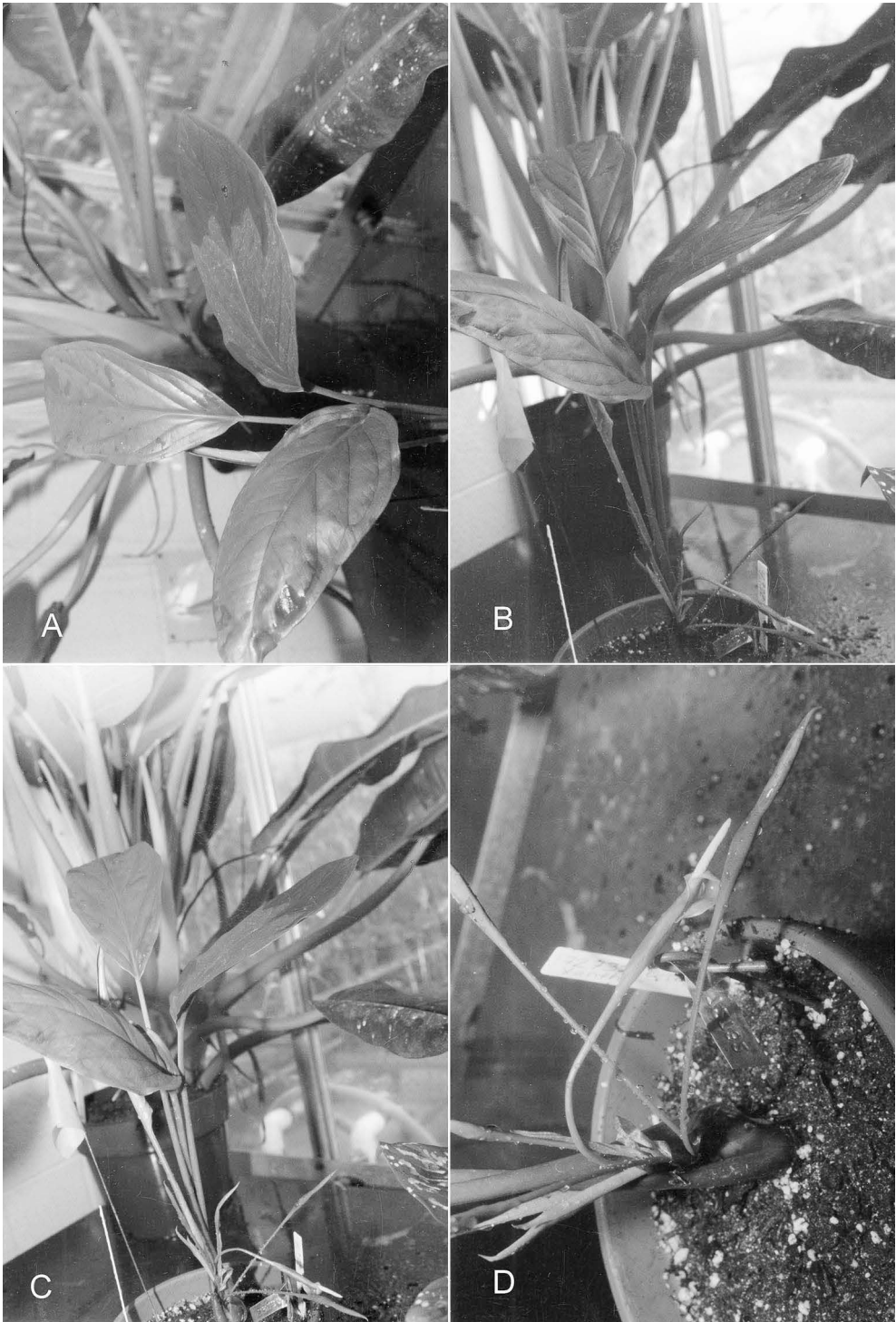


Figure 42. *Chlorospatha portillae* Croat & L. P. Hannon. —A. Close-up of leaf blade adaxial surfaces. —B. Plant habit, potted accession at MO. —C. Sympodia emerging from basal cataphylls, with one post-anthetal inflorescence at right. —D. Stem with nine inflorescences per axil, five immature and stiffly erect, three spreading, one of which is at anthesis. Photographed from the MO cultivar from the paratype Croat 72732.

semiglossy to glossy, dark green, drying weakly glossy, dark brownish green; lower surface glossy, drying semiglossy to glossy, weakly to moderately paler; midrib and major venation deeply sunken and concolorous on upper surface, narrowly raised on lower surface, concolorous or weakly to prominently maroon-tinged, drying \pm flattened, much darker than surface; primary lateral veins 5 to 6 pairs, arising at 25° – 40° , \pm straight to weakly arcuate; minor veins mostly flattened on lower surface, weakly darker than surface, drying concolorous to weakly darker than surface; secondary veins drying weakly prominent on lower surface; tertiary and reticulate veins flat, visible on lower surface, frequently darker than surface, drying in part visible; collective veins 3 to 4, the innermost arising from base, loop-connected with all preceding lateral veins, moderately scalloped, 5–13 mm from margin. INFLORESCENCES erect, to 10 per axil, the sympodium held within a sympodial cataphyll; sympodial cataphyll 7.4–12 \times ca. 1.5 cm, acuminate at apex, 1-ribbed abaxially; peduncle 9–17.5 cm \times ca. 1 mm, prominently thicker than broad, prominently purple-tinged or weakly to prominently dark purple-mottled, drying matte, blackish brown; **spathe** erect, 3–5.4 cm long, acuminate at apex; spathe tube medium green and purple-tinged on outer surface, pale green on inner surface, 1.2–2.8 cm \times 3–4.5 mm, drying matte, dark brown on outer surface, weakly paler on inner surface; spathe blade medium green and prominently purple-tinged on outer surface, pale green on inner surface, 1.6–2.6 cm \times 2.5–4 mm, 7–10 mm wide (flattened), drying matte, dark brown on outer surface, weakly paler on inner surface, marcescent, erect after anthesis; **spadix** erect, 2.3–3.5(–5) cm long, sessile, adnate to spathe 0.7–1.8 cm at base, 1/2 to 3/4 of the length of pistillate portion; pistillate portion white, 1–2.4 cm \times 2.2–3 mm, broadest near apex, drying dark brown; fertile staminate portion white, 1.1–2 cm \times 2–3 mm, ellipsoid, narrowly rounded at apex, drying medium yellow-brown; sterile staminate portion white, 3–4 \times 1–1.5 mm, cylindrical, drying pale-medium yellow-brown; pistils densely arranged, ca. 3 to 4 across the axis (viewed from above), 1.5–2 mm long; ovaries ovoid to \pm cylindrical, ca. 1.5 \times 1 mm, 2-locular, with axile placentation; ovules 8 to 10 per locule, hemianatropous, biseriolate; funicles shorter than ovules; style Type 2 (Fig. 1), 0.3–0.5 \times ca. 0.8 mm, comprising ca. 1/4 of the length of pistil, as broad as ovary apex, the margins obscure and weakly or not at all coherent with those of adjacent styles; **stigma** ca. 0.2 mm diam., capitate, weakly elevated on narrowed portion of style, drying dark brown; synandria ca. 1 \times ca. 1 mm, coherent, truncate, 2-

3-lobed, 2- to 3-androus; sterile flowers ca. 0.5 \times ca. 0.8 mm, coherent, truncate, subprismatic to prismatic, in 3 whorls. Berries not known.

Phenology. Flowering is only known to occur in *Chlorospatha portillae* during the months of July and September.

Etymology. *Chlorospatha portillae* is named for José (Pepe) Portilla Andrade, owner of Ecuagenera in Gualaceo, Ecuador, benefactor of our work with Araceae in Ecuador, and noted expert on Ecuadorian Orchidaceae. The species was collected near Portilla's hometown of El Panguí, Ecuador, and it is named in his honor for his support of our work with Ecuadorian Araceae.

Discussion. *Chlorospatha portillae* is known from five collections made in premontane wet forest on the eastern slopes of the Andes in Zamora-Chinchipec Province, Ecuador, at 875–1465 m elevation, with most made in the vicinity of El Panguí. The type was collected 10 km south of El Panguí, the other collections to the west and south of the type locality. The localities lie near the borders with Morona-Santiago Province and Peru, and the species would be expected to occur to the north in that adjoining province and possibly eastward into Peru. However, these sites are on the western side of the Cordillera del Cóndor, the summit of which follows the border between the two countries and possibly serves as a barrier to eastward distribution.

Chlorospatha portillae is a member of *Chlorospatha* sect. *Orientales* and is distinguished by its glossy, dark green, narrowly ovate leaf blades that are acute, rounded, or cordulate at the base, a shape not known in any other species from the eastern slopes of the Andes. The species is also distinguished by having 10 inflorescences per sympodium, the maximum number observed in the genus, with the sympodium held within a sympodial cataphyll, and by its small, purplish spathes (3–5.4 cm long). The synandria are truncate at the apex, an unusual condition in species from the eastern slopes in Ecuador. The pistils of this species are similar to those of only two species, *C. cutucuensis* and *C. sizemoreae*, also from the eastern slopes of the Andes in Ecuador, with the ovaries elongated and somewhat cylindrical or ovoid and the styles briefly attenuated and lacking a mantle. In *C. cutucuensis* and *C. sizemoreae*, the inflorescences are held within the petiole sheath, whereas in *C. portillae*, the inflorescences are held within a sympodial cataphyll toward the base of the petiole. Vegetatively, the two species are quite different from

C. portillae, both having more or less prominent posterior lobes.

Chlorospatha portillae could not be confused with any known species of *Chlorospatha*. Vegetatively, it most closely resembles *C. oblongifolia* from the western slopes of the Andes in Chocó Department in northern Colombia (see discussion under *C. oblongifolia*).

Paratypes. ECUADOR. **Zamora-Chinchipe:** along Zamora–Gualaquiza rd., 70.9 km N of bridge over Río Zamora in Zamora, betw. Los Encuentros & El Panguí, 935 m, 3°42'S, 78°25'W, 4 Mar. 1992, *Croat 72732* (MO [cult. at MO, cf. Fig. 42]); Los Encuentros–El Sarsa rd., Km. 14.7, 1455 m, 3°48'40''S, 78°36'28''W, 15 July 2004, *Croat, L. P. Hannon, G. Wahlert & T. Katan 91089* (MO, QCNE); along rd. from near Paquisha, S to Las Orquídeas, & end of rd. at Río Nangaritzta, via Guayzimi, beginning at 15.9 km E of Zumbi & Río Zamora, then 47 km S of intersection near Paquisha, 2.6 km N of Las Orquídeas, 875 m, 4°12'48''S, 78°38'41''W, 17 July 2004, *Croat, L. P. Hannon, G. Wahlert & T. Katan 91343* (MO, QCNE); betw. San Carlos & Nambija, on mining rd. E off of main San Carlos–Nambija rd. beginning 6 km S of San Carlos, 0.9 km up rd. toward mining operation at end of rd., 2.4 km from rd., 1465 m, 4°02'18''S, 78°47'52''W, 23 July 2004, *Croat, L. P. Hannon, G. Wahlert & T. Katan 91999* (MO, QCNE).

57. *Chlorospatha pubescens* Croat & L. P. Hannon, sp. nov. TYPE: Ecuador. Napo: along Archidona–San Vicente Para rd., 15.8 km E of Archidona, 5.7 km E of Santo Domingo, 10 km E of San Pablo, 797 m, 0°57'24''S, 77°43'49''W, 23 Apr. 2003, *Croat, L. P. Hannon & N. Altamirano 88000* (holotype, MO-5692342!; isotypes, B!, COL!, K!, NY!, QCNE!, S!, US!). Figure 43A, B.

Herba minus quam 50 cm; internodia 0.8–2 × 1–1.5 cm; cataphylla 7–13 cm longa. Petiolus (13–)16–29(–32) cm longus, vaginatus per 5–10(–14) cm; lamina foliaris hastata vel subhastata, interdum sagittata, (12.5–)15–21.5(–27) × (10–)12.5–19.5 cm, lobis posterioribus 5–10(–11.5) × (3–)3.5–6.5 cm, nervis basalibus utroque 1 vel 2(3), nervis primariis lateralibus utroque 3 vel 4. Inflorescentiae (1 ad)3 ad 6 in quaque axilla cataphyllo sympodiali 5–8 cm longo cinctae; pedunculus (3.5–)4.5–7(–8.5) cm × 1–1.5 mm; spatha 4.3–7(7.1) cm longa, tubo 3–6 mm diam., lamina complanata (2.5–)3.2–5.2(–5.5) × 1.2–1.8 cm; spadix 3.3–4.3(–4.6) cm longus.

Terrestrial herb, less than 50 cm tall, in small colonies; stem decumbent, erect 10–15 cm at apex, with remnants of old cataphylls persisting ± intact along its length, occasionally producing bulbils along its length; bulbils solitary, green, 2–3 × 2–3 mm; internodes 0.8–2 × 1–1.5 cm, weakly glossy to semiglossy, dark green or yellow-green, drying 7–10 mm diam., matte to weakly glossy, medium to dark brown or green; cataphylls 7–13 cm long, cuspidate

at apex, rarely obtuse with apiculum (apiculum 3–15 mm long), entirely acutely or bluntly 1- to 2-ribbed or in part only toward apex, usually entirely densely crispy-puberulent in minutely spaced longitudinal rows, or sparsely, crispy-puberulent along rib(s) and some veins, matte to weakly glossy, medium green, drying matte to weakly glossy, medium to dark brown. LEAVES (2 to)6 to 8, erect, erect-spreading, spreading to reflexed-spreading; **petioles** (13–)16–29(–32) cm long, minutely obtusely many-ribbed abaxially, usually crispy-puberulent along ribs, frequently more densely so or scurfy-pubescent in apical 3–4 cm, rarely only near apex, occasionally entirely granular-puberulent, matte, medium to dark green, drying matte, (medium) dark brown or greenish, sheathed 5–10(–14) cm, 1/10 to 1/4(1/3 to 1/2) of its length; sheath with sides ± erect, decurrent at apex, or with one side wider and prominently free-ending (free-ending portion 5 mm long, acute at apex), glossy and paler on inner surface; free portion 5–7 mm diam. midway (drying 2–5 mm diam.), obtusely D-shaped, the margins acute toward apex, rarely entirely sharply D- or U-shaped, obtusely or narrowly and shallowly sulcate, rarely narrowly triangular sulcate with flared margins concave in apical 4 cm; **blades** hastate or subhastate, occasionally sagittate, (12.5–)15–21.5(–27) × (10–)12.5–19.5 cm, 1.1 to 1.4 times longer than wide, weakly acuminate to apiculate at apex, rarely bluntly acute, broadest at base (rarely broadest across anterior lobe), 1.5 to 1.9(to 2.3) times broader at base than across anterior lobe (measured tip to tip across posterior lobes), thin to thinly coriaceous, conspicuously bicolorous (rarely moderately bicolorous), the margins broadly undulate, rarely crispate-undulate; upper surface broadly quilted, rarely flat, velvety, dark green, drying matte or velvety-matte, dark green (rarely dark yellow-brown); lower surface reticulate, matte, narrowly colliculate along all venation, drying weakly glossy to semiglossy, moderately to prominently paler (rarely weakly paler); anterior lobe (8.5–)10.5–18(–19.5) × (5.5–)7.5–12.5(–15.5) cm, (1.3)1.4 to 1.6(to 1.9) times longer than wide, (1.5 to)1.7 to 2.2(to 2.5 to 2.7) times longer than posterior lobes, broadest near base, weakly or not at all constricted at base, rarely moderately to prominently constricted, ± symmetrical; posterior lobes directed outward, 5–10(–11.5) × (3–)3.5–6.5 cm, (1.2 to)1.4 to 2.3(to 2.5) times longer than wide, bluntly acute to narrowly rounded at apex, broadest midway or near base, rarely weakly constricted at base, ± symmetrical, rarely weakly or moderately inequilateral, the inner side narrower, weakly to broadly rounded toward base and briefly attenuate



Figure 43. A, B. *Chlorospatha pubescens* Croat & L. P. Hannon. —A. Live plant from the paratype collection L. P. Hannon 02-071 (ABG-911415). —B. Herbarium specimen, Palacios 4795 (MO-4373109, sheet 1 of 2). C, D. *Chlorospatha ricautensis* Croat & L. P. Hannon, photographed from the type collection Croat 71405 (MO-3789359). —C. Fertile habit. —D. Close-up, showing erect inflorescence.

onto posterior rib, rarely decurrent onto petiole; outer side straight to weakly concave toward base, rarely 1.2 to 2.3 times wider than inner side midway; all orders of venation usually \pm crispy-puberulent to prominently granular-puberulent on lower surface, most densely so toward base of midrib, major veins and entire length of posterior rib; midrib deeply sunken on upper surface, occasionally entirely sparsely crispy-puberulent or in part only in basal 1/2, concolorous or weakly paler than surface and yellow-green, drying concolorous or weakly to moderately paler, round-raised or occasionally obtusely angular on lower surface, minutely many-ribbed, weakly paler to weakly darker than surface, drying weakly raised to \pm flattened, concolorous or weakly darker than surface; **basal veins** 1 to 2(3) pairs, coalesced into prominent posterior rib, the first free to the base, or with 3 to 6 branching off, the first free to the base, 1 to 2 acroscopic, 2 to 3 basiscopic, coalesced into weak posterior rib 3–4 cm long; posterior rib naked 3–8 mm per side (rarely not naked), round-raised with an acute medial rib on lower surface, finely many-ribbed, frequently \pm scurfy-pubescent, drying raised, darker than surface; primary lateral veins 3 to 4 pairs, arising at 15° – 45° (– 70°), most acutely toward apex, straight or moderately arcuate, deeply quilted-sunken (rarely etched-sunken) on upper surface, occasionally entirely sparsely crispy-puberulent or in part in basal 1/4 to 1/2, drying concolorous, or in part concolorous and otherwise weakly to moderately paler in basal 1/2, round-raised on lower surface, occasionally acutely or obtusely angular, minutely many-ribbed, weakly paler to weakly darker than surface, drying weakly raised and weakly flattened, concolorous or weakly darker than surface; secondary veins in part weakly sunken or obtusely sunken on upper surface, convex to narrowly raised on lower surface, concolorous to weakly darker than surface, drying raised or narrowly raised, concolorous to weakly darker than surface; tertiary veins usually obscure on upper surface, rarely obtusely sunken, entirely raised on lower surface, or in part raised and otherwise prominulous, concolorous to weakly darker than surface, drying entirely raised or in part raised and otherwise prominulous, weakly darker than surface; reticulate veins usually obscure on upper surface, rarely obtusely sunken, entirely prominulous on lower surface, or mostly prominulous and otherwise visibly distinct and flat, weakly darker than surface, drying entirely or in part prominulous and otherwise flat, weakly darker than surface; collective veins 2 to 4, the innermost arising from one of the lowermost lateral veins on inner side of posterior lobe, occasionally from apex of posterior rib,

