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Botany

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FLORA COSTARICENSIS
Family #39 Orchidaceae: Tribe Cymbidieae: Subtribe Zygopetalinae

Franco Pupulin

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FLORA COSTARICENSIS
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Franco Pupulin

Introduction

This is the second volume of the series on Orchidaceae for Flora Costaricensis, after the fundamental contribution by Atwood and Mora de Retana, published 10 years ago. The present work was conceived and realized at Lankester Botanical Garden, University of Costa Rica (LBG), as part of the commitment by the center to carry out a complete inventory of the orchid flora of the country and to provide relevant information for the conservation of endangered taxa. In the past 10 years, the activities of botanical exploration carried out by the staff of LBG significantly improved the living plant collections grown at the Garden, revealed several floristic novelties, and made important steps toward a better understanding of species identity in this large and taxonomically complex group of plants. Perhaps more important, the activities of LBG focused on the retrieval of historic and critical taxonomic documentation, including original protologues and digital images of types, fundamental to interpretation of the diverse flora of Costa Rica. Several institutions have been particularly cooperative in this effort, among which the Harvard University Herbaria, the Herbarium of the Royal Botanic Gardens, Kew, the Herbarium of the Naturhistorisches Museum in Vienna, and the Herbarium of the Marie Selby Botanical Gardens must be mentioned for establishing formal agreements with the University of Costa Rica to allow the reproduction and use of the relevant material kept in their respective collections.

The treatment of the orchid subtribe Zygopetalinae greatly benefited from the molecular work done at the Florida Museum of Natural History, University of Florida, and the generic concepts adopted in this volume are based on the phylogenies suggested by DNA analyses carried out there. These are reflected in the new classification formally proposed in *Genera Orchidacearum* (Pupulin, 2009b), and I hope that the nomenclature used in the present treatment will persist.

Although they only represent a small portion (around four percent) of the Costa Rican orchid flora, species of Zygopetalinae are frequently grown (and often avidly collected) for horticultural purposes, and their study is crucial to understanding distribution patterns and species frequency as the first step to establish conservation priorities. Among the genera of Zygopetalinae, *Dichaea* constitutes a particularly common element in any type of vegetation in the country, and its taxonomic treatment should have a certain utility to field botanists working in Costa Rica. Sixteen genera (including a natural hybrid genus) and 60 species are treated. The work was based on direct examination of the available specimens deposited at AMES, CR, INB, K, M, SEL, USJ, and W; the spirit collection of Lankester Botanical Garden (JBL-Spirit); and scrutiny of digital images from the collections kept at F, NY, MO, and US. To ensure nomenclature stability, many of the Costa Rican taxa in the group were recently typified (Pupulin, 2001, 2007a), and additional lectotypes are selected here for *Cryptarrhena guatemalensis* Schltr. (AMES), *Kefersteinia subquadrata* Schltr. (AMES), and *Warczewiczella caloglossa* Schltr. (AMES). Many of the descriptions of individual species are based on those appearing in recent generic revisions by the author (Pupulin 2001, 2006a, 2006b, 2007a, 2009a); they include the observed variations among specimens native from Costa Rica. All the treated taxa are illustrated with one or more ink illustrations. With the exceptions of *D. acostae* Schltr., *D. gracillima* C.Schweinf., and *D. gomez-lauritoi* Pupulin, which are known only from the dried material of the type collections, the illustrations of all the remaining taxa were prepared by the author on the basis of living specimens with the aid of a stereomicroscope fitted with a drawing tube. As in the previous volume of this series on Costa Rican Orchidaceae, the illustrations are arranged according to their occurrence in the keys to facilitate the comparison of closely allied taxa.