loop-connected with all preceding lateral veins, weakly to moderately scalloped, 4–10(–16) mm from margin. INFLORESCENCES erect, (1 to)3 to 6 per axil, emitting a weak, sweet fragrance at anthesis; sympodium held within a sympodial cataphyll; sympodial cataphyll 5–8 cm long, pale-medium green, usually weakly crispy-puberulent or granular-puberulent along longitudinal veins (rarely glabrous), drying matte to weakly glossy, medium brown; peduncle (3.5–)4.5–7(–8.5) cm \times 1–1.5 mm, terete, or cylindroid and wider than thick, to 2.5 mm wide and 1.5 mm thick, rarely obtusely triangular and flattened adaxially, narrowest at base, matte, pale to medium-dark green (rarely creamy white or entirely or in part deeply purple-tinged), sparsely crispy-puberulent or granular-puberulent in longitudinal rows (rarely glabrous), drying matte to weakly glossy, medium to dark brown or greenish brown; **spathe** erect, frequently weakly cucullate, 4.3–7(7.1) cm long, usually entirely greenish cream, pale green or medium-pale green on both surfaces, rarely \pm deeply purple-tinged on outer surface, most prominently so on tube, oblanceolate, cuspidate at apex, opening narrowly or broadly most of its length at anthesis, the margins directed forward or weakly outward; spathe tube weakly glossy (semiglossy) on outer surface, \pm narrowly, sparsely crispy-puberulent or granular-puberulent at base (rarely entirely glabrous), weakly glossy (glossy) on inner surface, (1–)1.5–1.9 cm \times 3–6 mm, weakly thicker than broad, drying 2–4 mm diam., matte to weakly glossy, medium to dark brown or greenish on outer surface, paler on inner surface; spathe blade erect to erect-spreading, matte (semiglossy) on outer surface, matte (glossy) on inner surface, (2.5–)3.2–5.2(–5.5) cm long, 1.2–1.8 cm wide (flattened), obtusely 1-ribbed with most venation prominulous on outer surface, drying matte (rarely weakly glossy), medium to dark brown on both surfaces, usually weakly to moderately paler than tube, marcescent, usually erect after anthesis, rarely spreading; **spadix** erect, curving forward at anthesis, 3.3–4.3(–4.6) cm long, usually weakly stipitate ca. 1 mm at base (stipe and axis pale green), occasionally sessile, \pm cylindrical, adnate to spathe 2–3(–5) mm at base, along stipe and narrowly onto pistillate portion 2–3 mm, 1/4 or less of the length of pistillate portion, rarely to 1/2 of the length (*L. P. Hannon et al.* 97-365); pistillate portion cream or pale yellow-green, 0.8–1.7 cm \times 1.5–3 mm, broadest midway; fertile staminate portion white, cream, or creamy yellow, 1.2–2.3(–2.5) cm \times 2–3 mm, bluntly acute to narrowly rounded at apex, broadest at base, \pm cylindrical to weakly tapering; sterile staminate portion cream or rarely white and weakly purple-

tinged or minutely purple-speckled, 3–8(–10) × 2–2.5 mm, ± cylindrical or weakly broadest at apex or base, occasionally naked at base to 1 mm; pistils weakly coherent to ± laxly arranged (most conspicuously so toward base), 2 to 4 across the axis (viewed from above), 1–1.3 mm long; ovaries cream, 1–1.5 mm diam., ± cylindrical to obtusely obconical, frequently broadly depressed medially, 2-locular, with axile or subaxile placentation, 5 to 8(to 10) ovules per locule, or rarely 1-locular with subaxile placentation and ca. 12 ovules; ovules hemianatropous, biseriate; funicles shorter than ovule; style Type I (Fig. 1), (0.8–) 1–1.2 mm diam., weakly narrower than to as broad as ovary apex, with red chromoplasts, the margins distinct, not coherent with those of adjacent styles; **stigma** white, 0.2–0.3 mm diam., sessile, ± capitate or cylindrical, rarely broadest and truncate at apex; synandria ca. 1 mm long, (1.3–)1.8–2 × (0.8–)1.3–1.5 mm diam. and ± elongated in direction of axis, occasionally highly bilaterally symmetrical, sometimes subrounded, prominently and deeply (2)3- to 4(5)-lobed, occasionally almost to middle (rarely [2]3-lobed, on one inflorescence), broadly concave medially, with lobes prominently thickened, the margins sinuate-undulate and interlocking with those of adjacent flowers, coherent, (2)3- to 4(5)-androus, the thecae each with a terminal pore; pollen cream-colored, in tetrahedral tetrads, with exine reticulate; sterile flowers, 0.7–1 mm long, 1.5–2 × (0.5–)1–1.2 mm diam. and ± elongated in direction of axis, less so in basal whorl, coherent, truncate, subprismatic to irregularly subprismatic, in 3 to 5(6) whorls. Berries not known.

Phenology. Flowering is known to occur in *Chlorospatha pubescens* during all months except February and June, and probably occurs throughout the year. The sympodial leaf is a cataphyll rather than a fully expanded foliage leaf, an unusual character state in *Chlorospatha*. Inflorescences are fragrant and emerge in quick succession, each reaching anthesis approximately one to three days after anthesis of the preceding inflorescence.

Etymology. The epithet is taken from the Latin “pubescens,” meaning “hairy,” referring to the conspicuous puberulent indumentum usually encountered on the cataphyll, petiole, peduncle, spathe tube, and veins on the lower surface of the leaf blade of *Chlorospatha pubescens*.

Discussion. *Chlorospatha pubescens* is widespread on the eastern slopes of the Andes in Ecuador, occurring in Morona-Santiago, Napo, Pastaza, Sucumbíos, and Zamora-Chinchipe provinces at

400–1551 m elevation, with most collections from Napo and Pastaza. The various collection sites are widely separated, and the species would be expected to occur in intervening areas. The species would also be expected to occur in Peru, possibly northward into Putumayo Department, Colombia. *Chlorospatha pubescens* has been collected in tropical wet forest, premontane wet forest, premontane rainforest, and rarely in premontane moist forest.

Chlorospatha pubescens is a member of *Chlorospatha* sect. *Orietales*. Although blade shape is somewhat variable in this section, the species is distinguished by its usually prominently hastate leaf blades that are velvety, dark green, and usually broadly quilted on the upper surface and much paler and conspicuously reticulate on the lower surface, with all venation more or less raised and crispy-puberulent to granular-puberulent. This indumentum usually extends the full length of the petiole, occasionally becoming scurfy-pubescent near the apex and on the posterior rib, and is usually found also on the peduncle and the base of the spathe tube. The petiole sheath is short in most collections, comprising one tenth to one fourth of the total length, occasionally one third to one half of the length. The entire length or basal half of the midrib and major venation are occasionally sparsely crispy-puberulent on the upper surface, a condition observed in no other species. The peduncle is short (4.5–7 cm long) and the inflorescence is small (4.3–7 cm long) and usually pale green, with the spathe blade marcescent and erect after anthesis (rarely spreading). The spadix is usually weakly stipitate. The synandria are unusual for a species from the eastern slopes of the Andes in occasionally being 5-androus, although most are 3- to 4-androus.

Chlorospatha pubescens would be most easily confused with *C. plowmanii*, which is also widespread on the eastern slopes of the Andes in Ecuador, at 220–1050(–1200) m elevation. The species appear to be sympatric in all provinces in which both occur (see discussion under *C. plowmanii*).

Chlorospatha pubescens could possibly be confused with *C. engleri*, known only from the type collection made along the Macas–Riobamba road in the Parque Nacional Sangay in Morona-Santiago Province, Ecuador, on the eastern slopes of the Andes, at 1659 m elevation (see discussion under *C. engleri*).

Paratypes. ECUADOR. **Morona-Santiago:** along Gualaquiza–Limón rd., vic. Indanza, ca. 1200 m, 3°02′10″S, 78°28′28″W, 8 Sep. 2002, *Croat 87329* (MO, QCNE); Méndez–Paute rd., 43.7 km W of Méndez, 1551 m, 2°36′36″S, 78°28′12″W, 12 July 2004, *Croat, L. P. Hannon, G. Walther & T. Katan 90932* (MO, QCNE). **Napo:** Tena–Puyo rd., Río Napo, Añangu, 550 m, 18–19 July

1982, *L. Besse, H. Kennedy & R. Baker 1638* (SEL); Tena-Puyo rd., 61.5 km N of Puyo, 500 m, 22 Dec. 1979, *Croat 49647* (MO); Archidona-Baeza rd., 5 km S of turn-off to Loreto, 1033 m, 0°45.924'S, 77°47.545'W, Apr. 2003, *Croat, L. P. Hannon & N. Altamirano 87803* (MO, QCNE); Cantón Tena, Est. Biol. Jatún Sacha, Río Napo, 8 km E of Misahuallí, 400 m, 1°04'S, 77°36'W, 8 Jan. 1990, *W. Palacios 4795* (MO-4373109 [sheet 1], MO-4373110 [sheet 2], QCNE). **Pastaza:** Hac. San Antonio von Humboldt, 2 km NE of Mera, 1300 m, 1°27'S, 78°06'W, *R. Baker et al. 5795* (MO, NY, QAME, QCNE); along rd. to Río Anzu, trail W into mtns., 1238–1400 m, 1°23'27"S, 78°03'19"W, 6 May 2003, *Croat, L. P. Hannon & M. Menke 88730* (B, CAS, MEXU, MO, NY, QCNE); along Mera-Río Anzu rd., 7.7 km N of Río Alpayacu, 1267 m, 1°25'51"S, 78°04'34"W, 8 May 2003, *Croat, L. P. Hannon & M. Menke 88813* (K, MO, QCNE, US). **Sucumbios:** along rd. to La Bonita, 8 km N of cut-off at Río Aguatico bridge, N of Lumbaquí on Baeza-Lago Agrío rd., 487 m, 0°04'18"N, 77°21'42"W, Mar. 1997, *L. P. Hannon 97-365* (CUVC, GB, GH, HUA, INB, MO). **Zamora-Chinchipe:** vic. El Panguí, Quime crossing Río Zamora, 861 m, 3°32'28"S, 78°26'40"W, Mar. 1996, *Croat & L. P. Hannon 81351* (MO); along rd. from Quime Ferry crossing into Cordillera de Cóndor, 22 km SW of Río Zamora, & Quime crossing, 1489 m, 3°37'46"S, 78°26'17"W, 14 July 2004, *Croat, L. P. Hannon, G. Walther & T. Katan 91068* (MO, QCNE); along rd. betw. Zumbi on Río Zamora & summit of Cordillera del Cóndor, 27.3 km E of Zumbi, 8.6 km E of Río Nangaritz bridge, 1259 m, 3°56'17"S, 78°37'45"W, 16 July 2004, *Croat, L. P. Hannon, G. Walther & T. Katan 91229* (MO, QCNE).

Cultivated specimens examined. ECUADOR. **Napo:** Tena-Puyo rd., *T. Plowman 14063* (F, K, ex. *L. Besse et al. 1638*, SEL live acc. 82-517). **Pastaza:** Vic. Puyo, *L. P. Hannon 02-071* (MO, ex. *M. McGovern s.n.*, ABG live acc. 911415).

58. *Chlorospatha queremalensis* Croat & L. P. Hannon, sp. nov. TYPE: Colombia. Valle: along Old Calí-Buenaventura rd., betw. Queremal & Anchicayá, departing rd. on trail at Km. 55, 6.5 km W of Queremal via Río San Juan, 1250 m, 3°32'23"N, 76°45'26"W, 26 July 1997, *Croat & J. Gaskin 80373* (holotype, MO-04937477!; isotype, CUVC not seen). Figure 44A.

Herba minus quam 1 m; cataphylla ca. 20 cm longa. Petiolus ca. 59 cm longus; lamina foliaris anguste ovata, cordato-sagittata, ca. 38 × 21.5 cm, lobis posterioribus 10.4–10.5 × 9–10 cm, nervis basalibus utroque 7 ad 9, nervis primariis lateralibus utroque 8 vel 9. Inflorescentia ignota.

Terrestrial herb, less than 1 m tall; stem to 39 cm long, with remnants of old cataphylls persisting ± intact to semi-intact and ± fibrous at upper nodes, otherwise as short, pale fibers; internodes (1.7)–2–4 cm × to 2.7 mm, dark green, becoming brown with age, drying matte to weakly glossy, dark reddish brown (all measurements made from dried material); cataphylls ca. 20 cm long, apex not known, drying

semiglossy to glossy, dark reddish brown. LEAVES 1; **petiole** ca. 59 cm long, ± spongy, glabrous, weakly glossy, dark green, drying semiglossy, dark blackish brown; sheath not determined; free portion ca. 5 mm diam. midway, terete; **blade** narrowly ovate, cordate-sagittate at base, 38 × 21.5 cm (12.5 cm wide at base), 1.8 times longer than wide, weakly acuminate at apex, broadest across anterior lobe, 1.7 times wider across anterior lobe than at base (measured tip to tip across posterior lobes), subcoriaceous, moderately bicolorous; upper surface weakly glossy, dark green, drying semiglossy, blackened gray-green; lower surface weakly glossy, drying weakly glossy to semiglossy, weakly paler; anterior lobe 27.8 × 21.5 cm, 1.3 times longer than wide, 2 times longer than posterior lobes, broadest below middle; posterior lobes directed toward base, 10.4–10.5 × 9–10 cm, weakly longer than wide, narrowly rounded at apex, broadest at base, markedly inequilateral, the inner side narrower, weakly rounded toward base and briefly attenuate onto posterior rib; outer side 3.2 to 4.6 times wider than inner side midway, convex or weakly concave toward base; sinus ± oblong; midrib and major venation sunken on upper surface, glabrous on lower surface, darker than surface, drying ± flattened, moderately darker than surface; midrib round-raised on lower surface; **basal veins** 7 to 9 branching off, 5 to 6 acroscopic, 3 to 4 basisopic, the first free to the base, fourth and fifth coalesced 3–6 cm into a moderately prominent posterior rib 9 cm long; posterior rib naked ca. 1 cm per side; primary lateral veins 8 to 9 pairs, arising at 40°–70°, most acutely toward apex, moderately arcuate, convex on lower surface; secondary veins raised on lower surface, drying raised, weakly to moderately darker than surface; tertiary veins visible and distinct on lower surface, drying distinct, in part weakly prominulous to weakly raised, otherwise flat, concolorous to weakly darker than surface; reticulate veins drying obscure; collective veins 3, the innermost arising from one of the lowermost lateral veins on inner side of posterior lobe, loop-connected with all preceding lateral veins, parallel to and 2–4 mm from margin. INFLORESCENCE not known. Berries not known.

Phenology. Flowering is not known in *Chlorospatha queremalensis*.

Etymology. *Chlorospatha queremalensis* is named for Queremal in Valle Department of Colombia where the type specimen was collected.

Discussion. *Chlorospatha queremalensis* is known only from the sterile type collection made in Valle Department, Colombia, along a trail departing the old

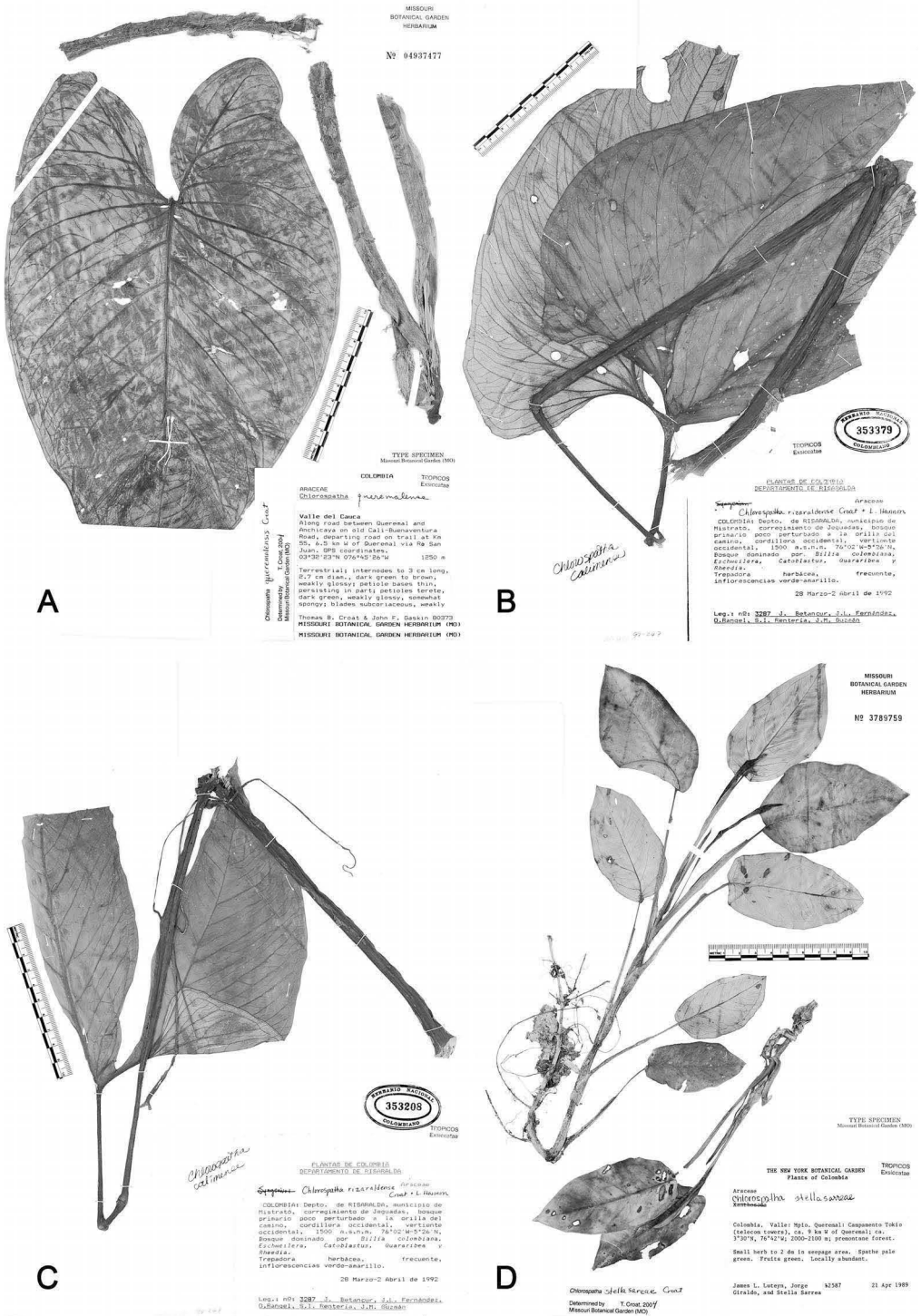


Figure 44. —A. *Chlorospatha queremalensis* Croat & L. P. Hannon, holotype Croat & Gaskin 80373 (MO-4937477). B, C. *Chlorospatha risaraldensis* Croat & L. P. Hannon, holotype Betancur et al. 3287 (MO). —B. Isotype of *C. risaraldensis* (COL-353379). —C. Holotype of *C. risaraldensis* (COL-353379). —D. *Chlorospatha stellarsareae* Croat & L. P. Hannon, holotype Luteyn et al. 12587 (MO-3789759).

road from Calí to Buenaventura at Km. 55, 6.5 km west of Queremal, between Queremal and Anchicayá, at 1250 m elevation, in tropical wet forest on the western slopes of the Cordillera Occidental. The species would be expected to occur elsewhere within the department.

Chlorospatha queremalensis is a member of *Chlorospatha* sect. *Occidentales* and is distinguished by its long internodes (2–4 cm long) and subcoriaceous, dark green, narrowly ovate leaf blades that are cordate-sagittate at the base and dry blackened, gray-green, with short, broad posterior lobes that are narrowly rounded at the apex. The species is also characterized by its numerous primary lateral veins (eight to nine pairs), a feature that distinguishes it from the relatively few species with similarly shaped blades, from the western slopes in Colombia and Ecuador: *C. besseae*, *C. bogneri*, *C. macphersonii*, and species indet. 1. *Chlorospatha besseae*, *C. bogneri*, and species indet. 1 occur only in the frontier region along the border between Colombia and Ecuador, the last two species in Nariño Department, Colombia, and the first in northern Ecuador. *Chlorospatha macphersonii* occurs only in Antióquia Department, Colombia, to the north, on the eastern slopes of the Cordillera Occidental. These four species have between three and five pairs of primary lateral veins, rarely six pairs. The blades of *C. queremalensis* are significantly larger than those of the aforementioned species, with the upper surface smooth and weakly glossy. The blades of *C. besseae* and species indet. 1 are velvety, those of *C. bogneri* rugose, and those of *C. macphersonii* bullate.

59. *Chlorospatha ricourtensis* Croat & L. P. Hannon, *Aroideana* 33: 84–86. 2010. TYPE: Colombia. Nariño: Res. Nat. La Planada, 7 km above Chucunés, on Túquerres–Ricaurte rd., along La Rosa–Potrero de Hermogenes trail, 1800–1850 m, 1°06'N, 77°53'W, 13 Mar. 1990, Croat 71405 (holotype, MO-3789359!; isotype, PSO not seen). Figure 43C, D.

Terrestrial herb, ca. 50 cm tall; stem with remnants of old leaf bases and cataphylls persisting \pm intact along its length; internodes 1–1.5 \times 1.5–2.3 cm, semiglossy, medium green, drying matte to weakly glossy, dark greenish brown (all measurements made from dried material); cataphylls 20–24 cm long, cuspidate at apex, drying weakly glossy to semiglossy, medium-dark to dark reddish brown. LEAVES 2 to 5, erect-spreading; **petioles** 36–49 cm long, glabrous, medium green, purple-tinged, most prominently so toward base, drying matte, dark reddish brown to occasionally almost black, sheathed

21–31 cm, ca. 2/3 of total length; sheath free-ending at apex; free portion ca. 3 mm diam. midway, obtusely angular; **blades** sagittate, weakly subhastate on drying, 24–25 \times 13 cm, 1.8 to 1.9 times longer than wide, abruptly acuminate at apex, broadest at base, 1.3 to 1.7 times wider at base than across anterior lobe (measured tip to tip across posterior lobes), thinly coriaceous, moderately bicolorous; upper surface semiglossy, dark green, drying semiglossy, dark brownish green; lower surface semiglossy, drying weakly glossy, in part semiglossy, moderately paler; anterior lobe 14–14.2 \times 7.5–10 cm, 1.4 to 1.9 times longer than wide, 1.1 to 1.4 times longer than posterior lobes, broadest at or below middle, moderately inequilateral, with one side 1 cm wider than opposite side; posterior lobes directed toward the base, 10–12.5 \times 4–4.5 cm, 2.2 to 3 times longer than wide, narrowly rounded at apex, broadest at or below middle, \pm symmetrical, the inner side broadly rounded toward base, briefly to moderately attenuate onto posterior rib; outer side \pm straight toward base; midrib and major veins paler than upper surface, round-raised on lower surface, paler than surface, drying prominently darker than surface; midrib sunken on upper surface, drying raised on lower surface; **basal veins** 4 to 6 pairs, coalesced into a prominent posterior rib; posterior rib naked 1–1.2 cm per side; primary lateral veins 3 pairs, arising irregularly at 35°–50°, strongly arcuate, occasionally in part irregularly ascending, narrowly sunken on upper surface, drying weakly raised and \pm flattened on lower surface; secondary veins in part obtusely sunken on upper surface, raised on lower surface, drying weakly raised, weakly to moderately darker than surface; tertiary veins visible, distinct on lower surface, darker than surface, drying distinct, in part weakly prominulous, otherwise flat, weakly darker than surface; reticulate veins drying obscure; collective veins 3, the innermost arising from one of the lowermost lateral veins on inner side of posterior lobe, \pm parallel to and 3–7 mm from margin. INFLORESCENCES erect, to 3 per axil; peduncle held within the sheath, 23–31 cm \times 3–4 mm, drying weakly glossy, dark blackish brown; **spathe** erect, ca. 12.5–13 cm long, apex not known; spathe tube deeply purple-tinged on outer surface, dark purple on inner surface, 6.5–7 cm \times 7 mm, drying matte, dark reddish brown on outer surface, weakly glossy on inner surface; spathe blade greenish cream, weakly purple-tinged, narrowly and most prominently so along outer margin toward base, ca. 6 cm \times 7 mm, drying matte, dark brown on outer surface, semiglossy on inner surface, marcescent, erect after anthesis; **spadix** erect, 11.5–12 cm long, sessile, adnate to

spathe 4.5–5 cm at base, ca. 1 cm less than total length of pistillate portion; pistillate portion 5.5–6 cm \times ca. 4 mm, drying medium-dark to dark reddish brown; fertile staminate portion ca. 5 cm \times 4–5 mm, narrowly rounded at apex, ellipsoid, drying dark reddish brown; sterile staminate portion ca. 1.5–1.8 cm \times 4 mm, cylindrical, drying dark blackish brown; pistils weakly coherent, 4 across the axis (viewed from above), ca. 2 mm long; ovary subglobose, ca. 1 \times 2–2.5 mm, drying tan; style Type 9 (Fig. 1), 0.8–1 \times 1.5–2.5 mm, weakly broader than ovary apex, the margins weakly coherent with those of adjacent styles; **stigma** 0.3–0.5 mm diam., elevated on and weakly wider than narrowed portion of style, drying medium to dark brown; synandria ca. 1 mm long, 2–2.2 \times 1 mm diam. and elongated in direction of axis, coherent, truncate, irregularly (4)5- to 6-lobed, (4)5- to 6-androus (mostly 5); sterile flowers 1–1.5 mm long, 0.5–1 \times 2.5–3 mm diam. and markedly elongated in direction of axis, in 7 whorls, deeply, irregularly lobed, coherent, truncate at apex and abruptly narrowing below in apical 2 whorls, otherwise 1- to 6-branched, the branches broadest and obtusely truncate at apex, narrowing below. Berries not known.

Phenology. Flowering is only known to occur in *Chlorospatha ricourtensis* during the month of March.

Discussion. *Chlorospatha ricourtensis* is known only from the type collection made at La Planada Reserve on the western slopes of the Cordillera Occidental in Nariño Department, Colombia, near the border with Ecuador, at 1800–1850 m elevation. The species would be expected to occur elsewhere in the department and southward into Ecuador, possibly northward into Cauca Department. *Chlorospatha ricourtensis* is terrestrial and was collected in a pasture, and although nothing is known about the surrounding forest or its condition, it is possibly either lower montane wet forest or lower montane moist forest.

Chlorospatha ricourtensis is a member of *Chlorospatha* sect. *Occidentales* and is distinguished by its sagittate, semiglossy, dark green leaf blades with the midrib and major venation paler on both surfaces, and the posterior lobes narrow and almost as long as the anterior lobe. The species is also distinguished by its purple-tinged petiole that is sheathed two thirds of its length, with the sheath free-ending, and large inflorescence (to 13 cm long) with the spathe tube deeply purple-tinged on the outer surface and dark purple on the inner surface, and the blade purple-tinged, greenish cream. The 5- to 6-androus synandria are unusual. The sterile staminate portion

of the spadix is unusually long, 1.5–1.8 cm, with most sterile flowers several-branched and densely arranged.

Chlorospatha ricourtensis could be most easily confused with *C. planadensis*, with which it is sympatric at La Planada Reserve (see discussion under *C. planadensis*).

Chlorospatha ricourtensis could possibly be confused with two species from Valle Department, in the vicinity of Calí, on the eastern and western slopes of the Cordillera Occidental at similar elevations: *C. giraldoi* and *C. noramurphyae* (see discussions under these two species).

60. *Chlorospatha risaraldensis* Croat & L. P. Hannon, sp. nov. TYPE: Colombia. Risaralda: Mpio Mistrató, Jequadas distr., W slope of Cordillera Occidental, 1500 m, 5°26'N, 76°02'W, 28 Mar.–2 Apr. 1992, *J. Betancur, J. Fernández, O. Rangel, S. Rentería & J. Guzmán 3287* (holotype, COL-35208!; isotype, COL-353379!). Figure 44B, C.

Herba hemiepiphytica. Petiolus 62.5–65 cm longus, vaginatus per 30–40 cm; lamina foliaris profunde 3-lobulata vel fere trisecta, 30–33 \times 32–38 cm, lobo medio elliptico, 26–31.5 \times 9–11(–14) cm, anguste confluyente cum lobo laterali, nervis primariis lateralibus utroque 8 ad 11. Inflorescentiae 3 in quaque axilla; pedunculus 35–40 cm \times 1–2 mm; spatha erecta, ca. 4.5 cm longa, tubo ca. 3.5 mm diam., lamina ca. 1.9 cm \times 3–4.5 mm diam.; spadix ca. 4.2 cm longus.

Hemiepiphytic herb; stem and internodes not known (all measurements made from dried material); cataphylls known only from fragments, drying glossy, pale tan, weakly fibrous, the fibers linear, paler than surface. LEAVES 2; **petioles** 62.5–65 cm long, glabrous, drying matte to weakly glossy, dark blackish brown, sheathed 30–40 cm, 1/2 to 2/3 of total length; sheath decurrent at apex; free portion 3–4 mm diam. midway; **blades** deeply 3-lobed to nearly trisect, 30–33 \times 32–38 cm, ca. 1.1 times wider than long, drying thin to thinly coriaceous, moderately bicolorous; upper surface drying weakly glossy, dark brown; lower surface drying weakly glossy to semiglossy; **medial lobe** \pm elliptical, 26–31.5 \times 9–11(–14) cm, (2.3 to)2.9 times longer than wide, acuminate at apex, usually as long as and narrower than lateral lobes, acute to cuneate and narrowly attached at base, 2.5–3 cm wide at point of attachment, weakly to moderately inequilateral, one side to 1.4 times wider than opposite side; **lateral lobes** directed toward the apex, 23–31.5 \times 10–12.5 cm, 2.3 to 2.8 times longer than wide, acute to acuminate at apex, broadest near base, markedly

inequilateral, the inner side always narrower, attenuate to long-attenuate toward base, narrowly confluent with medial lobe, the confluent portion 2–2.5 mm wide; outer side 4 to 7 times wider than inner side midway, broadly rounded at base, occasionally weakly constricted near base, moderately narrowly to briefly attenuate onto posterior rib; midrib and major veins drying \pm flattened on lower surface, conspicuously darker than surface, usually almost black; midrib round-raised on lower surface; posterior rib naked 2.5–5 cm per side; primary lateral veins on medial lobe 6 to 8 pairs, arising at 25°–30°(–40°), straight to weakly arcuate, convex on lower surface; primary lateral veins on lateral lobes 8 to 11 pairs, 1 to 2 basal pairs fused near base, arising at 35°–75°, weakly to markedly arcuate, aggregated toward base; secondary veins drying raised on lower surface, conspicuously darker than surface; tertiary veins drying in part prominulous, otherwise flat and visible on lower surface, moderately darker than surface; reticulate veins drying flat on lower surface, in part darker than surface; collective veins 3, the innermost arising from lowermost lateral vein at base, loop-connected with all preceding lateral veins, weakly scalloped, 2–8 mm from margin. INFLORESCENCES erect, to 3 per axil; peduncle held within the sheath, 35–40 cm \times 1–2 mm, glabrous, drying matte, dark blackish brown; **spathe** erect, entirely yellow-green, ca. 4.5 cm long, abruptly acuminate at apex, drying dark blackish brown; spathe tube ca. 2.5 cm \times ca. 3.5 mm; spathe blade ca. 1.9 cm \times 3–4.5 mm; **spadix** erect, ca. 4.2 cm long, sessile, adnate to spathe ca. 2 cm at base, the entire length of pistillate portion; pistillate portion ca. 2 cm \times ca. 2.5 mm; fertile staminate portion white, ca. 1.3 cm \times 3 mm, narrowly rounded at apex, \pm cylindrical, drying dark brown; sterile staminate portion 7–9 \times ca. 2 mm, drying tan; pistils weakly coherent, ca. 4 across the axis (viewed from above), ca. 0.5 mm long; ovaries subglobose, ca. 1–1.2 mm diam., drying medium brown; style Type 3 (Fig. 1), ca. 1 mm diam., weakly broader than ovary apex, the margins not coherent with those of adjacent styles; **stigma** ca. 0.3 mm diam., sessile, drying dark brown; synandria ca. 0.7 \times ca. 1 mm, coherent, truncate, deeply 3- to 4-lobed, 3- to 4-androus; sterile flowers ca. 0.5 mm long, 1–1.3 \times 0.5 mm diam. and elongated in direction of axis, coherent, truncate, subprismatic, in 5 to 6 whorls, drying tan. INFRUCTESCENCE (immature) 5.5 cm \times 7 mm; berries 2–2.5 mm diam.

Phenology. Flowering and fruiting are only known to occur in *Chlorospatha risaraldensis* during the months of March and April.

Etymology. *Chlorospatha risaraldensis* is named for Risaralda Department, Colombia, where this species is endemic.

Discussion. *Chlorospatha risaraldensis* is known only from the region of Mistrató in Risaralda Department, Colombia, in tropical rainforest on the western slopes of the Cordillera Occidental at 1500–1550 m elevation. The species would be expected to occur elsewhere within the department, also in Antioquia to the north and Valle to the south.

Chlorospatha risaraldensis is a member of *Chlorospatha* sect. *Chlorospatha* and is distinguished by its hemiepiphytic habit and deeply 3-lobed to nearly trisect leaf blades with the lateral lobes broader than and as long as the medial lobe or nearly so. The blades dry blackened, dark brown, with the midrib, major, and secondary venation almost black on the lower surface, as is the petiole. Also noteworthy are the numerous primary lateral veins on the lateral lobes (eight to 11 pairs), with most aggregated toward the base. The species is also distinguished by its small inflorescence (less than 5 cm long) and long peduncle (35–40 cm long).

Chlorospatha risaraldensis could not be easily confused with any species. Only *C. corrugata* shares its unusual blade shape and will be considered here (see discussion under *C. corrugata*). *J. Fernández et al.* 9745 has lateral lobes slightly shorter than the medial lobe and only weakly wider. It is a sterile specimen, but the label notes report details of the inflorescence that accord with this species and also indicate that the collection was hemiepiphytic. A fertile specimen was not found.

Paratype. COLOMBIA. **Risaralda:** Mpio. Mistrató, betw. Geguadas & Puerto de Oro districts, Pisones forest, 1550 m, 5°26'N, 76°2'W, 2 Apr. 1992, *J. Fernández et al.* 9745 (MO, QCNE).

61. *Chlorospatha sagittata* Croat & L. P. Hannon, sp. nov. TYPE: Ecuador. Imbabura: along Selva Alegre–Otavalo rd., 61.3 km S of jct. with main rd. at Otavalo, 1678 m, 0°17'57"N, 78°30'08"W, 1 May 2003, *Croat & L. P. Hannon 88410* (holotype, MO-5687884–85!; isotypes, K!, QCNE!). Figure 45A–D.

Herba parum plus quam 1 m; internodia 1.5–2 \times 1–2.5 cm. Petiolus 59–105 longus, vaginatus per ca. 89 cm; lamina foliaris sagittata, 35–51 \times 22–34 cm, lobis posterioribus 16–25 \times 8.5–15 cm, nervis basalibus utroque 4 vel 5, nervis primariis lateralibus utroque 6 vel 7. Inflorescentiae 6 in quaque axilla; pedunculus usque ad 88 cm \times 5 \times 3 mm; spatha erecta, ca. 10.5 cm longa, tubo ca. 8 mm diam.; spadix ca. 8.2 cm longus.

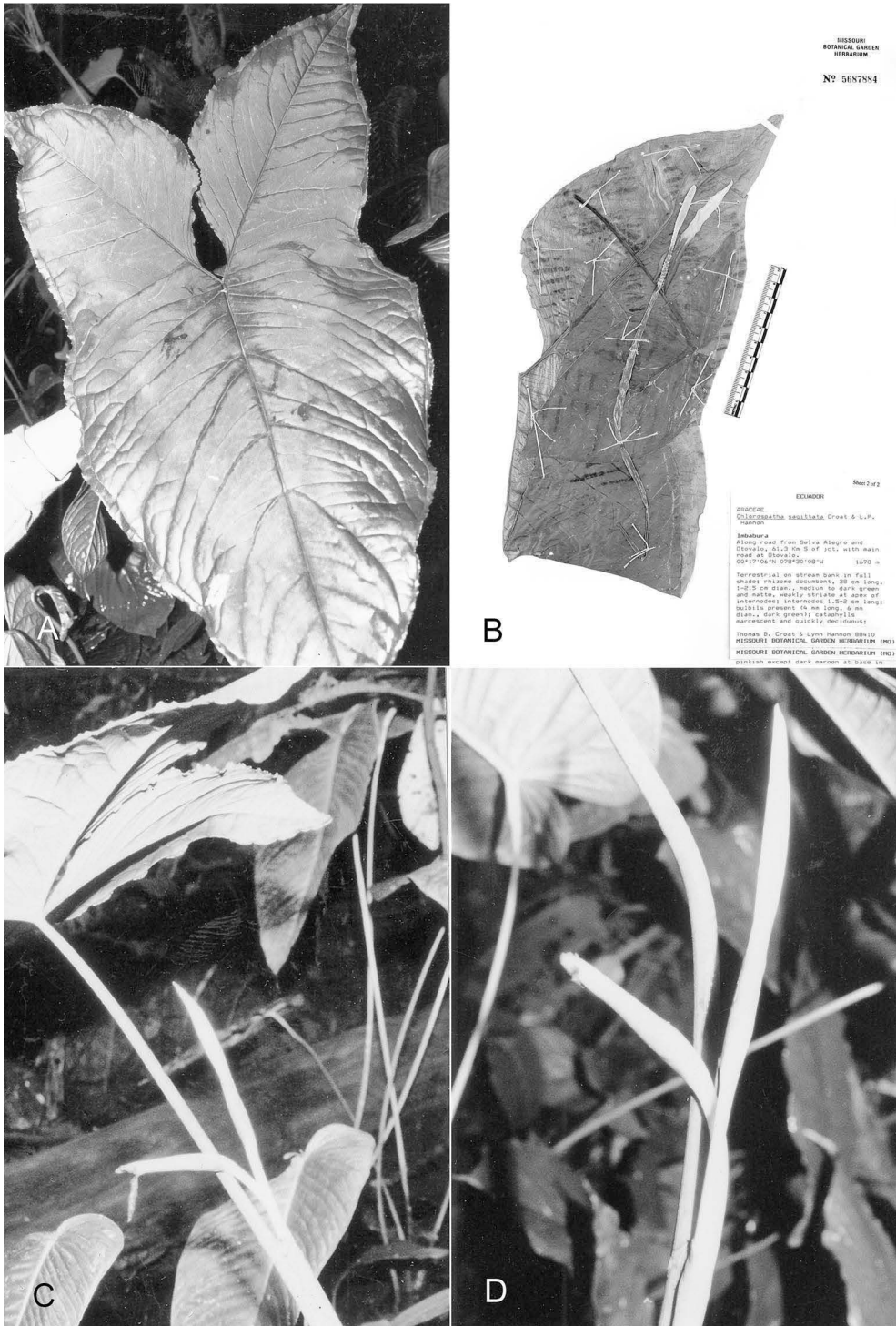


Figure 45. *Chlorospatha sagittata* Croat & L. P. Hannon. —A. Leaf blade adaxial surface. —B. Holotype sheet 2 of 2 (MO-5687884 [sheet 1 is MO-5687885, not pictured here]). —C. Fertile habit. —D. Sympodium, with three spathes of inflorescences near anthesis. A, C, D photographed from the holotype Croat & L. P. Hannon 88410 (MO).