Subtribe Zygopetalinae Schlechter

REFERENCES—K. M. Cameron, M. W. Chase, W. M. Whitten, P. J. Kores, D. C. Jarrell, V. A. Albert, T. Yukawa, H. G. Hills, & D. H. Goldman, A phylogenetic analysis of the Orchidaceae: Evidence from *rbcL* nucleotide sequences. Am. J. Bot. 86: 208–224. 1999. M. W. Chase, J. V. Freudenstein, K. M. Cameron, & R. L. Barrett, DNA data and Orchidaceae systematics: A new phylogenetic classification. Pp. 69–89 *in* K. W. Dixon, S. P. Kell, R. L. Barrett, & P. J. Cribb (eds.). Orchid Conservation. Natural History Publications, Kota Kinabalu, Sabah. 2003. R. L. Dressler & C. H. Dodson, Classification and phylogeny in the Orchidaceae. Ann. Missouri Bot. Gard. 47: 25–68. 1960. R. L. Dressler, Orquídeas huérfanas II. *Cryptarrhena*—Una nueva tribu, Cryptarrheneae. Orquídea (Mex.) 7: 283–288. 1980. R. L. Dressler, The Orchids. Harvard University Press, Cambridge, Massachusetts, and London, England, 332 pp. 1981. R. L. Dressler, Phylogeny and Classification of the Orchid Family. Dioscorides Pres, Portland, Oregon, 314 pp. 1993. R. L. Dressler, Precursor to a revision of the *Chondrorhyncha* complex. Orquideología 21: 233–247. 2000. L. A. Garay, El complejo *Chondrorhyncha*. Orquideologiá 4: 139–152. 1969. F. W. L. Kränzlin, *Dichaea*. Pp. 33–64 *in* A. Engler, Pflanzenr. 4(50). 1923. E. H. H. Pfitzer, Entwurf einer natürlichen

Anordnung der Orchideen. Carl Winter's Universitätsbuchhandlung, Heidelberg. 1887. G. A. Romero & G. Carnevali, Reappraisal of subtribe Vargasiellinae (Maxillarieae, Orchidaceae). Novon 3: 79. 1993. R. Schlechter, Die Orchideen, ihre Bechreibung, Kultur und Züchtung. Paul Parey, Berlin. 1915. K. Senghas & G. Gerlach, Subtribus Huntleyinae. *In* R. Schlechter, Die Orchideen, ed. 3, 1/B: 1620–1674. 1992–1993. K. Senghas & G. Gerlach, Subtribus Zygopetalinae. *In* R. Schlechter, Die Orchideen, ed. 3, 1/B: 1674–1727. 1993. D. L. Szlachetko, Systema Orchidalium. Fragm. Flor. Geobot. Suppl. 3: 1–152. 1995. W. M. Whitten, N. H. Williams, R. L. Dressler, G. Gerlach, & F. Pupulin, Generic relationships of Zygopetalinae (Orchidaceae: Cymbidieae): Combined molecular evidence. Lankesteriana 5(2): 87–107. 2005. F. Pupulin, Subtribe Zygopetalinae. Pp. 456–546 *in* A. M. Pridgeon, P. J. Cribb, M. W. Chase & F. N. Rasmussen (eds.). Genera Orchidacearum, Volume 5. Epidendroideae (Part Two). Oxford University Press.

Zygopetalinae Schltr., Orchideen: 417. 1915. Type: *Zygopetalum* Hook.

Syn.: Huntleyinae Schltr., Orchideen: 425. 1915. Type: *Huntleya* Batem. ex Lindl.
Dichaeinae Schltr., Orchideen: 532. 1915. Type: *Dichaea* Lindl.
Cryptarrheninae Dressler, Phytologia 21(7): 443. 1971. Type: *Cryptarrhena* R. Br.
Cryptarrheneae Dressler, Orquídea (Méx.) 7(4): 288. 1980. Type: *Cryptarrhena* R. Br.
Warreinae Szlach., Fragm. Fl. Geobot. Suppl. 3: 96. 1995. Type: *Warrea* Lindl.