Terrestrial herb, on stream bank, slightly more than 1 m tall; stem decumbent, to 38 cm long, erect 15 cm, producing few bulbils randomly along its length; bulbils ovoid, green, 4 × 6 mm; internodes 1.5–2 × 1–2.5 cm, matte, medium-dark green, weakly striate at apex, drying 1–1.2 cm diam., matte, dark brown; cataphylls ultimately deciduous (total length and features not known), drying weakly glossy, dark brown. LEAVES 1 to 2, erect-spreading; **petioles** 59–105 cm long, moderately firm, glabrous, minutely many-ribbed throughout, matte, dark green, dark purple-mottled in narrow transverse bands, less so toward apex, drying matte to weakly glossy, dark reddish brown, sheathed 89 cm, more than 3/4 of total length when in flower (less than 1/3 on foliage leaf); sheath free-ending at apex, with one margin longer and more prominently rounded at apex than opposite margin; free portion 1–1.3 cm diam. midway, obtusely flattened toward apex, otherwise terete; **blades** sagittate, 35–51 × 22–34 cm, 1.5 to 1.6 times longer than wide, acuminate at apex, broadest at base, 1.2 times wider at base than across anterior lobe (measured tip to tip across posterior lobes), thinly coriaceous, moderately bicolorous, moderately constricted on one side in area of petiole attachment, weakly constricted on opposite side, drying thin, weakly to moderately bicolorous; upper surface broadly quilted, velvety, dark green, drying matte to weakly glossy, dark olive-green; lower surface weakly glossy to semiglossy, drying semiglossy to glossy; anterior lobe 23.5–35 × 16–26.6 cm, 1.3 to 1.5 times longer than wide, 1.4 to 1.5 times longer than posterior lobes, broadest below middle, ± symmetrical; posterior lobes directed toward the base, 16–25 × 8.5–15 cm, 1.7 to 1.9 times longer than wide, broadly acuminate (or not) and acute to narrowly rounded at apex, broadest below middle, weakly inequilateral, the inner side narrower, weakly rounded at base, briefly attenuate onto posterior rib; midrib deeply sunken and concolorous on upper surface, round-raised and minutely ribbed on lower surface, weakly paler than surface, drying weakly raised and ± flattened, weakly paler than surface; **basal veins** 4 to 5 pairs, coalesced into a prominent posterior rib; posterior rib naked 2–5 mm per side, round-raised, acutely 1-ribbed medially toward base; primary lateral veins 6 to 7 pairs, arising at 45°–60°, ± straight to weakly arcuate, quilted-sunken on upper surface, round-raised on lower surface, obtusely angular, minutely ribbed and concolorous, drying weakly raised and ± flattened, concolorous to weakly paler than surface; secondary veins etched-sunken on upper surface, raised and concolorous on lower surface, drying weakly raised, concolorous to

weakly darker than surface; tertiary veins prominulous on lower surface, concolorous, drying weakly prominulous, weakly darker than surface; reticulate veins in part visible on lower surface, drying visible, in part weakly darker than surface, otherwise concolorous; collective veins 3, the innermost arising from the lowermost lateral vein on inner side of posterior lobe, ± parallel to and 3–6 mm from margin. INFLORESCENCES erect, 6 per axil; peduncle held within the sheath, to 88 cm long, thicker than broad, 5 mm thick, 3 mm wide, matte, pale green, drying matte to semiglossy, medium yellowish brown; **spathe** erect, 10.5 cm long, lanceolate, acuminate at apex; spathe tube matte, medium green, deeply purple-tinged, most deeply so along outer margin and at base on outer surface, weakly glossy, dark purple on inner surface, 4.5 cm × 8 mm, drying matte, dark brown and weakly purplish on both surfaces; spathe blade matte, creamy white on both surfaces, 6 cm × 8 mm, drying matte, brownish green-cream on both surfaces, darker toward base, marcescent, erect after anthesis; **spadix** erect, 8.2 cm long, sessile, adnate to spathe 1.5 cm at base, slightly more than 1/2 of the length of pistillate portion; axis medium maroon; pistillate portion maroon, 2.4–2.6 cm × 5 mm, weakly broadest midway, drying medium purplish brown; fertile staminate portion yellowish cream, 3.5 cm × 6.5 mm midway, 4 mm diam. at base, ± clavate, bluntly rounded at apex, drying brownish cream; sterile staminate portion pale pink, 1.8–2 cm × 4–5 mm, broadest at base, drying cream-colored; pistils laxly arranged, ca. 4 across the axis (viewed from above), ca. 2 mm long; ovaries densely, minutely dark maroon-speckled, obtusely conical, 1.3–1.5 × 2–3 mm, 3-locular, with pseudoaxile placentation, 8 to 10 ovules per locule; ovules small, hemianatropous, biseriate; funicles shorter than or as long as ovules; style Type 4 (Fig. 1), pinkish, 0.2 × 2–2.5 mm, moderately broader than ovary apex, obscurely attenuate, some margins weakly coherent with those of adjacent styles; **stigma** yellowish cream, 0.2–0.3 × 0.6–0.8 mm, obscurely elevated on style, appearing sessile, disklike, broadest and obtusely truncate at apex; synandria 1–2 × 1.8–2 mm, coherent, truncate, (3)4- to 6-lobed, mostly 4- to 6-androus; sterile flowers entirely pale pink in apical whorls, dark maroon at base in basal whorls, 0.5–0.8 × 1.5–2 mm, subprismatic or weakly lobed, truncate at apex or occasionally weakly broadly concave, ± laxly arranged in basal whorls, weakly coherent in apical whorls, in 6 to 7 whorls. Berries not known.

Phenology. Flowering is only known to occur in *Chlorospatha sagittata* during the months of April

and May. Inflorescences emerge in slow progression, with several days between anthesis of one inflorescence and emergence of the next inflorescence at the apex of the petiole sheath.

Etymology. The epithet is taken from the Latin "sagittatus," meaning "sagittate," referring to the arrowhead shape of the leaf blade of *Chlorospatha sagittata*, with the posterior lobes directed toward the base.

Discussion. *Chlorospatha sagittata* is known only from the type locality in Imbabura Province, near the border with Pichincha, in lower montane wet forest on the western slopes of the Andes at 1678 m elevation. The species was collected on a stream bank in deep shade. It would be expected to occur elsewhere within both provinces and possibly northward into Carchi Province. The species is a member of *Chlorospatha* sect. *Occidentales* and is distinguished by its sagittate, velvety, dark green leaf blades and unusually long (105 cm long), purple-mottled petiole sheathed more than three fourths of its length, with the sheath free-ending at the apex. The peduncle is the longest recorded for the genus (to 88 cm long). The inflorescence is distinctive in having the spathe tube purplish, the ovaries and the axis of the spadix dark maroon, and the styles and sterile flowers pale pink. The style is unusual, of a type observed in only one species, but which possibly occurs in two other species. The mantle portion is broadly spreading, as in the other three species, yet obscurely attenuated, with the stigma appearing to be sessile, as in *C. hastata* and possibly also in *C. castula* and *C. corrugata*. The other species differ from *C. sagittata* in most respects and could not be confused with this species. The style is remarkably thin in the other species and somewhat more thickened in *C. sagittata*.

Chlorospatha sagittata could possibly be confused with *C. bayae* and *C. jaramilloi* from the western slopes of the Andes, with the latter known only from the western slopes of the Andes in Pichincha Province, Ecuador, and *C. bayae* known only from Valle Department in northern Colombia (see discussions under the latter two species).

62. *Chlorospatha sizemoreae* Croat & L. P. Hannon, sp. nov. TYPE: Ecuador. Zamora-Chinchipec: Río Nangaritzza, 45 min. by boat, upriver from end of rd. at Las Orquídeas, at base of cliffs above river, 1200–2000 m (est.), 4°16'42"S, 78°38'55"W, 19 Jan. 2004, *M. Sizemore 04-003* (holotype, MO-5882513!). Figures 46B, 47A–D.

Herba ca. 40 cm; internodia 0.5–1 × 1.5–2 cm; cataphylla 7–22 cm longa. Petiolus 26–35 cm longus, vaginatus per ca. 3.5–4 cm; lamina foliaris ± oblongo-elliptica, sagittata, 27.5–31.5 × 8–9.3 cm, lobis posterioribus 6–9 × 2.5–3.5 cm, nervis basalibus utroque 4 vel 5, nervis primariis lateralibus utroque 4; inflorescentiae 5 in quaque axilla; pedunculus 6.5–9.5 cm × 2.5 mm; spatha erecta, 4.3–5.6 cm, tubo 4–5 mm diam. (ante anthesin), lamina 2.5–3.1 cm longa; spadix 3.3–4.1 cm longus.

Terrestrial herb, ca. 40 cm tall; stem decumbent, erect 5 cm, with remnants of old cataphylls persisting intact at upper nodes; sap milky; internodes 0.5–1 × ca. 1.5–2 cm, weakly glossy to semiglossy, medium-dark green; cataphylls one to two, 7–22 cm long, obtuse with acumen at apex, acutely 1-ribbed abaxially in apical 3 cm, matte to weakly glossy, medium pink on outer surface, green-tinged in basal 1/4, densely irregularly weakly darker purple-lineate in narrow transverse bands, prominently so in apical 1/2, glossy and paler on inner surface, drying matte to weakly glossy, dark brown. LEAVES 4 to 5, erect-spreading; **petioles** 26–35 cm long, glossy, medium green, densely and weakly darker purple-lineate and purple-speckled in transverse bands, obscurely so in apical 3–4 cm, drying weakly glossy to semiglossy, dark brown, with epidermis in part separated ± intact and paler, sheathed ca. 3.5–4 cm, ca. 1/10 of total length; sheath weakly free-ending at apex, the sides convolute; free portion 5–6 mm diam. midway, terete, obtusely D-shaped in apical 1/4; **blades** ± oblong-elliptic, sagittate (subhastate on juvenile blade), frequently subhastate on drying, 27.5–31.5 × 8–9.3 cm (21 × 13 cm on juvenile blade), ca. 3.3 times longer than wide, weakly long-acuminate at apex, weakly broadest across anterior lobe, moderately constricted in area of petiole attachment, subcoriaceous, moderately bicolorous, drying thinly coriaceous; upper surface quilted, matte to weakly glossy, medium-dark grayish green, narrowly darker along midrib and major veins, drying matte, in part weakly glossy, medium-dark yellow-green; lower surface semiglossy to glossy, medium yellow-green, narrowly minutely colliculate along all veins, drying glossy, concolorous, narrowly paler along all veins; anterior lobe 23–25.5 × 8–9.3 cm (14 × 6.8 cm on juvenile blade), 2.7 times longer than wide, 2.9 to 3 times longer than posterior lobes, broadest near base, ± symmetrical to weakly inequilateral; posterior lobes directed toward the base, 6–9 × 2.5–3.5 cm, 2.4 to 3 times longer than wide, narrowly rounded at apex, broadest at base, moderately inequilateral, the inner side narrower, ± acute to weakly rounded at base, decurrent onto petiole; outer side 1.8 to 2.1 times wider than inner side midway; all venation drying etched-sunken on upper surface, concolorous;

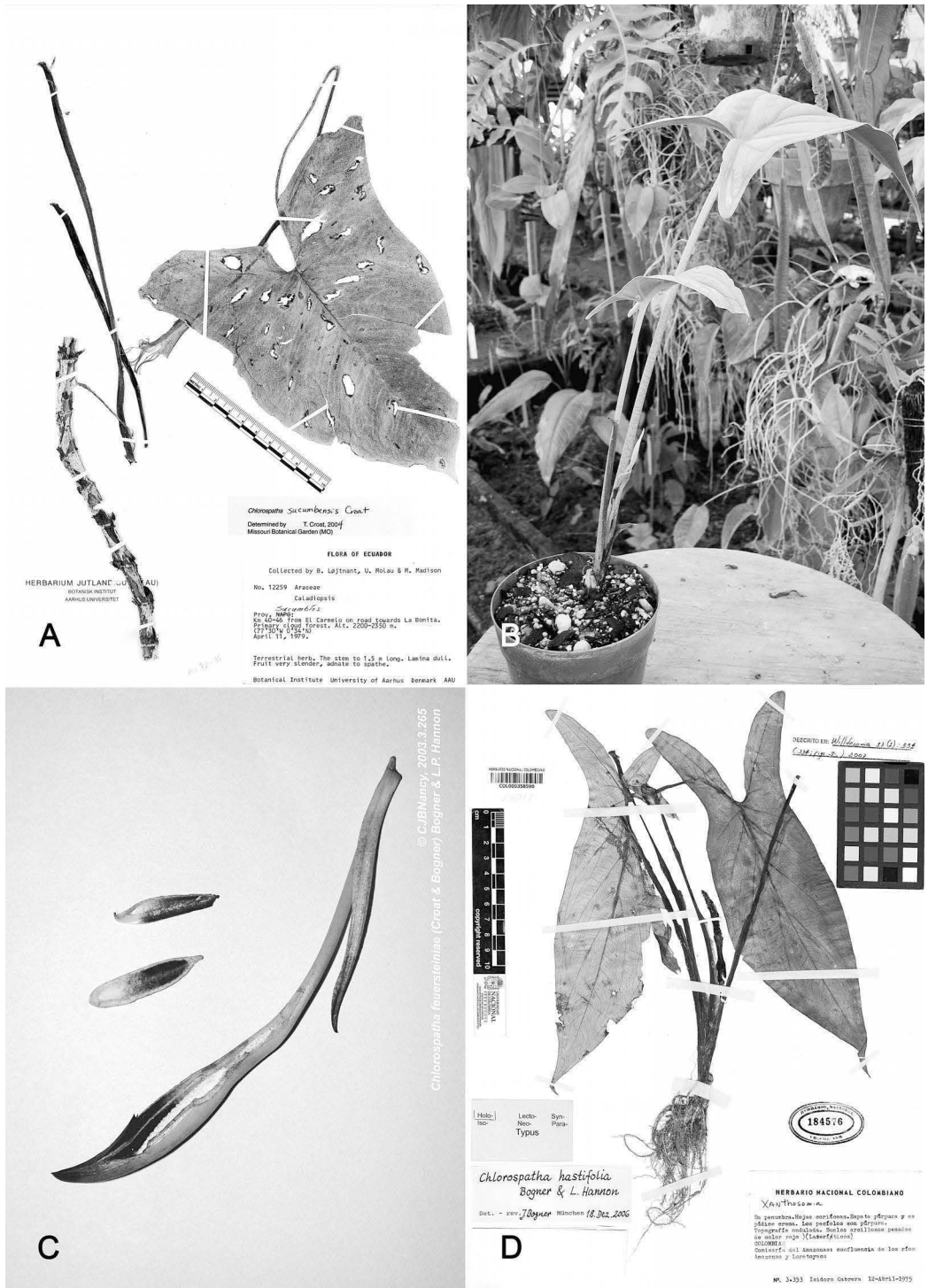


Figure 46. —A. *Chlorospatha succumbens* Croat & L. P. Hannon, the holotype Lajtnant *et al.* 12259 (AAP). —B. *Chlorospatha sizemoreae* Croat & L. P. Hannon, fertile plant habit from cultivar at Lynn Hannon greenhouse from the type collection Sizemore 04-003 (pre-anthesis; MO). —C. *Chlorospatha feuersteiniae* (Croat & Bogner) Bogner & L. P. Hannon, spathe cut open. —D. *Chlorospatha hastifolia* Bogner & L. P. Hannon, holotype Cabrera 3353 (COL-184576). Herbarium scan used by permission of COL.



Figure 47. *Chlorospatha sizemoreae* Croat & L. P. Hannon. —A. Leaf blade adaxial surface. —B. Stem showing a sympodium of successive inflorescences. —C. Close-up of inflorescence at anthesis, frontal view. —D. Close-up of inflorescence at anthesis, side view. Photos from the MO cultivar of the type collection *Sizemore 04-003*.

midrib and major veins deeply quilted-sunken on upper surface, convex on lower surface, concolorous to weakly paler than the surface, drying weakly raised, moderately darker than surface; midrib moderately paler yellow-green on upper surface; **basal veins** 4 to 5 coalesced into prominent posterior rib, the first free to the base or briefly fused 1–2 mm, extending into anterior lobe, 2 to 3 acroscopic, 1 to 2 basicopic; posterior rib acutely raised on lower surface, concolorous; primary lateral veins 4 pairs, arising at 25°–30°, straight to weakly arcuate, moderately darker than upper surface; secondary veins quilted-sunken on upper surface, less prominently so than major veins, weakly darker than surface, in part prominulous and otherwise flat on lower surface, concolorous, drying in part weakly darker than surface; tertiary and reticulate veins etched-sunken and concolorous on upper surface, visible on lower surface, flat, concolorous, drying flat and moderately paler than surface; collective veins 2 or 3, the innermost arising from apex of posterior rib, loop-connected with all preceding lateral veins, \pm parallel to and 3–5 mm from margin. INFLORESCENCES erect, 5 per axil, with a sweet, fruity fragrance at anthesis; peduncle held within the sheath, 6.5–9.5 cm \times 2.5 mm, obtusely triangular or cylindroid, semiglossy, pale-medium green, weakly darker-speckled in narrow transverse bands; **spathe** erect, 4.3–5.6 cm \times 4–5 mm (pre-anthesis), \pm cylindrical, prominently acuminate at apex, weakly constricted between tube and blade, ca. 1.5 cm wide (flattened) and \pm ovate, constricted between tube and blade and \pm funnel-shaped at anthesis, opening slightly more than 2/3 of total length; spathe tube matte, medium yellow-green on outer surface, glossy on inner surface, 1.7–2.5 cm \times ca. 7.5 mm at anthesis; spathe blade matte, much paler medium and yellow-green on both surfaces, with weakly darker longitudinal veins on outer surface, 2.5–3.1 cm long, erect-spreading and opening \pm broadly at anthesis, prominently acuminate at apex, the opening \pm elliptical, ca. 1.3 cm wide, with margins directed \pm forward, in-rolled in apical 7 mm, marcescent, erect after anthesis; **spadix** erect, 3.3–4.1 cm long, sessile, adnate to spathe 0.7–1.1 cm at base, ca. 2/3 of the length of pistillate portion; pistillate portion medium yellow-green, 1.4–1.7 cm \times 3.5 mm, broader than thick, broadest midway; fertile staminate portion matte, pale greenish yellow, 1.5–1.7 cm \times 2.5–3 mm, broadest near base, weakly tapering, narrowly rounded at apex; sterile staminate portion matte, greenish white, 5–6 \times 2–2.5 mm, broadest at base; pistils weakly coherent, 4 to 5 across the axis (viewed from above), ca. 2 mm long; ovaries \pm ovoid, glossy,

pale-medium yellow-green, ca. 1.5 \times 1 mm, broadest ca. midway, 2- to 3-locular, with pseudoaxial placentation; ovules 12 to 14 per locule, anatropous, biseriate; funicle shorter than ovule; style (Type 2, Fig. 1), ca. 0.5 mm long, comprising ca. 1/4 of the length of pistil, narrower than ovary apex, red chromoplasts lacking, the margins obscure, not coherent with those of adjacent styles; **stigma** greenish, ca. 0.2 mm diam., \pm cylindrical, weakly elevated on style; synandria ca. 1 \times 1–1.2 mm, truncate at apex, 2- to 3-lobed, 2- to 3-androus (mostly 3); sterile flowers 0.5–1 \times ca. 1.2 mm, frequently weakly elongated in direction of axis, coherent, truncate, subprismatic, in 4 whorls. Berries not known.

Phenology. Flowering in *Chlorospatha sizemoreae* is known only from a single flowering event in cultivation in the month of May. The species was collected in sterile condition in January. Several inflorescences emerge from the apex of the petiole sheath in quick succession before anthesis of the first, with seven to eight days between anthesis of one inflorescence and anthesis of the next.

Etymology. *Chlorospatha sizemoreae* is named for Mary Sizemore, who collected the species in 2004 and originally brought it to our attention and provided the material for the type.

Discussion. *Chlorospatha sizemoreae* is a member of *Chlorospatha* sect. *Orientalis* and is known only from the type collection made on the eastern slopes of the Andes in Zamora-Chinchipe Province, Ecuador, at the base of some cliffs along the Río Nangaritzta on the western slopes of the Cordillera del Condor, at an estimated elevation of 1200–2000 m (based on GPS coordinates), in either premontane wet forest or lower montane wet forest, depending on actual elevation. The species possibly occurs in Peru, the collection site being near the Peruvian border; however, the mountain range possibly serves as an obstacle to distribution eastward into Peru. *Chlorospatha sizemoreae* is distinguished by its subcoriaceous, narrowly sagittate, grayish green leaf blades that are prominently quilted on the upper surface, with the tertiary and reticulate veins etched-sunken on that surface. The species is also distinguished by its short, narrow posterior lobes. The lower surface of the blade is narrowly colliculate along all veins, a character frequently observed in species from the Amazon basin; however, in this species, the minor veins are flat and somewhat obscure, which is not the case in the other species, in all of which the lower blade surface is conspicuously reticulate, with the minor

veins more or less raised or prominulous. The species is also distinguished by its unusual, somewhat bottle-shaped pistils with briefly attenuated styles. It is one of only three species with attenuated styles in section *Orientalis*, but it could not be confused with the other two species: *C. cutucuensis* and *C. portillae*.

Chlorospatha sizemoreae could not be confused with any other species, particularly any species from the eastern slopes of the Andes in Colombia or Ecuador. The shape of the leaf blade is similar to that of *C. longiloba* from the western slopes in Ecuador, both species having long, relatively narrow, oblong-elliptic, sagittate blades with short, narrow posterior lobes. However, the colliculate area bordering all veins on the lower surface in *C. sizemoreae* is lacking in *C. longiloba*. The inflorescence of the latter species is considerably larger, with the spathe tube and some portions of the blade more or less purple, whereas those of *C. sizemoreae* are yellow-green, lacking any purple. The style of the latter species lacks a mantle, whereas that of *C. longiloba* has a broadly spreading mantle.

Cultivated specimen examined. ECUADOR. **Zamora-Chinchipec:** Río Nangaritza, 1200–2000 m (est.), 4°16'42"S, 78°38'55"W, 19 Jan. 2004 (cultivated by Lynn Hannon), *M. Sizemore 04-003*.

63. *Chlorospatha stellasarreae* Croat & L. P. Hannon, sp. nov. TYPE: Colombia. Valle: Queremal, Campamento Tokio (telecom towers), ca. 9 km W of Queremal, 2000–2100 m, 3°30'N, 76°42'W, 21 Apr. 1989, *J. Luteyn, J. Giraldo & S. Sarrea 12587* (holotype, MO-3789759!). Figure 44D.

Herba usque ad 20 cm; internodia (1–)2–4 cm × 5–7 mm; cataphylla 6.5–7.5 cm longa. Petiolus 8–10 cm longus, vaginatus per 5–9 cm; lamina foliaris ovata vel ovato-elliptica, (6.5–)8.8–9.9 × (3.3–)4.3–5.8 cm, rotundata vel debiliter subcordata vel cordulata ad basim, nervis primariis lateralibus utroque 4 vel 5(6). Inflorescentiae 2 vel 3 in quaque axilla; pedunculus 5.5–7 cm × < 1 mm; spatha erecta, 6–6.5 cm longa, tubo 2–3 mm diam., lamina 3–3.3 cm × ca. 4 mm; spadix ca. 5.2 cm longus.

Terrestrial herb, to 20 cm tall; stem decumbent, to 33.5 cm long, with remnants of old leaf bases persisting ± intact along its length (all measurements made from dried material); internodes (1–)2–4 cm × 5–7 mm, drying matte to weakly glossy, medium to medium-dark brown, irregularly transversely striate, the striations short; cataphylls ultimately deciduous, 6.5–7.5 cm long, obtuse with acumen at apex, obtusely 1-ribbed abaxially, drying weakly glossy to semiglossy, medium-dark reddish brown. LEAVES 3 to 7, erect-spreading; **petioles** 8–10 cm long,

glabrous, drying matte, dark reddish brown, sheathed 5–9 cm, most of length (2/3 in juvenile plants); sheath free-ending at apex; free portion ca. 1 mm diam. midway; **blades** ovate to ovate-elliptic, (6.5–)8.8–9.9 × (3.3–)4.3–5.8 cm, 1.7 to 1.9 times longer than wide, weakly acuminate at apex, broadest at or below middle, rounded to weakly subcordate or cordulate at base and inequilateral, decurrent onto petiole, weakly inequilateral, with one side 2–3 mm wider than opposite side, drying thinly coriaceous, weakly bicolorous; upper surface drying matte to weakly glossy, medium-dark to dark yellow-green; lower surface drying weakly glossy to semiglossy; midrib round-raised on lower surface, drying weakly raised to ± flattened, weakly darker than surface; primary lateral veins 4 to 5(6) pairs, arising at 30°–75°(–80°) (most at ca. 40°), most acutely toward apex, weakly arcuate, convex on lower surface, drying ± flattened, concolorous to weakly darker than surface; secondary veins drying weakly raised and ± concolorous on lower surface; tertiary veins drying in part weakly prominulous, otherwise flat and in part distinct on lower surface, ± concolorous; reticulate veins drying obscure; collective veins 3, the innermost arising from the base, loop-connected with all preceding lateral veins, ± parallel to and 3–6 mm from margin. INFLORESCENCES erect, 2 to 3 per axil; peduncle held within the sheath, 5.5–7 cm × < 1 mm, drying matte to weakly glossy, dark brown; **spathe** erect, pale green, 6–6.5 cm long, acuminate at apex; spathe tube 3–3.2 cm × 2–3 mm, drying matte to weakly glossy, dark brown on outer surface, weakly glossy and weakly paler on inner surface, densely pale, punctiform medially; spathe blade 3–3.3 cm × ca. 4 mm, drying weakly glossy, medium to dark brown on outer surface, semiglossy and weakly paler on inner surface, with reticulate venation conspicuous, prominulous and moderately darker than surface, marcescent, erect after anthesis; **spadix** erect, ca. 5.2 cm long, sessile, adnate to spathe 3–3.2 cm at base, the entire length of pistillate portion; pistillate portion 3–3.2 cm × ca. 1.5 mm, drying dark reddish brown; fertile staminate portion ca. 2 cm × 2 mm, bluntly acute at apex, ellipsoid, drying medium-dark reddish brown; sterile staminate portion ca. 2 × 1–1.5 mm, drying medium-dark reddish brown; pistils markedly laxly arranged, the axis bare between whorls, 1 to 2 across the axis (viewed from above), 1.5–1.75 mm long; ovaries ± cylindrical to obtusely conical, ca. 1 × 1.2–1.5 mm, drying pale tan with darker veins; style Type 7 (Fig. 1), ca. 0.5–0.75 × 0.3–0.5 mm, comprising slightly less than 1/2 of the length of pistil, narrower than ovary apex, the margins not coherent with those of adjacent styles; **stigma** ca.

0.3 mm diam., elevated on and weakly broader than narrowed portion of style; synandria ca. 0.8×1 –1.1 mm, coherent, truncate, (2)3- to 4(5)-lobed, (2)3- to 4(5)-androus (mostly 4), with flowers lacking microsporangia in apical whorl; sterile flowers 0.5 – $0.7 \times$ ca. 0.8 mm, fungiform (like toadstools), broadest and weakly convex at apex, abruptly narrowing below, laxly arranged, in 1 to 2 whorls (extending briefly into pistillate and fertile staminate portions). Berries green.

Phenology. Flowering and fruiting are only known to occur in *Chlorospatha stellarraeae* during the month of April.

Etymology. *Chlorospatha stellarraeae* is named for Ing. Stella Sarrea, Director of Parque Nacional Faldas de Farrallones in Colombia, who, along with James Luteyn and Jorge Giraldo, participated in collecting the type specimen.

Discussion. *Chlorospatha stellarraeae* is known only from the type locality near the Tokio Microwave Station near Queremal in Valle Department, Colombia, at 2000–2100 m elevation in premontane wet forest on the western slopes of the Cordillera Occidental. The species was reported as locally abundant and would be expected to occur elsewhere within the department, although it should be noted that the area around Queremal exhibits a high level of endemism.

Chlorospatha stellarraeae is a member of *Chlorospatha* sect. *Occidentales* and could not be confused with any other species. It is the smallest known species of *Chlorospatha*, the small, ovate leaf blades making it unique in the genus. The blades dry yellow-green and are less than 10 cm long on fully mature specimens, and rounded to weakly subcordate at the base. The species is also distinguished by its long internodes (usually 2–4 cm long) and long-sheathed petiole, which is sheathed most of its length when in flower, with the sheath prominently free-ending at the apex. The spathe is entirely pale green and 6–6.5 cm long, relatively large for such a diminutive plant. No other species observed has so few pistils so laxly arranged. There are only one to two pistils per whorl and the axis is clearly visible and naked between the whorls. The sterile staminate portion of the spadix is also unusual, being only ca. 2 mm long, with only a few fungiform (like toadstools) flowers.

64. *Chlorospatha sucumbensis* Croat & L. P. Hannon, sp. nov. TYPE: Ecuador. Sucumbíos: Km. 40–46 from El Carmelo on rd. to La Bonita, 2200–2350 m, $0^{\circ}34'N$, $77^{\circ}30'W$, 11 Apr. 1979,

B. Løjtnant, U. Molau & M. Madison 12259 (holotype, AAU). Figure 46A.

Herba usque ad 50 cm; internodia 2–2.5(–3) cm \times 8–10 mm. Petiolus ca. 33.5 cm longus, vaginatus per ca. 10.5 cm; lamina foliaris subhastata, ca. 21.5×17 cm, lobis posterioribus ca. 9.7×6.2 cm, nervis basalibus utroque 5 vel 6. Inflorescentiae 2 in quaque axilla; pedunculus 18–19 cm \times ca. 3 mm; spathae tubo ca. $3.7 \text{ cm} \times 4.5 \text{ mm}$; spadix (parte pistillata) ca. $3.5 \text{ cm} \times 3 \text{ mm}$.

Terrestrial herb, to 50 cm tall; stem decumbent, to 1.5 m long, with remnants of old cataphylls persisting as short, \pm intact fragments along its length (all measurements made from dried material); internodes 2–2.5(–3) cm \times 8–10 mm, drying matte, dark reddish brown, with epidermis in part separated and pale tan; cataphylls (known only from fragments) drying matte, dark brown. LEAVES 1; **petiole** 33.5 cm long, drying glabrous, matte to weakly glossy, medium-dark brown, paler and darker transversely lineate toward base, sheathed 10.5 cm, ca. 1/3 of total length; sheath free-ending at apex, drying paler on inner surface; free portion ca. 2 mm diam. midway; **blade** subhastate, 21.5×17 cm, briefly acuminate at apex, broadest at base, 1.3 times longer than wide, 1.3 times broader at base than across anterior lobe (measured tip to tip across posterior lobes), weakly concave in area of petiole attachment, drying thin, weakly bicolorous; upper surface drying matte, medium-dark olive-green; lower surface drying semi-glossy, medium green, narrowly colliculate along all veins except reticulate and some tertiary; anterior lobe 16×13 cm, 1.2 times longer than wide, 1.6 times longer than posterior lobes, broadest below middle, \pm symmetrical; posterior lobes 9.7×6.2 cm, 1.6 times longer than wide, narrowly rounded at apex, broadest at base, weakly inequilateral, the inner side narrower, acute to weakly rounded at base, decurrent onto petiole; outer side 1.5 to 1.7 times broader than inner side midway; all orders of venation drying visible on upper surface, weakly prominulous and weakly darker than surface; midrib, major, and secondary veins drying raised on lower surface, weakly granular-puberulent, weakly paler than surface; **basal veins** 5 to 6 pairs, coalesced into prominent posterior rib; primary lateral veins 5 to 7 pairs, arising at 55° – 65° , \pm straight to weakly arcuate, occasionally prominently arcuate; tertiary veins drying mostly raised on lower surface, weakly paler than surface, in part prominulous and weakly darker than surface; reticulate veins drying distinct and visible on lower surface, weakly darker than surface; collective veins 3, the innermost arising from lowermost lateral vein on inner side of posterior lobe, loop-connected with all preceding lateral veins, \pm

parallel to and 7–9 mm from margin. INFLORESCENCES 2 per axil, erect-spreading; peduncle held within the sheath, 18–19 cm × 3 mm, drying matte to weakly glossy, dark brown; **spathe** total length not known; spathe tube 3.7 cm × 4.5 mm midway, drying matte, dark reddish brown, narrowly weakly paler along outer margin; spathe blade not known; **spadix** presumably erect, total length not known, sessile, adnate to spathe 3.5 cm at base, entire length of pistillate portion; pistillate portion 3.5 cm × ca. 3 mm, weakly broadest midway, drying brownish yellow; fertile staminate portion not known; sterile staminate portion not known; pistils weakly coherent, more laxly arranged near base, ca. 3 across the axis (viewed from above), ca. 2 × 1.5–2 mm; ovaries subglobose, ca. 2 mm diam.; style Type 9 (Fig. 1), 2–2.5 mm diam., briefly attenuate, weakly broader than ovary apex, the margins coherent with those of adjacent styles; **stigma** ca. 0.5 mm diam., disklike, elevated on style, drying medium reddish brown; synandria not known; sterile flowers not known. INFRACTESCENCE (immature) 5.5 cm × 4.5 mm, drying matte, dark reddish brown; berries not known.

Phenology. Flowering and fruiting are only known to occur in *Chlorospatha sucumbensis* during the month of April.

Etymology. *Chlorospatha sucumbensis* is named for Sucumbíos Province, Ecuador, where the type was collected and the new species is endemic.

Discussion. *Chlorospatha sucumbensis* is known only from the type locality in lower montane wet forest in Sucumbíos Province, Ecuador, on the eastern slopes of the Andes at 2200–2350 m elevation, along the El Carmelo–La Bonita road that parallels the border with Colombia. The species would almost certainly occur in adjacent Carchi Province and in Putumayo Department, Colombia, directly across the border.

Chlorospatha sucumbensis is one of only two species in *Chlorospatha* sect. *Occidentales* that occur on the eastern slopes of the Andes, the other being *C. huilensis* (see discussion under *C. huilensis*).

65. *Chlorospatha timbiquensis* Croat & L. P. Hannon, sp. nov. TYPE: Colombia. Cauca: Timbiquí, 100 m (est.), 1903, *C. Lehmann* 390 (holotype, K!). Figure 48A.

Herba ca. 50 cm; internodia ca. 1 cm × 5 mm; cataphylla usque ad 21 cm longa. Petiolus 20–30 cm longus, vaginatus per 12–22 cm; lamina foliaris hastata vel subhastata, 16.5–18 × 12.7–14.3 cm, lobis posterioribus 6.3–9.5 × 2.7–3.5 cm, nervis basalibus utroque 2, nervis primariis lateralibus

utroque 3 vel 4. Inflorescentiae 2 in quaque axilla; pedunculus 23–26 cm × 1–1.5 mm; spatha erecta, ca. 8.5 cm longa, tubo ca. 3 mm diam., lamina ca. 5 cm × 6 mm; spadix ca. 6.2 cm longus.

Terrestrial herb, ca. 50 cm tall; stem with remnants of old cataphylls persisting ± intact along its length (all measurements made from dried material); internodes ca. 1 cm × 5 mm, drying matte, dark brown; cataphylls to 21 cm long, cuspidate at apex, drying matte, dark brown. LEAVES 4, erect-spreading; **petioles** 20–30 cm long, drying glabrous, matte to weakly glossy, dark brown, sheathed 12–22 cm, more than 3/4 of total length (1/3 to 1/2 when sterile); sheath decurrent at apex; free portion 2–2.5 mm diam. midway, finely many-ribbed abaxially, possibly sulcate near apex; **blades** hastate to subhastate, 16.5–18 × 12.7–14.3 cm, ca. 1.3 times longer than wide, acute to acuminate at apex (rarely long-acuminate), broadest at base, 1.3 to 1.9 times wider at base than across anterior lobe (measured tip to tip across posterior lobes), weakly constricted in area of petiole attachment, drying moderately thin, moderately bicolorous; upper surface drying matte to weakly glossy, dark brown; lower surface reticulate, drying weakly glossy; anterior lobe 13–14 × (6.7–)9–10.2 cm, ca. 1.5 times longer than wide, 1.5 to 2.2 (to 3.3) times longer than posterior lobes, broadest below middle, weakly inequilateral; posterior lobes directed outward, 6.3–9.5 × 2.7–3.5 cm, 2.1 to 3.2 (to 3.4) times longer than wide, bluntly acute to narrowly rounded at apex, broadest at base, moderately to markedly inequilateral, the inner side narrower, rounded toward base and decurrent onto petiole; outer side 2 to 3.3 times wider than inner side midway, ± straight to weakly concave toward base; midrib, major, and secondary veins raised and granular-puberulent on lower surface, drying raised, darker than surface; midrib minutely ribbed on lower surface; **basal veins** 2 pairs, coalesced into prominent posterior rib; primary lateral veins 3 to 4 pairs, arising at 30°–40°, weakly arcuate, minutely many-ribbed on lower surface; tertiary veins granular-puberulent on lower surface, drying mostly weakly raised, otherwise prominulous, darker than surface; reticulate veins drying mostly prominulous, otherwise visible and flat on lower surface, darker than surface; collective veins 3, the innermost arising at apex of posterior rib, loop-connected with all preceding lateral veins, ± parallel to and 4 mm from margin. INFLORESCENCES erect, 2 per axil; peduncle held within the sheath, 23–26 cm × 1–1.5 mm, longer than petiole, drying matte, dark brown; **spathe** erect, 8.5 cm long, acute at apex; spathe tube 3.5 cm × 3 mm, drying matte, dark brown; spathe blade ca. 5 cm × 6 mm, drying matte, moderately paler than tube,

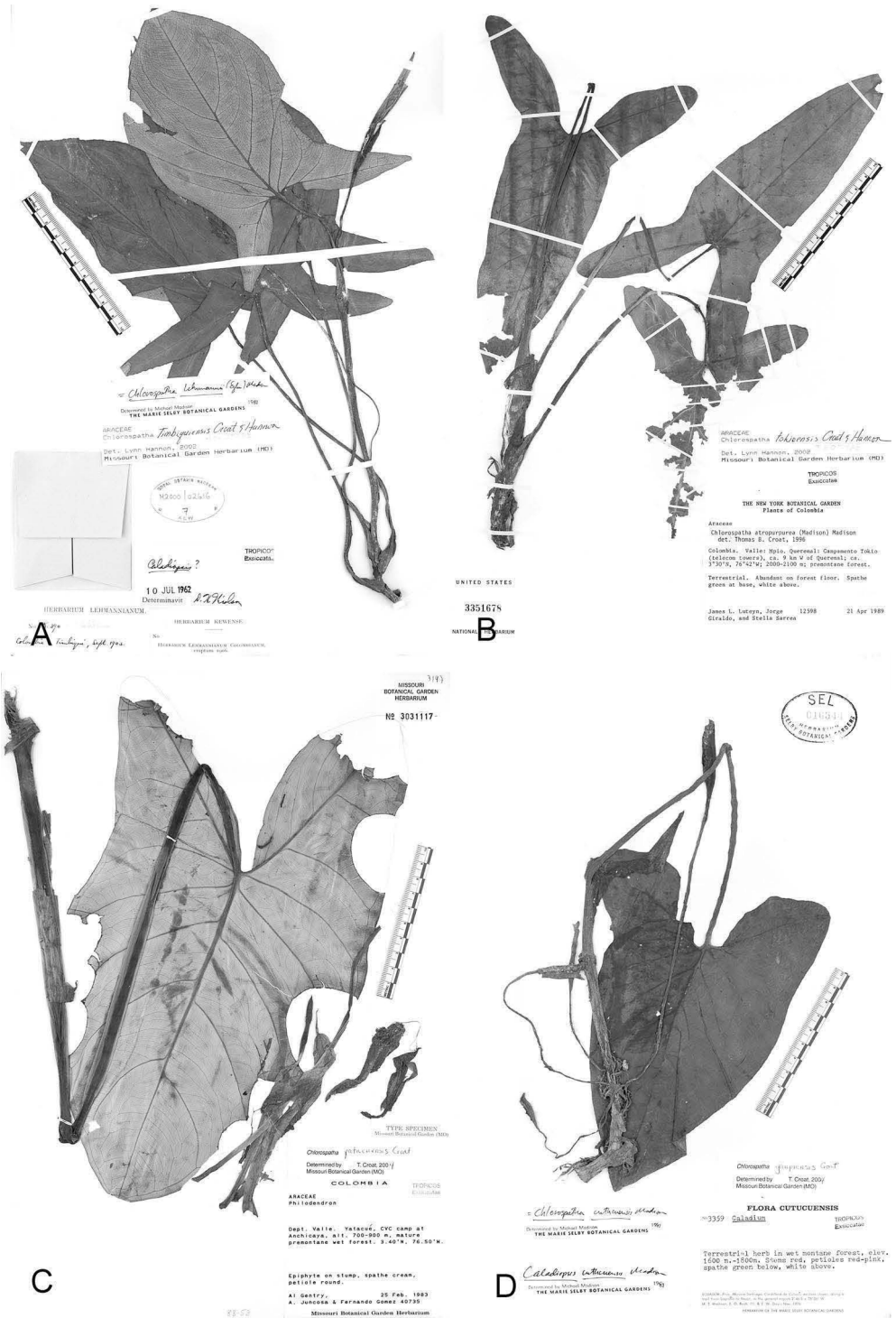


Figure 48. —A. *Chlorospatha timbiquensis* Croat & L. P. Hannon, Lehmann 390 (K holotype). —B. *Chlorospatha tokioensis* Croat & L. P. Hannon, the isotype Lutey *et al.* 12598 (US-3351678). —C. *Chlorospatha yatacuensis* Croat & L. P. Hannon, the holotype Gentry *et al.* 40735 (MO-3031117). —D. *Chlorospatha yaupiensis* Croat & L. P. Hannon, the holotype Madison *et al.* 3359 (SEL-16544).

marcescent, erect after anthesis; **spadix** erect, 6.2 cm long, sessile, adnate to spathe 2 cm at base, most of the length of pistillate portion; pistillate portion 2.5 cm \times ca. 2 mm, drying creamy white; fertile staminate portion 3.1 cm \times ca. 3 mm, acute at apex, ellipsoid, drying medium dark brown; sterile staminate portion ca. 7 \times 1–1.5 mm, narrowest midway, naked in basal 1/3, drying dark brown; pistils weakly coherent, more laxly arranged near base, 3 to 4 across the axis (viewed from above), 1–1.5 mm long; ovaries subglobose, ca. 1.5 mm diam., drying creamy white with weakly darker veins; style Type 9 (Fig. 1), ca. 0.5 \times 1–1.3 mm, comprising ca. 1/4 to 1/3 of the length of pistil, broader than ovary apex, the margins \pm coherent with those of adjacent styles; **stigma** 0.3–0.5 mm diam., weakly elevated on narrowed portion of style, drying pale amber; synandria 1–1.5 \times 1–1.5 mm, weakly elongated in direction of axis in basal 3 whorls, coherent, truncate, 3- to 4(5)-lobed, 3- to 4(5)-androus; sterile flowers ca. 1 mm long, 0.8–0.9 \times 1.5 mm diam. and \pm elongated in direction of axis, subprismatic to subrounded, truncate, markedly laxly arranged, in 3 to 4 whorls. **INFRUCTESCENCE** (immature) 5 cm \times 6 mm, drying dark brown; berries ca. 2 mm diam., drying dark tan.