Herb epiphytic, terrestrial or rarely lithophytic, cespitose or creeping, with or without pseudobulbs. **Roots** terete, slender to thick, produced from the rhizome or caulinar, with velamen of *Cymbidium* type. **Pseudobulbs**, when present, homoblastic or heteroblastic, or **stem** abbreviate or rarely elongate, erect to pendent, cylindrical to flattened, mostly enclosed by imbricating, sometimes foliaceous sheaths, occasionally provided with hyaline-scarious margins. **Leaves** several to many, distichous, plicate or conduplicate, dorsiventrally flattened, articulated or not, membranaceous to coriaceous or fleshy, often distinctly petiolate, the petiole rarely articulate to the lamina. **Inflorescence** lateral, single- to many-flowered, mostly unbranched, peduncle and rachis terete, glabrous, provided with one or more conduplicate bracts; floral bracts often double, the external one larger, the internal bractlet ligulate. **Flowers** resupinate or not, small to large, membranaceous to fleshy, often scented. **Sepals** free, rarely slightly connate at the base, the basal margins often inrolled-folded, the apex sometimes uncinate. **Petals** free, sometimes decurrent on the column foot. **Labellum** free, mostly articulate with the column foot, entire to 3-lobed or anchor-shaped, the disc mostly provided with a callus or keel. **Column** terete or semiterete, straight or arcuate, usually with a column foot, often provided with inconspicuous to large wings and a well-developed clinandrium; anther terminal, incumbent, rarely subdorsal, operculate, usually 2-celled; **pollinia** 4, dorsiventrally compressed, in 2 superposed pairs mostly different in size, with stipe and viscidium, sometimes scarcely distinct; stigma ventral, mostly transverse, narrow, rarely elliptic-suborbicular; rostellum mostly acicular, often flanked by small to prominent lobes. **Capsule** elliptic-globose, sometimes echinate, 6-keeled; seeds of *Maxillaria* type, or *Chondrorhyncha* variant (sensu Dressler, 1993).

Zygopetalinae species occur throughout the American tropics, from southern Mexico to Brazil, Paraguay, Bolivia, northern Argentina, and the West Indies. The northernmost taxa are species of the genera *Kefersteinia* Rchb.f. and *Stenotyla* Dressler, while in South America *Warrea warreana* (Lodd. ex Lindl.) C.Schweinf. and *Zygopetalum maxillare* Lodd. extend to Paraguay and Argentina. The highest diversity in Zygopetalinae, both in number of genera and in number of species, is to be found along the Andean chain of northwestern South America. The members of the subtribe are mainly inhabitants of constantly wet, temperate premontane forests at medium elevations, where they grow as epiphytes in the shade of the lower canopy and the main trunks of trees. Zygopetalinae are by far less frequent in lowland seasonal forests.

In creating subtribe Zygopetalinae, Schlechter (1915) mainly distinguished it from the closely related Huntleyinae Schltr. on the basis of leaf vernation, convolute in the Zygopetalinae and conduplicate in the Huntleyinae. Both subtribes, according to Schlechter's concept, included pseudobulbous genera as well as genera without pseudobulbs. Dressler and Dodson (1960) reduced Huntleyinae and Zygopetalinae under the subtribe Maxillariinae Bentham, stating that the traditional criteria used to separate the two subtribes (i.e., characters of leaf vernation) were inconsistent, both conduplicate and convolute vernation being observable in young growths of *Zygopetalum* and *Cochleanthes*. The genus *Dichaea* was placed as the monotypic member of its own alliance within subtribe Oncidiinae Bentham. Dressler (1981) assigned the subtribe Zygopetalinae to Maxillarieae Pfitzer, with 26 genera grouped in four closely related alliances on the basis of the presence and characteristics of the corms or pseudobulbs, leaf vernation, and inflorescence type, considering the series with plicate leaves and homoblastic pseudobulbs (*Warrea* and its close relatives) as the primitive elements of the subtribe. A possible derivation of the anomalous genus *Dichaea* from some Zygopetalinae-like ancestors was suggested for the first time, while *Cryptarrhena* was placed in its own tribe, Cryptarrheneae Dressler.

In the past 15 years, several systems of classification of the Maxillarieae were proposed, often disagreeing in the circumscription of Zygopetalinae. Senghas and Gerlach (1992–1993, 1993a) followed Schlechter in retaining Zygopetalinae, Huntleyinae, and Dichaeinae but mainly distinguished the first two subtribes by the presence or absence of distinct pseudobulbs. Dressler (1993a) broadened his previous concept of Zygopetalinae to include *Dichaea* and *Scuticaria* Lindl. Szlachetko (1995) divided the genera of Zygopetalinae into three different tribes and six subtribes, formally recognizing Dressler's alliances at the subtribal level.