Phenology. Flowering and fruiting are only known to occur in *Chlorospatha timbiquensis* during the month of September.

Etymology. *Chlorospatha timbiquensis* is named for the town of Timbiquí on the Río Timbiquí in Cauca Department of Colombia, near which the type was collected.

Discussion. *Chlorospatha timbiquensis* is known only from the type, a Lehmann collection made in 1903, near the Pacific town of Timbiquí in Cauca Department, Colombia. The town is near the coast, near the mouth of the Río Timbiquí; therefore, the authors have estimated the elevation to be ca. 100 m and the life zone as tropical wet forest.

Chlorospatha timbiquensis is a member of *Chlorospatha* sect. *Occidentales* and is distinguished by its hastate to subhastate leaf blades with all abaxial venation drying raised or prominulous, relatively short yet narrow posterior lobes, and long petiole sheath and peduncle. The petiole is sheathed more than three fourths of its length and the peduncle is longer than the petiole, but the inflorescence is relatively small, less than 9 cm long. *Chlorospatha timbiquensis* is also distinguished by its style, which is briefly attenuated and dries creamy white, and the sterile staminate portion of the spadix, which is

markedly laxly flowered, with the axis naked in the basal one third.

Chlorospatha timbiquensis could not be easily confused with any species. Madison (1981) previously filed *Lehmann 390*, the type for *C. timbiquensis*, as *C. lehmannii*, but the collection differs from that species in significant ways and should be considered distinct. *Chlorospatha lehmannii* has leaf blades with proportionally longer posterior lobes, the posterior rib naked 5–7 mm on each side, all abaxial venation (except midrib) drying flattened, the petiole sheathed ca. one half of its length and the sheath free-ending at the apex. In *C. timbiquensis*, the posterior lobes are short, with the inner margins decurrent onto the petiole (posterior rib not naked); all abaxial venation dries raised or prominulous; the petiole is sheathed more than three fourths of its length; and the sheath is decurrent at the apex. In *C. lehmannii*, the peduncle is one half (two thirds) as long as the petiole and the spathe is more than 10 cm long, thus differing from *C. timbiquensis*, in which the peduncle is longer than the petiole and the spathe is less than 9 cm long. The style of *C. lehmannii* is long-attenuated and only as wide as the ovary apex, whereas that of *C. timbiquensis* is briefly attenuated and broader than the ovary apex. The sterile staminate portion of the spadix is markedly laxly flowered in the latter species, with the axis bare in the basal one third and the flowers subprismatic. That portion is densely flowered in *C. lehmannii* and the flowers are fungiform (like toadstools) or branched.

There are two specimens of *Lehmann 390* at Kew, and it is apparently a mixed collection. The leaf blade of the sterile specimen dries weakly or not at all bicolorous, with the upper surface weakly glossy to semiglossy, medium-dark brown, the lower surface semiglossy and smooth (not reticulate), and the anterior lobe narrowly oblong-elliptic, 4 times longer than wide, and long-acuminate at the apex. All abaxial venation is more or less flattened and paler than the surface. In the type indicated for *C. timbiquensis* (cf. Fig. 48A), which is a fertile specimen, the blade dries moderately bicolorous, with the upper surface matte to weakly glossy dark brown, the lower surface reticulate and weakly glossy, and the anterior lobe comparatively short, broad, and ovate, 1.5 times longer than wide and weakly to moderately acuminate at the apex, with the abaxial venation raised or prominulous and darker than the surface. The sterile specimen has been determined as *C. grayumii*, a new species from Chocó Department to the north of the type locality of *C. timbiquensis* from Cauca Department in Colombia and, therefore, has been assigned a new number, *Lehmann 390A* (K).

66. *Chlorospatha tokioensis* Croat & L. P. Hannon, sp. nov. TYPE: Colombia. Valle: Mpio. Quere-mal, Campamento Tokio (telecom towers), 9 km W of Quere-mal, 2000–2100 m, ca. 3°30'N, 76°42'W, 21 Apr. 1989, *J. Luteyn, J. Giraldo & S. Sarrea 12598* (holotype, MO-3789758!; isotypes, NY!, US!). Figure 48B.

Herba ca. 50 cm; internodia 1–1.5 × 1–2 cm. Petiolus 24.5–44.5 cm longus, vaginatus per 8–13.5 cm; lamina foliaris subhastata, 21.5–34.5 × 14–27 cm, lobis posterioribus 9–12(–14.5) × 2.6–4(–6.2) cm, nervis basalibus utroque 5 ad 7(ad 9), nervis primariis lateralibus utroque 5 ad 6(7). Inflorescentiae 2 in quaque axilla; pedunculus 13.5–15 cm × 1–2 mm; spatha erecta, 8.8–9.5 cm longa, tubo 5–6 mm diam., lamina ca. 5 cm × 6–7 mm; spadix 6.6–8 cm longus.

Terrestrial herb, ca. 50 cm tall; stem decumbent, to 60 cm long, with remnants of old leaf bases and cataphylls persisting ± intact along its length (all measurements made from dried material); internodes 1–1.5 × 1–2 cm, drying matte, dark brown; cataphylls 9–11(–20) cm long, obtuse with acumen at apex (acumen to 4 mm long), drying weakly glossy, dark yellowish to reddish brown. LEAVES 2 to 3, erect-spreading; **petioles** 24.5–44.5 cm long, drying glabrous, weakly glossy, pale-medium to dark brown, sheathed 8–13.5 cm, ca. 1/3 of total length; sheath decurrent at apex; free portion 2–3(–4) mm diam. midway; **blades** subhastate, 21.5–34.5 × 14–27 cm, 1 to 1.5 times longer than wide, acute to bluntly acute or weakly acuminate at apex, broadest at base, (2.2 to)2.5 to 3.5 times broader at base than across anterior lobe (measured tip to tip across posterior lobes), weakly to moderately constricted in area of petiole attachment, thin, drying weakly to moderately bicolorous; upper surface drying matte to weakly glossy, medium-dark to dark green or weakly brownish green, with pale, punctiform to short, linear raphid cells; lower surface drying weakly glossy to semiglossy; anterior lobe 14–25 × 5.5–7.7(–13) cm, (1.9 to)2.3 to 3.5 times longer than wide, (1.3 to)1.6 to 1.8 times longer than posterior lobes, broadest near base, ± symmetrical to weakly inequilateral; posterior lobes directed outward, 9–12(–14.5) × 2.6–4(–6.2) cm, (2.3 to)2.8 to 4 times longer than wide, bluntly acute to narrowly rounded at apex, broadest below middle, ± symmetrical to weakly inequilateral, the inner side weakly rounded toward base rarely broadly so, briefly attenuate onto posterior rib; outer side straight to weakly concave toward base; midrib round-raised on lower surface, drying raised, concolorous to weakly paler or weakly darker than surface, rarely much darker toward base; **basal veins** 5 to 7(9) pairs, coalesced into a prominent posterior rib; posterior rib naked 3–12 mm per side; primary lateral

veins 5 to 6(7) pairs, arising at 30°–55°, most acutely toward apex, moderately arcuate, occasionally irregularly ascending, rarely straight, round-raised on lower surface, drying ± raised, occasionally in part weakly flattened, concolorous to weakly paler than surface, occasionally weakly darker; secondary veins raised on lower surface, drying entirely or in part raised and otherwise prominulous, concolorous to weakly paler than surface; tertiary veins drying mostly prominulous on lower surface, otherwise visible and distinct, ± concolorous to weakly darker than surface; reticulate veins drying obscure; collective veins 3, the innermost arising from the lowermost lateral vein on inner side of posterior lobe, loop-connected with all preceding lateral veins, ± parallel to and 2–7 mm from margin. INFLORESCENCES erect, 2 per axil; peduncle held within the sheath, 13.5–15 cm × 1–2 mm, drying matte, medium to dark brown; **spathe** erect, 8.8–9.5 cm long, ± acute at apex; spathe tube green, 4–4.5 cm × 5–6 mm, drying matte, dark reddish brown on outer surface, weakly glossy, moderately paler on inner surface; spathe blade white, ca. 5 cm × 6–7 mm, drying weakly glossy, dark brown on outer surface, weakly glossier and concolorous on inner surface, marcescent, erect after anthesis; **spadix** erect, 6.6–8 cm long, sessile, adnate to spathe 3.8–4.5 cm at base, the entire length of pistillate portion; pistillate portion 3.8–4.5 cm × ca. 3 mm, drying dark purplish brown; fertile staminate portion 2.7–3.5 cm × 2–4.5 mm, narrowly rounded at apex, weakly clavate or ellipsoid, drying medium orangish brown or medium-dark grayish brown; sterile staminate portion 1–1.5 × ca. 2 mm, drying medium grayish brown; pistils weakly coherent, ca. 3 across the axis (viewed from above), ca. 2 mm long; ovaries subglobose, ca. 1.1 × ca. 2 mm, drying dark tan; style Type 8 (Fig. 1), ca. 0.8 × 1.3–1.8 mm, weakly broader than ovary apex, the margins ± coherent with those of adjacent styles; **stigma** 0.5–0.8 mm diam., moderately elevated on and broader than narrowed portion of style, drying medium reddish brown; synandria ca. 1 × 1.5–2 mm., coherent, truncate, 3- to 4(5)-lobed, 3- to 4(5)-androus (mostly 3); sterile flowers ca. 0.5–0.8 × 0.6–1 mm, fungiform (like toadstools) and convex at apex, or deeply lobed (as per synandria but lacking microsporangia), ± laxly arranged, in 1 to 2 whorls. Berries not known.

Phenology. Flowering is only known to occur in *Chlorospatha tokioensis* during the month of April.

Etymology. *Chlorospatha tokioensis* is named for Estación Micronondas Tokio, a telecommunications station in Valle Department of Colombia, where the new species is endemic.

Discussion. *Chlorospatha tokioensis* is known only from the type collection made near the Estación Microndas Tokio, an encampment with telecommunications towers near Queremal in Valle Department, Colombia, in premontane wet forest on the western slopes of the Cordillera Occidental at 2000–2100 m elevation. The species would be expected to occur elsewhere in the department.

Chlorospatha tokioensis is a member of *Chlorospatha* sect. *Occidentales* and is distinguished by its greenish drying, subhastate leaf blades with long, narrow posterior lobes. The petiole of *C. tokioensis* is sheathed one third of its length, and the peduncle is accordingly short, 13.5–15 cm. The inflorescence is of moderate size, 8.8–9.5 cm long, with the spathe tube green and the blade white. The unusually short, sterile staminate portion of the spadix is noteworthy in being less than 2 mm long, with laxly arranged, fungiform, or deeply lobed flowers. The morphology of the style is not common in *Chlorospatha*, being appressed to the ovary and also long-attenuated.

Chlorospatha tokioensis would be most easily confused with *C. nicolsonii* from the Parque Nacional Las Orquídeas on the western slopes of the Cordillera Occidental in Antioquia Department, Colombia, at 1500–1800 m elevation (see discussion under *C. nicolsonii*).

67. *Chlorospatha yatacuensis* Croat & L. P. Hannon, sp. nov. TYPE: Colombia. Valle: Yatacué, CVC camp at Anchicayá, 700–900 m, 3°40'N, 76°50'W, 25 Feb. 1983, A. Gentry, A. Juncosa & F. Gomez 40735 (holotype, MO-3031117). Figure 48C.

Herba hemiepiphytica; cataphylla 8–23 cm longa. Petiolus ca. 63.5 cm longus, vaginatus per ca. 20 cm; lamina foliaris ovato-sagittata, ca. 34.5 × 19.5 cm; lobis posterioribus ca. 15 × 9 cm, nervis basalibus utroque 4, nervis primariis lateralibus utroque 4. Inflorescentiae 3 in quaque axilla, erecta; pedunculus 14.5–21 cm × 1.5–3 mm; spatha erecta, 4.2–5.5 cm longa, tubo 4–5 mm diam, lamina 2.2–3 cm × 4.5–6 mm; spadix 3.8–4.5 cm longus.

Hemiepiphytic herb; stem not known; internodes not known (all measurements made from dried material); cataphylls 8–23 cm long, obtuse with acumen at apex, drying weakly glossy to glossy, medium-dark to dark reddish brown. LEAVES 1; **petiole** 63.5 cm long, drying weakly glossy, blackish brown, the epidermis in part separated intact and semi-transparent, semiglossy, medium brown, sheathed ca. 20 cm, ca. 1/3 of total length; sheath decurrent at apex; free portion 5–7 mm diam. midway, terete; **blade** ovate-sagittate, ca. 34.5 × 19.5 cm, 1.8 times longer than wide, abruptly acuminate at apex, as broad at base as across

anterior lobe, drying thin, moderately bicolorous; upper surface drying matte, medium-dark olive-green; lower surface drying weakly glossy, pale-medium grayish green; anterior lobe 23 × 19.5 cm, 1.2 times longer than wide, 1.5 times longer than posterior lobes, broadest below middle, ± symmetrical; posterior lobes directed toward the base, ca. 15 × 9 cm, 1.6 times longer than wide, apex not known, broadest at base, moderately inequilateral, the inner side narrower, weakly rounded toward base, decurrent onto petiole, possibly weakly confluent with opposite lobe, with confluent portion obscuring petiole apex; outer side 1.6 to 2.7 times wider than inner side midway, ± straight toward base; midrib convex on lower surface, drying weakly raised, moderately darker than surface, darkest toward base; **basal veins** 4 pairs, coalesced into a prominent posterior rib; primary lateral veins 4 pairs, arising at 50°–65°, most acutely toward apex, moderately arcuate, drying ± flattened on lower surface, moderately darker than surface; secondary veins drying weakly raised on lower surface, weakly darker than surface; tertiary veins drying visible, distinct on lower surface, weakly darker than surface; reticulate veins drying obscure; collective veins 3 to 4, point of origin not known, ± parallel to and 3–7 mm from margin. INFLORESCENCES to 3 per axil, erect, possibly erect-spreading; sympodium possibly held within a sympodial cataphyll; sympodial cataphyll ca. 14 × ca. 2 cm, acuminate at apex, 1-ribbed abaxially; peduncle 14.5–21 cm × 1.5–3 mm, broadest toward base, drying weakly glossy to semiglossy, pale-medium brown, occasionally dark brown toward apex; **spathe** erect, cream-colored, 4.2–5.5 cm long, acuminate at apex, drying matte to weakly glossy, dark brown on both surfaces; spathe tube 2–2.5 cm × 4–5 mm; spathe blade 2.2–3 cm × 4.5–6 mm, marcescent, erect after anthesis; **spadix** erect, 3.8–4.5 cm long, sessile, adnate to spathe 8–10 mm at base, ca. 1/2 of the length of pistillate portion; pistillate portion 1.5–1.8 cm × 3–4 mm, broadest midway, drying medium reddish brown; fertile staminate portion 1.5–1.7 cm long, narrowly rounded at apex, weakly ellipsoid, drying medium-dark to dark reddish brown; sterile staminate portion 8–10 × 2.5–3 mm, ± cylindrical or weakly broadest at apex, drying dark blackish brown; pistils weakly coherent, ca. 3 to 4 across the axis (viewed from above), ca. 1.5–1.8 mm long; ovaries 1–1.3 × 1.5–1.8 mm, ± cylindrical or subglobose, obtusely truncate at apex, drying yellowish cream; style Type 9 (Fig. 1), 0.3–0.6 × 1.5–1.8 mm, broader than ovary apex, with most margins coherent with those of adjacent styles; **stigma** ca. 0.3 mm diam., weakly elevated on and

weakly broader than narrowed portion of style; synandria 1–1.3 × 1.5–2 mm, coherent, truncate, 3- to 4(5)-lobed, with narrowly sinuate margins, 3- to 4(5)-androus; sterile flowers ca. 1 × 1.5 mm, weakly elongated in direction of axis, coherent, truncate, ± prismatic, in 7 to 8 whorls (a few flowers extending into pistillate portion). Berries not known.

Phenology. Flowering is only known to occur in *Chlorospatha yatacuensis* during the month of February.

Etymology. *Chlorospatha yatacuensis* is named for Yatacué, a town in the Parque Nacional de Farrallones in Valle Department of Colombia, near the area where the type of the new species was collected.

Discussion. *Chlorospatha yatacuensis* could possibly be one of the few species in which the sympodium is held within a sympodial cataphyll toward the base of the petiole. A prominent cataphyll appears to subtend the sympodium of this specimen, but since there is no morphological difference between sympodial or vegetative cataphylls, this condition cannot be confirmed, the sympodium having been removed from its associated leaf on the herbarium specimen. The petiole sheathing of 20 cm and peduncle lengths of 14.5–21 cm would easily accord with a plant whose peduncle is held within the sheath. It is hoped that additional collections will clarify the issue. The single herbarium specimen is further incomplete and also provides no information pertaining to the stem or its internodes.

Chlorospatha yatacuensis is known only from the type locality at the CVC camp at Anchicayá, near Yatacué in Valle Department, Colombia, in mature tropical wet forest or premontane wet forest on the western slopes of the Cordillera Occidental at 700–900 m elevation. The species would be expected to occur elsewhere within the department and to the north in Chocó and possibly southward into Cauca.

Chlorospatha yatacuensis, a member of *Chlorospatha* sect. *Occidentales*, is a moderately large plant, possibly 1 m tall, with the petiole 63.5 cm long and the leaf blade 34.5 cm long, drying an unusual pale-medium grayish green on the lower surface. The species is one of few hemiepiphytes in the genus and was collected on a stump. The species is distinguished by its broadly ovate-sagittate leaf blades with few primary lateral veins (four pairs), and broad, moderately long posterior lobes with the inner margins decurrent onto the petiole. The petiole is distinctive in drying with the epidermis partially separated intact from the main body and semi-transparent, and in being sheathed only one third of

its length. The peduncles are short, 14.5–21 cm long. Particularly noteworthy is the uncommonly small, entirely cream-colored inflorescence, 4.2–5.5 cm long, which would not be expected in such a large plant. Also unusual are the prismatic sterile flowers.

Chlorospatha yatacuensis could not be easily confused with any species, but could possibly be confused with *C. bayae*, which occurs in the same general area, but at higher elevations along the old Cali–Buenaventura road, 50.5 km north of Agua Clara, on the western slopes of the Cordillera Occidental in Valle Department, Colombia, at 1100–1200 m elevation (see discussion under *C. bayae*).

68. *Chlorospatha yaupiensis* Croat & L. P. Hannon, sp. nov. TYPE: Ecuador. Morona-Santiago: Cordillera de Cutucú, W slope, along Logroño–Yaupi trail, in the general region, 1600–1800 m, 2°46'S, 78°06'W, Nov. 1976, *M. Madison, M. Bush & W. Davis 3359* (holotype, SEL-016544!). Figure 48D.

Herba ca. 50 cm; internodia 1.5–2.3 cm × 8–10 mm; cataphylla usque ad 12 cm longa. Petiolus usque ad 36 cm longus, vaginatus per ca. 15 cm; lamina foliaris ovato-triangularis, subsagittata, ca. 21 × 14.5 cm, lobis posterioribus 8–8.5 × ca. 5.5 cm, nervis basalibus utroque 2 vel 3, nervis primariis lateralibus utroque 3 vel 4. Inflorescentiae 4 in quaque axilla; pedunculus (12–)14.5–21 cm × 1–2 mm; spatheae tubo 2.4–3.2 cm × 3.5–4 mm; spadix longitudine ignota.

Terrestrial herb, ca. 50 cm tall; stem decumbent, with remnants of old cataphylls persisting as pale linear fibers along its length (all measurements made from dried material); internodes 1.5–2.3 cm × 8–10 mm, red, drying weakly glossy, medium brown; cataphylls to 12 cm long, apex not known, drying ± fibrous. LEAVES 2 to 3; **petiole** to 36 cm long, reddish pink, granular-puberulent, crispy-puberulent toward apex, most densely so in apical 3 cm, drying matte, dark yellowish brown, sheathed ca. 15 cm, ca. 1/2 of total length; sheath decurrent at apex; free portion 3.5 mm diam. midway; **blade** ovate-triangular, subsagittate at base, 21 × 14.5 cm, 1.4 times longer than wide, bluntly acute at apex, broadest at base, ca. 1.5 times wider at base than across anterior lobe (measured tip to tip across posterior lobes), weakly constricted in area of petiole attachment, drying thinly coriaceous, weakly bicolorous; upper surface drying matte to weakly glossy, dark brown; lower surface reticulate, drying matte, with pale, linear cellular inclusions in developing blade; anterior lobe 16.5 × 11.8 cm, 1.4 times longer than wide, 1.9 to 2.1 times longer than posterior lobes, broadest at

base, \pm symmetrical; posterior lobes directed toward the base, $8\text{--}8.5 \times 5.5$ cm, 1.5 times longer than wide, broadly to narrowly rounded at apex, broadest at base, \pm symmetrical to weakly inequilateral, the inner side narrower, broadly rounded toward base, briefly attenuate onto posterior rib; outer side (1 to) 1.6 times wider than inner side midway, straight toward base; major and minor venation drying weakly prominulous on upper surface, entirely \pm crispy-puberulent to granular-puberulent on lower surface; midrib drying weakly convex in basal 3 cm on upper surface, prominently raised on lower surface, \pm crispy-puberulent, darker than surface; **basal veins** 2 to 3 pairs, coalesced into a prominent posterior rib; posterior rib naked 4–5 mm per side; primary lateral veins 3 to 4 pairs, arising at $30^\circ\text{--}50^\circ$, most acutely toward apex, weakly arcuate, drying prominently raised on lower surface, darker than surface; secondary and tertiary veins drying raised on lower surface, weakly darker than surface; reticulate veins drying prominulous on lower surface, weakly darker than surface; collective veins 3, the innermost arising from one of the lateral veins on inner side of posterior lobe, moderately scalloped, 4–9 mm from margin. INFLORESCENCES erect, to 4 per axil; peduncle held within the sheath, (12–)14.5–21 cm \times 1–2 mm, entirely crispy-puberulent, or in part only in apical 3–4 cm, and otherwise glabrous or granular-puberulent, drying matte, dark brown; **spathe** total length not known; spathe tube green, 2.4–3.2 cm \times 3.5–4 mm, weakly crispy-puberulent abaxially, drying matte, dark brown; spathe blade white; **spadix** total length not known, adnate to spathe 1.2–1.6 cm at base, ca. 1/2 of the length of pistillate portion; pistillate portion 2–3 cm \times 4–4.5 mm.; fertile staminate portion not known; sterile staminate portion not known; pistils weakly coherent, 3 across the axis (viewed from above), ca. 1 mm long; ovaries \pm cylindrical to obtusely obconical, 1.5 mm diam.; style Type 1 (Fig. 1), ca. 1.5 mm diam., as broad as ovary apex, the margins not coherent with those of adjacent styles; **stigma** sessile; synandria not known; sterile flowers not known. INFRUCTESCENCE 5.3 cm \times 9 mm; berries 3–4 mm diam.

Phenology. Flowering and fruiting are known to occur in *Chlorospatha yaupiensis* only during the month of November. The single collection has only an infructescence and two inflorescences past staminal anthesis, the staminate portion of the spadix and spathe blade having already abscised; therefore, little is known about the details of the flowers.

Etymology. The name refers to the Logroño–Yaupi trail in the Cordillera de Cutucú in Morona-

Santiago Province, Ecuador, where the type of *Chlorospatha yaupiensis* was collected.

Discussion. *Chlorospatha yaupiensis* is known only from the type locality in an area southeast of Logroño in Morona-Santiago Province, in lower montane wet forest on the western slopes of the Cordillera de Cutucú, east of the Andes, at 1600–1800 m elevation. The species would be expected to occur elsewhere in the Cutucú and perhaps nowhere else, the Cutucú being a region noted for a high level of endemism in species of Araceae.

Chlorospatha yaupiensis is a member of *Chlorospatha* sect. *Orientalis* and is distinguished by its ovate-triangular, subsagittate leaf blades that dry dark brown above, matte on both surfaces, and reticulate on the lower surface, with the posterior lobes broad, ca. 1.5 times longer than wide. All orders of venation dry more or less raised on the lower surface, crispy-puberulent to granular-puberulent, and darker than the surface. The indumentum also occurs on the peduncles, abaxial surface of the spathe tube, and apical portion of the petiole. The stem is red, a color not observed in any other species, and the petiole reddish pink, with the sheath comprising one half of its length. The peduncle is accordingly long, (12–)14.5–21 cm, unusual for species from the eastern slopes, most of which have peduncles less than 12 cm long.

Chlorospatha yaupiensis would be most easily confused with *C. cutucuensis*, with which it is sympatric in the area near Logroño, in the Cordillera de Cutucú (see discussion under *C. cutucuensis*).

CHLOROSPATHA SPECIES NOT FORMALLY PUBLISHED IN THIS REVISION

The following four species are distinct and validly new, but were collected in sterile condition and will be formally and completely described only after they have been collected again in fertile condition.

Chlorospatha sp. indet. 1. Colombia. Nariño: Mpio. Ricaurte, Altaquér–Tumaco rd., Río Nambí, 7 km W of Altaquér, 1100–1130 m, $1^\circ 18' N$, $78^\circ 04' W$, 20 Mar. 1990, Croat 71604 (MO).

Terrestrial herb, to ca. 40 cm tall (all measurements made from dried material); stem decumbent, erect 10 cm, with remnants of old cataphylls persisting \pm intact along its length; internodes 1–1.5 \times 1–1.5 cm, semiglossy, dark green, drying weakly glossy, medium-dark brown; cataphylls not known. LEAVES 4, erect-spreading; **petioles** 18–25 cm long, moderately soft, glabrous, semiglossy, medium green, with weakly darker transverse

markings, drying weakly glossy, medium-dark brown, with epidermis in part separated \pm intact and semi-transparent, sheathed 8–10 cm, ca. 1/2 of total length; sheath decurrent at apex; free portion 4–6 mm diam. midway, terete, weakly and narrowly sulcate; **blades** broadly ovate, cordate at base, 15.5–18.5 \times 11.5–13 cm, 1.3 to 1.4 times longer than wide, apiculate at apex, broadest across anterior lobe, 1.6 to 1.7 times wider across anterior lobe than at base (measured tip to tip across posterior lobes), soft, thin, conspicuously bicolorous; upper surface quilted, velvety, dark green, drying matte to weakly glossy, medium-dark olive-green; lower surface matte, drying matte to weakly glossy, moderately paler; anterior lobe 10.5–13 \times 11.5–13 cm, as wide as long or weakly wider to weakly narrower than long (ca. 1 cm wider or narrower), 1.8 to 2.2 times longer than posterior lobes, broadest at or below middle, \pm symmetrical to weakly inequilateral, with one side to 8 mm wider than opposite side; posterior lobes directed toward the base, 5.8–6 \times 5.8–6 cm, about as wide as long, broadly rounded at apex, broadest at base, moderately to markedly inequilateral, the inner side narrower, weakly to broadly rounded toward base, briefly attenuate onto petiole apex, possibly weakly confluent with opposite lobe; outer side 2.3 to 4 times wider than inner side midway; midrib and major venation deeply sunken on upper surface, round-raised on lower surface, drying \pm flattened, moderately darker than surface; **basal veins** 3 to 4 pairs, coalesced into a prominent posterior rib; primary lateral veins 3(4) pairs, arising at 35°–55°, most acutely toward apex, moderately arcuate; secondary veins drying in part weakly raised to prominulous and otherwise flat on lower surface, \pm concolorous; tertiary veins flat on lower surface, distinct, darker than surface, drying \pm obscure; reticulate veins drying \pm obscure; collective veins 3, the innermost arising from one of the lowermost lateral veins on inner side of posterior lobe, loop-connected with all preceding lateral veins, \pm parallel to and 2.5–6 mm from margin. INFLORESCENCE erect; peduncle pale green; spathe tube matte, medium green toward base, semiglossy, dark purple at apex. Berries not known.

Phenology. Flowering is only known to occur in species indet. 1 during the month of March. The inflorescence was not examined.

Discussion. *Chlorospatha* sp. indet. 1 is known from a single, incomplete herbarium specimen, with label notes providing some details regarding the inflorescence. The collection was made in premon-tane wet forest on the western slopes of the Cordillera

Occidental in Nariño Department in southern Colombia, at 1100–1300 m elevation. It would be expected to occur southward into northern Ecuador.

Chlorospatha sp. indet. 1 is probably a member of *Chlorospatha* sect. *Occidentales* and is distinguished by its ovate-cordate, velvety, dark green leaf blades that are only slightly longer than wide, giving them a rounded appearance. It is also distinguished by its spathe tube, which is green toward the base and dark purple at the apex.

Chlorospatha sp. indet. 1 could possibly be confused with *C. besseae* in the sterile state, a species that occurs on the western slopes of the Andes in Carchi and Esmeraldas provinces in northern Ecuador (see discussion under *C. besseae*). The petiole of *C. besseae* is matte, entirely green, and moderately firm, differing from that of *Chlorospatha* sp. indet. 1, which is moderately soft, semiglossy, and green, with obscure, darker transverse markings. The petiole of the latter species dries weakly glossy, with the epidermis partially separated intact from the main body, whereas that of *C. besseae* dries matte, with no separation of the epidermis. The leaf blades are similar, but the blade of *C. besseae* is more elongated, with the inner margins of the posterior lobes decurrent onto the petiole. In *Chlorospatha* sp. indet. 1, the inner margin either terminates at the petiole apex or is possibly weakly confluent with that of the opposite lobe. The major venation on the lower surface of the blade of *Chlorospatha* sp. indet. 1 dries flattened, whereas that of *C. besseae* dries raised. The latter species has four to five(six) pairs of primary lateral veins versus three(four) pairs in *Chlorospatha* sp. indet. 1. The spathe tube of *C. besseae* is semiglossy, pale green to yellow-green, and that of *Chlorospatha* sp. indet. 1 is matte, medium green toward the base, and semiglossy, dark purple at the apex.

Additional specimen examined. COLOMBIA. Nariño: Mpio. Ricaurte, Altaquér–Tumaco rd., Río Ñambí, 7 km W of Altaquér, 1100–1130 m, 1°18'N, 78°04'W, 20 Mar. 1990, Croat 71604 (MO).

***Chlorospatha* sp. indet. 2.** Colombia. Valle: along Queremal–Buenaventura rd., 28 km W of Queremal, 3 km W of Anchicayá, 220–230 m, 3°37'N, 76°58'W, 12 July 1997, Croat & J. Gaskin 79751 (CUVC, MO).

Terrestrial herb, less than 1 m tall; stem not known; internodes short, to 2.7 cm diam. (all measurements made from dried material); cataphylls not known. LEAVES 2, erect-spreading; **petioles** ca. 40 cm long, glabrous, semiglossy, medium green, irregularly transversely lineate, less so toward apex, drying weakly glossy, dark brown, sheathed ca. 15

cm, slightly more than 1/3 of total length; sheath decurrent at apex, the sides erect; free portion 2–3.5 mm diam. midway, terete; **blades** sagittate, narrowly triangular, 29–31 × 9.3–11.5 cm, 2.7 to 3 times longer than wide, acuminate at apex, weakly broadest at base, 1.1 to 1.2 times broader at base than across anterior lobe (measured tip to tip across posterior lobes), weakly constricted in area of petiole attachment (at least on one side), subcoriaceous, prominently bicolorous; upper surface glossy, dark green, drying weakly glossy, medium-dark yellow-brown; lower surface weakly glossy, drying matte, brownish cream, prominently paler; anterior lobe 19.5–21 × 9.3–10 cm, 2.1 times longer than wide, 1.8 to 1.9 times longer than posterior lobes, broadest below middle, ± symmetrical; posterior lobes directed toward the base, 10.5–12 × 4–4.6 cm, 2.5 to 2.8 times longer than wide, acute to bluntly acute at apex, broadest at base, weakly to moderately inequilateral, the inner side narrower, weakly rounded toward base, narrowly attenuate and decurrent onto petiole; outer side 1.2 to 2.1 times wider than inner side midway; midrib deeply sunken on upper surface, round-raised on lower surface, drying raised, moderately darker than surface; **basal veins** 4 pairs, coalesced into prominent posterior rib; primary lateral veins 4 pairs, arising at 30°–65°, most acutely toward apex, weakly to moderately arcuate, etched on upper surface, convex on lower surface, drying weakly raised and ± flattened, moderately darker than surface; secondary veins drying in part weakly raised on lower surface, otherwise flat or weakly prominulous, concolorous to weakly darker than surface; tertiary veins visible, distinct on lower surface, moderately darker than surface, drying flat, visible, concolorous to weakly darker than surface; reticulate veins drying flat, in part visible on lower surface, ± concolorous; collective veins 3 to 4, the innermost arising from the lowermost lateral vein on inner side of posterior lobe, loop-connected with all preceding lateral veins, ± parallel to and 3–7 mm from margin. INFLORESCENCE not known. Berries not known.

Chlorospatha sp. indet. 2 is known from a single sterile collection made near Anchicayá in Valle Department, Colombia, in either tropical wet forest or premontane wet forest on the western slopes of the Andes at 220–230 m elevation. The species is probably a member of *Chlorospatha* sect. *Occidentales* and is distinguished by its narrowly triangular-sagittate leaf blades that are conspicuously bicolorous in both living and dried material, with the lower surface drying matte and markedly pale brownish cream.

Chlorospatha sp. indet. 2 would be most easily confused with *Chlorospatha* sp. indet. 4 and *C.*

nicolsonii, all three species having long, narrow posterior lobes. However, the blades of the latter two species dry concolorous to only moderately bicolorous, with the lower surface weakly glossy to semiglossy. The blades of *Chlorospatha* sp. indet. 2 have four pairs of primary lateral veins and dry yellow-brown, whereas those of *Chlorospatha* sp. indet. 4 have two or three pairs and dry yellow-green. The blades of *C. nicolsonii* are subhastate, with the posterior lobes directed outward, not toward the base as they are in *Chlorospatha* sp. indet. 2, and much narrower, 3.4 to 3.8 times longer than wide versus 2.5 to 2.8 times longer than wide in *Chlorospatha* sp. indet. 2, which has narrowly triangular blades.

Additional specimen examined. COLOMBIA. **Valle:** along Queremal–Buenaventura rd., 28 km W of Queremal, 3 km W of Anchicayá, 220–230 m, 3°37'N, 76°58'W, 12 July 1997, *Croat & J. Gaskin 79751* (CUVC, MO).

Chlorospatha sp. indet. 3. Colombia. Valle: along Queremal–Anchicayá rd., 3 km W of Queremal, 1400 m, 3°31'N, 76°44'W, 10 July 1997, *Croat & J. Gaskin 79662* (CUVC, MO).

Terrestrial herb, ca. 50 cm tall; stem with internodes ca. 1 × 1.5 cm (all measurements made from dried material); cataphylls ultimately deciduous. LEAVES 1 (probably erect-spreading); **petiole** 32 cm long, spongy, glabrous, pale green, drying weakly glossy, dark brown, sheathed ca. 22 cm, ca. 2/3 of total length; sheath decurrent at apex; free portion 3–5 mm diam. midway, terete; **blade** sagittate-subhastate, 20.5 × 13.5 cm, 1.5 times longer than wide, briefly acuminate at apex, broadest at base, 1.4 times wider at base than across anterior lobe (measured tip to tip across posterior lobes), thinly coriaceous, drying ± concolorous; upper surface semiglossy, green, drying weakly glossy, dark yellowish brown; lower surface glossy, drying semiglossy to glossy; anterior lobe 14.5 × 9.5 cm, 1.5 times longer than wide, 1.7 times longer than posterior lobes, broadest below middle, ± symmetrical; posterior lobes directed somewhat outward, 8.5 × 4.5 cm, 1.9 times longer than wide, bluntly acute at apex, broadest at base, moderately inequilateral, the inner side narrower, weakly rounded toward base, briefly attenuate onto posterior rib; outer side ca. 2 times wider than inner side midway, weakly concave toward base; midrib sunken on upper surface, round-raised on lower surface, paler than surface, drying weakly raised and ± flattened, weakly darker than surface; **basal veins** 4 pairs, coalesced into a prominent posterior rib; posterior rib naked ca. 6 mm per side; primary lateral veins 7 to 8 pairs, arising at 55°–65°, weakly to moderately arcuate, etched on upper

surface, convex on lower surface, drying \pm flattened, weakly darker than surface; secondary veins drying weakly prominulous on lower surface, \pm concolorous; tertiary veins drying in part weakly prominulous on lower surface, otherwise flat, \pm concolorous; reticulate veins drying obscure; collective veins 3, the innermost arising from one of the lowermost lateral veins on inner side of posterior lobe, loop-connected with all preceding lateral veins, \pm parallel to and 3–6 mm from margin. INFLORESCENCES 2 per axil; spathe tube green on outer surface; spathe blade white on outer surface. Berries not known.

Phenology. Flowering is only known to occur in *Chlorospatha* sp. indet. 3 during the month of July. The inflorescence was not examined.

Discussion. *Chlorospatha* sp. indet. 3 is known from a single collection made in premontane wet forest on the western slopes of the Cordillera Occidental, near Queremal in Valle Department, Colombia, at 1400 m elevation. The specimen examined was sterile, with label notes indicating the color of the spathe. The species is probably a member of *Chlorospatha* sect. *Occidentales* and is distinguished by its sagittate-subhastate leaf blades that are flat (not quilted) on the upper surface, with the midrib and major veins etched, and dry weakly glossy, yellowish brown, with the lower surface somewhat glossy and all orders of venation somewhat flattened. The posterior lobes are moderately broad, less than two times longer than wide, and bluntly acute at the apex. The petiole is noteworthy in being sheathed two thirds of its length, although the specimen is sterile.

Chlorospatha sp. indet. 3 could possibly be confused with *C. bayae*, also from Valle, and *C. jaramilloi* from Pichincha Province, Ecuador. All three species have moderately broad posterior lobes, but those of *C. bayae* and *C. jaramilloi* are directed more toward the base, less tapered and more rounded at the apex. The blades of the latter two species dry green or greenish, with the abaxial venation more or less raised, whereas those of *Chlorospatha* sp. indet. 3 dry yellowish brown, with most abaxial venation flattened. The spathe tube of *Chlorospatha* sp. indet. 3 is green, differing from those of *C. bayae* and *C. jaramilloi*, which are entirely or mostly purple.

Additional specimen examined. COLOMBIA. **Valle:** along Queremal–Anchicayá rd., 3 km W of Queremal, 1400 m, 3°31'N, 76°44'W, 10 July 1997, *Croat & J. Gaskin* 79662 (CUVC, MO).

Chlorospatha sp. indet. 4. Colombia. Chocó: Cerro del Torrá, E bank of Río Negro, below Heliport,

1000–1900 m, 22 Aug. 1988, *J. Ramos et al.* 1470 (CUVC, MO); along Bolívar–Quibdó rd., 23 mi. W of Bolívar, on S bank of Río Atrato, 1600 m, 5°50'N, 76°15'W, 16 Dec. 1980, *Croat & A. Cogollo* 52047 (MO).

Terrestrial herb, to 70 cm tall; stem decumbent, ca. 25 cm long, with some remnants of old cataphylls persisting semi-intact along its length (all measurements made from dried material); internodes 1.2–4 cm \times 5–10 mm, drying matte to weakly glossy, medium grayish tan to dark reddish brown; cataphylls 6.5–10 cm long, cuspidate at apex, drying weakly glossy to semiglossy, dark reddish brown. LEAVES 1 to 3, erect-spreading; **petioles** 23–25(–43) cm long, glabrous, greenish purple, drying matte to weakly glossy, dark reddish brown, sheathed 8–10.5 cm, ca. 1/3 to 1/2 of total length; sheath decurrent at apex; free portion 2–3 mm diam. midway, terete; **blades** sagittate, 24.5–30 \times 9–10.8 cm, 2.7 to 2.8 times longer than wide, acuminate or apiculate at apex, as broad as or weakly narrower at base than across anterior lobe (measured tip to tip across posterior lobes), weakly or not at all constricted in area of petiole attachment, drying thinly coriaceous, \pm concolorous to weakly bicolorous; upper surface drying weakly glossy, medium-dark brownish yellow-green; lower surface drying semiglossy; anterior lobe 15–16.5(–20) \times 9–10.8 cm, 1.5 to 1.7 times longer than wide, 1.2 to 1.4 times longer than posterior lobes, broadest at or below middle, weakly inequilateral; posterior lobes directed prominently toward the base, 10.5–13.5(–16) \times 4–4.8 cm, 2.4 to 2.8 times longer than wide, bluntly acute to narrowly rounded at apex, broadest at base, weakly to moderately inequilateral, the inner side narrower, \pm acute toward base, briefly attenuate and weakly confluent with opposite lobe, the confluent portion obscuring the petiole apex; outer side 1.2 to 1.9 times wider than inner side midway, \pm straight toward base; midrib round-raised on lower surface, drying raised, weakly to moderately darker than surface; **basal veins** 6 to 7 pairs, coalesced into a prominent posterior rib; primary lateral veins 2 to 3(4) pairs, arising at 35°–50°, weakly to prominently arcuate, convex on lower surface, drying weakly raised to \pm flattened, weakly to moderately darker than surface; secondary veins raised on lower surface, drying weakly raised, weakly darker than surface; tertiary veins drying weakly prominulous on lower surface, concolorous to weakly darker than surface; reticulate veins drying obscure; collective veins 3, the innermost arising from one of the lowermost lateral veins on inner side of posterior lobe, loop-connected with all preceding lateral veins, \pm parallel to and 3–7

mm from margin. INFLORESCENCE (not examined) 1 per axil; peduncle 9 cm long; spathe 15 cm long. Berries not known.

The specimen examined, *J. Ramos et al. 1470* (MO), was sterile; however, the label notes report that the collection was in flower during the month of August.

Chlorospatha sp. indet. 4 is known from two localities in lower montane rainforest and lower montane wet forest on the western slopes of the Cordillera Occidental in Chocó Department, Colombia, at 1000–1900 m elevation. *J. Ramos et al. 1470* is from the Cerro del Torrá, along the banks of the Río Negro. *Croat & A. Cogollo 52047* is from farther north, approximately 23 miles west of Bolívar, along the banks of the Río Atrato. The species would be expected to occur elsewhere within the department, possibly along watercourses.

Chlorospatha sp. indet. 4 is probably a member of *Chlorospatha* sect. *Occidentales* and is distinguished by its brownish yellow-green–drying, narrowly sagittate leaf blades that are usually narrower at the base than across the anterior lobe, with the posterior lobes directed prominently toward the base. The posterior lobes are long and moderately narrow, with the anterior lobe only slightly longer, and the inner margins weakly confluent across the petiole apex at the base. The species is unusual in having few primary lateral veins, relative to blade size, only two or three pairs, which are frequently prominently arcuate, rarely with a fourth vein on one side. The most distinguishing feature is possibly the unusual combination of a short peduncle (9 cm long) and remarkably long spathe, 15 cm long. However, this could not be confirmed, the information having come from the label notes. Such a combination would be unique in *Chlorospatha*. It could be argued that this combination of characters would not be unusual in *Xanthosoma*, but the other characters appear to better accord with *Chlorospatha*. *Chlorospatha* sp. indet. 4 is a small plant, less than 1 m tall, with long, narrow internodes and the remnants of old cataphylls persisting semi-intact along the length of the stem. These characters are more typical of *Chlorospatha*.

Chlorospatha sp. indet. 4 is most similar to *C. nicolsonii* from the Parque Nacional Natural Las Orquídeas in Antioquia Department to the north, at 1500–1800 m elevation on the western slopes of the Cordillera Occidental. Both species have long internodes, short peduncles, and relatively few pairs of primary lateral veins, two or three in *Chlorospatha* sp. indet. 4 versus three or four in *C. nicolsonii*. The leaf blades of *C. nicolsonii* are subhastate and dry brown, with narrower posterior lobes (3.4 to 3.8 times

longer than wide) with the inner margins decurrent onto the petiole. Species 4 differs in having leaf blades that dry yellow-green, with the posterior lobes directed prominently toward the base, broader (2.4 to 2.8 times longer than wide) and the inner margins weakly confluent across the petiole apex. The inflorescence of *C. nicolsonii* is significantly smaller, 7–8.5 cm long versus 15 cm long in *Chlorospatha* sp. indet. 4.

Additional specimen examined. COLOMBIA. **Chocó:** Cerro del Torrá, E bank of Río Negro, below Heliport, 1000–1900 m, 22 Aug. 1988, *J. Ramos et al. 1470* (CUVC, MO); along Bolívar–Quibdó rd., 23 mi. W of Bolívar, on S bank of Río Atrato, 1600 m, 5°50'N, 76°15'W, 16 Dec. 1980, *Croat & A. Cogollo 52047* (MO).

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Appendix 1. List of species, subspecies, and varieties accepted for the genus *Chlorospatha* Engl.

1. *Chlorospatha amalfiensis* Croat & L. P. Hannon
2. *Chlorospatha antioquiensis* Croat & L. P. Hannon
3. *Chlorospatha atropurpurea* (Madison) Madison
4. *Chlorospatha bayae* Croat & L. P. Hannon
5. *Chlorospatha besseae* Madison
6. *Chlorospatha betancurii* Croat & L. P. Hannon
7. *Chlorospatha bogneri* Croat & L. P. Hannon
8. *Chlorospatha boosii* Croat & L. P. Hannon
9. *Chlorospatha bullata* Croat & L. P. Hannon
10. *Chlorospatha caldasensis* Croat & L. P. Hannon
11. *Chlorospatha caliensis* Croat & L. P. Hannon

12. *Chlorospatha callejasii* Croat & L. P. Hannon
13. *Chlorospatha carchiensis* Croat & L. P. Hannon
14. *Chlorospatha castula* (Madison) Madison
15. *Chlorospatha cedralensis* Croat & L. P. Hannon
16. *Chlorospatha chocoensis* Croat & L. P. Hannon
17. *Chlorospatha cogolloi* Croat & L. P. Hannon
18. *Chlorospatha congensis* Croat & L. P. Hannon
19. *Chlorospatha corrugata* Bogner & Madison
20. *Chlorospatha croatiana* Grayum
- 20a. *Chlorospatha croatiana* Grayum subsp. *croatiana*
- 20b. *Chlorospatha croatiana* var. *enneaphylla* Grayum
21. *Chlorospatha cutucuensis* Madison
22. *Chlorospatha dodsonii* (G. S. Bunting) Madison
23. *Chlorospatha engleri* Croat & L. P. Hannon
24. *Chlorospatha feuersteiniae* (Croat & Bogner) Bogner & L. P. Hannon
25. *Chlorospatha gentryi* Grayum
26. *Chlorospatha giraldoi* Croat & L. P. Hannon
27. *Chlorospatha grayumii* Croat & L. P. Hannon
28. *Chlorospatha hammeliana* Grayum & Croat
29. *Chlorospatha hannoniae* Croat
30. *Chlorospatha hastata* Croat & L. P. Hannon
31. *Chlorospatha hastifolia* Bogner & L. P. Hannon
32. *Chlorospatha huilensis* Croat & L. P. Hannon
33. *Chlorospatha ilensis* Madison
34. *Chlorospatha jaramilloi* Croat & L. P. Hannon
35. *Chlorospatha kolbii* Engl.
36. *Chlorospatha kressii* Grayum
37. *Chlorospatha lehmannii* (Engl.) Madison
38. *Chlorospatha limonensis* Croat & L. P. Hannon
39. *Chlorospatha litensis* Croat & L. P. Hannon
40. *Chlorospatha longiloba* Croat & L. P. Hannon
41. *Chlorospatha longipoda* (K. Krause) Madison
42. *Chlorospatha luteynii* Croat & L. P. Hannon
43. *Chlorospatha macphersonii* Croat & L. P. Hannon
44. *Chlorospatha maculata* Croat & L. P. Hannon
45. *Chlorospatha mansellii* Croat & L. P. Hannon
46. *Chlorospatha mirabilis* (Mast.) Madison
47. *Chlorospatha morae* Croat & L. P. Hannon
48. *Chlorospatha munchiquensis* Croat & L. P. Hannon
49. *Chlorospatha nambiensis* Croat & L. P. Hannon
50. *Chlorospatha narinoensis* Croat & L. P. Hannon
51. *Chlorospatha nicolsonii* Croat & L. P. Hannon
52. *Chlorospatha noramurphyae* Croat & L. P. Hannon
53. *Chlorospatha oblongifolia* Croat & L. P. Hannon
54. *Chlorospatha planadensis* Croat & L. P. Hannon
55. *Chlorospatha plowmanii* (Madison) Croat & L. P. Hannon
56. *Chlorospatha portillae* Croat & L. P. Hannon
57. *Chlorospatha pubescens* Croat & L. P. Hannon
58. *Chlorospatha queremalensis* Croat & L. P. Hannon
59. *Chlorospatha ricautensis* Croat & L. P. Hannon
60. *Chlorospatha risaraldensis* Croat & L. P. Hannon
61. *Chlorospatha sagittata* Croat & L. P. Hannon
62. *Chlorospatha szemoreae* Croat & L. P. Hannon
63. *Chlorospatha stellarreae* Croat & L. P. Hannon

64. *Chlorospatha sucumbensis* Croat & L. P. Hannon
65. *Chlorospatha timbiquensis* Croat & L. P. Hannon
66. *Chlorospatha tokioensis* Croat & L. P. Hannon
67. *Chlorospatha yatacuensis* Croat & L. P. Hannon
68. *Chlorospatha yaupiensis* Croat & L. P. Hannon

Appendix 2. Index to exsiccatae. The numbers in parentheses refer to the numbered taxon in Appendix 1. Type specimens are indicated in boldface.

Asplund 19095 (39).

Baker et al. 5795 (55); Barfod et al. 48823 (38); Bartlett & Lasser 16938 (20a); Benavides **8686 (52)**; 11253 (52); Besse et al. 1638 (55); Betancur et al. **782 (6)**; **3287 (58)**; 4816 (48); 4872 (48); Bittner **2493 (7)**; Boyle & Dalmau 1756 (13).

Callejas 4719 (20b); Callejas & Gomez 10815 (2); Callejas et al. 3086 (24); 4570 (20b); **6212 (12)**; 6361 (40); 6408 (2); 6706 (19); 6742 (44); Cardona 1050 (2); Cerón 1003 (53); 48784 (39); 48890 (39); Cerón & Quinto curso de Biología U. C. 2111 (53); Christenson 1483 (31); Churchill 3804 (20a); Clark et al. 4174 (3); Cogollo & Ramirez 3160 (17); Cogollo et al. 3976 (49); 4127 (17); Cornejo et al. 2442 (3); 5219 (3).

Croat 16818 (20a); 17235 (20a); 22815 (20b); **22932 (20a)**; 27111 (20b); 27519 (20a); 38533a (9); 44589 (27); 48895 (27); 48993 (27); 49172 (20b); 49311 (45); 49647 (55); 49715 (39); 50130 (9); 50131 (cf. 49); 50189 (9); 50570 (39); 50723 (31); 50868 (cf. 31); 51832 (30); 51911 (30); **51944 (30)**; 55722 (22); 55831 (cf. 22); 55930 (45); 56133 (44); 56303 (45); 56972 (31); 57003 (31); 57021 (31); 57286 (45); 57304A (42); **57402 (16)**; 57496 (51); 58780 (39); 59062 (39); 59100 (39); 61421 (9); 61433 (25); 66627 (20a); 66996 (20b); 67109 (20a); 67528 (20a); 68750 (27); 68752 (20b); 68753 (20a); 68888 (44); 68943 (20a); 69556 (7); 69558 (52); 70881 (45); **70901 (42)**; 71002 (44); **71405 (57)**; 71456 (37); 71604 (sp. indet. 1); 72150 (32); 72326 (22); **72398 (48)**; 72732 (54); 73025 (3); 73039 (22); 73743 (31); 73772 (31); 74799 (20a); 74821 (20a); 75071 (27); **78252 (36)**; 81096 (31); 81258 (3); 81351 (55); 81473 (53); 81474 (5); 81475 (53); 81496 (53); 82836 (22); 83606 (20a); 87190 (53); **87201 (54)**; 87303 (39); 87329 (55); 87417 (8); 87454 (8); 87549 (37); 87557 (3); 91610 (8); Croat & Bay **75600 (4)**; 75777 (44); Croat & Cogollo 52047 (sp. indet. 4); Croat & Gaskin 79637 (9); 79662 (sp. indet. 3); 79751 (sp. indet. 2); **80042 (46)**; **80373 (56)**; 80503 (44); **80957 (51)**; Croat & Grayum 60208 (20a); 60078 (20b); 60343 (20a); Croat & Hannon 81476 (8); **81477 (28)**; **81478 (8)**; 86644 (39); 86662 (39); 86917 (39); 86941 (39); 87003 (39); **88410 (59)**; Croat & Mora 83686 (= Mora 304) (44); 83727 (= Mora 345) (33); Croat & Nuñez 82094 (22); Croat & Rodríguez 61450 (3); Croat & Watt 70380 (44); 70520 (9); Croat & Whitehill 82746 (22); 82749 (22); Croat & Zhu 76465 (20a); 76881 (27); Croat et al. 82131 (5); 82143 (43); 82265 (3); **82311 (37)**; **82326 (38)**; 82512 (37); **82531 (29)**; 83174 (38); 83223 (5); 84154 (cf. 22); 84232 (29); **86559 (23)**; 86561 (39); 86584 (39); 86607 (39); 87777 (39); 87803 (55); 87833 (53); **88000 (55)**; 88008A (53); 88036 (53); 88495 (39); 88514 (39); 88730 (55); 88813 (55); 88917 (39); 90681 (8); 90932 (55); 91068 (55); 91089 (54); 91229 (55); 91343 (54); 91356 (39); 91999 (54); 93345 (31); 93580 (53); 96410 (53); Cuadros et al. 3930 (44).

Delinks & Robles 121 (22); Dodson 6912 (3); **7547 (31)**; 8550 (3); 12414 (3); 12930 (22); 13907A (3); 14409 (31); Dodson & Dodson 6755 (22); Dodson & Gentry 12216 (22); 17519 (38); Dodson & Neill 15536 (31); Dodson & Thien

1190 (22); Dodson et al. **5911 (3)**; 7648 (31); 8530 (22); 9135 (31); 14408 (22); Dressler 4884 (20a).

Escobar et al. 7961 (6); 8482 (40).

Fernández et al. 9745 (58); Folsom 2663 (20a); 4340 (20a); 5870 (20a); Folsom et al. 5058 (20a); Fonnegra et al. 2914 (20b); 2928 (20b); Forget s.n. (44); Franco 5097 (37); Franco et al. **5056 (47)**; 5132 (47); 5148 (37); Franke s.n. (33); Fraume & Galle **215 (10)**.

Galeano et al. **2004 (15)**; Gentry 10130 (3); Gentry & Rentería **24585 (24)**; **24590 (49)**; Gentry et al. 24715 (22); **40735 (65)**; 55072 (7); Giraldo & Espinoza **255 (9)**; Giraldo & Algreto **228 (25)**; Gomez et al. 201 (2); Grayum 6657 (20a); Grayum & Zamora 9425 (3); 9427 (22); Grayum et al. 7633 (45); 7634 (42); **7643 (34)**; 7647 (26); 8742 (20a).

Haager & Jeník s.n. (39); Hammel 2571 (20a); 3528 (20a); 13401 (20a); Hammel & deNevers 13593 (20a); Hammel & Kress 11329 (20a); **13465 (27)**; Hammel & Wilder 17225 (22); Hammel et al. 6472 (44); 14867 (20a); 15383 (20a); Hannon 02-071 (55); 04-003 (60); 97-052 (3); 97-340 (3); **97-361 (43)**; 97-365 (55); Harling & Andersson 16816 (39); Hazen 11153 (9); Hort. Bull. s.n. (33).

Idrobo et al. 2869 (30).

Jacome s.n. (33); Jaramillo 6788 (3); 7020 (3); 14974 (53); Jaramillo & Grijalva **14574 (32)**; Jaramillo et al. 5237 (cf. 3).

Kalbreyer s.n. (44); Killip 35091 (44); **35298 (26)**; Knapp & Dressler 3471 (20a); Kress 83-1599 (20a).

Lawrance **794 (20b)**; Lehmann s.n. (35); Lehmann 388 (18); **389 (18)**; **390 (63)**; 390A (26); **5315 (35)**; **5384 (11)**; Leimbeck et al. 418 (53); Løjtnant et al. **12259 (62)**; Lozano et al. **6291 (45)**; Luteyn 3155 (20a); 12060 (17); Luteyn &

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Maas et al. 2740 (20b); MacDougal et al. **4034 (1)**; Madison s.n. (31); 775 (20a); 2106 (14); 2520 (39); 3357 (39); **3988 (13)**; **4151 (14)**; **6944 (21)**; Madison & Besse 7072 (5); 7080 (29); 7279 (5); 7557 (39); Madison & Coleman 2567 (39); Madison et al. **3359 (66)**; 3530 (21); 3747 (53); 4015 (22); 4179 (22); 4185 (53); 4187 (3); 4596 (29); 5054 (3); 5065 (22); **5144 (5)**; 6740 (5); 6947 (37); McPherson 12903 (41); Mora 50 (33); 161 (44); Murphy **383 (50)**.

Palacios 4795 (55); Palacios & Tirado 11289 (3); Palacios et al. 13522 (22); 15795 (53); Pipoly et al. **16992 (17)**; 17803 (24); 17820 (17); 17952 (17); 1334 (22); Pitman & Bass 954 (22); Plowman 14063 (55); Plowman et al. **3979 (53)**; Poulsen 80065 (39).

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Vargas 5363 (25).

Yanez & Shuigra 846 (53).

Zak 1601 (22).