The combined molecular analysis of the Maxillarieae (Whitten et al., 2005), indicated strong bootstrap support for a monophyletic Zygopetalinae, supporting the inclusion in the subtribe of the two morphologically anomalous genera *Cryptarrhena* and *Dichaea*. The subtribe has traditionally been placed in the Maxillarieae, but molecular data indicated that the tribe is sister to a paraphyletic grade of cymbidioid taxa, and Chase et al. (2003) lumped it with Cymbidiinae, Eulophiinae, Bromheadiinae, and Catasetinae into a broader, monophyletic Cymbidieae. The phylogenetic relationships of the subtribe were recently evaluated using parsimony analysis of combined sequence data of nuclear (nrITS) and plastid (*trnL-F* intron and spacer plus *matK*) DNA for 104 in-group and two out-group taxa. The analysis produced highly resolved cladograms, confirming the monophyly of the Zygopetalinae. The subtribe comprises a *Zygopetalum* grade (genera with prominent, heteroblastic pseudobulbs and usually plicate, revolute leaves); a *Huntleya* grade (pseudobulbs mostly absent or very reduced, leaves conduplicate), including the *Chondrorhyncha* complex plus *Dichaea* and a weakly supported *Cryptarrhena*; and a *Warrea* grade (pseudobulbs homoblastic, leaves plicate).

The inclusion of these anomalous genera results in a subtribe difficult to characterize in terms of morphological synapomorphies. Most of the genera in the subtribe present four superposed, dorsiventrally flattened pollinia; a transverse, narrow, slit-like stigma (with the notable exception of *Dichaea*); a column provided with a ventral keel; a tooth (often basal) or an infrastigmatic ligule; and the perianth variously spotted, blotched, or flushed with bluish-violet, a color rarely found in other Neotropical orchids. Among the genera of the *Huntleya* grade, an obvious synapomorphy is the presence of two floral bracts, greatly different in shape and size; the adaxial bract is large and cucullate, and the inner apical bract, abaxial to the lip, is smaller and ligulate. Ecologically, the species of the subtribe tend to occupy shady, suboptimal niches in forest canopies, sometimes associated with transformations in the epidermis (*Benzingia*, *Dichaea* spp.).

Key to the Genera of Subtribe Zygopetalinae

1a. Plants without pseudobulbs (or apparently so) . . . 2
1b. Plants with pseudobulbs . . . 14
2a. Inflorescence many-flowered . . . *Cryptarrhena*
2b. Inflorescence single-flowered . . . 3
3a. Stem much longer than the leaves; the flowers small, the lip mostly anchor-shaped, the stigma elliptic-suborbicular, with a basal ligule . . . *Dichaea*
3b. Stem much shorter than the leaves; the flowers mostly large, the lip never anchor-shaped; the stigma narrow, slit-like, without ligule (*Chondrorhyncha* complex) . . . 4
4a. Plants laxly pendent, the leaves gray-green, minutely papillose . . . 5
4b. Plants erect, the leaves not papillose or gray-green . . . 6
5a. Dorsal sepal distinctly shorter than the lateral sepals; lateral sepals reflexed, hooked; lip bilaterally symmetric; column without keel . . . *Benzingia*
5b. Dorsal sepal subequal to the lateral sepals; lateral sepals spreading, straight; lip excentric; column with a low keel . . . ×*Bensteinia*
6a. Flowers nonresupinate . . . *Chaubardiella*
6b. Flowers resupinate or pendent . . . 7
7a. Callus basal . . . 8
7b. Callus near or reaching the middle of the lip . . . 9
8b. Callus with more than 6 teeth, each one ending in an acuminate bristle . . . *Huntleya*
8a. Callus bilobed, umbonate or laminar, without bristles . . . *Kefersteinia*
9a. Callus flattened, bilobed . . . 10
9b. Callus raised, with rounded or digitate keels . . . 12
10a. Lip with a second thickening distal to the bilobed callus . . . *Chondroscaphe*
10b. Lip without a distal thickening . . . 11
11a. Callus narrow, with 2 or 4 teeth . . . *Stenotyla*
11b. Callus broad, rounded . . . *Daiotyla*
12a. Basal margins of the lip upturned, surrounding the column; flowers gullet-shaped . . . *Warczewiczella*
12b. Basal margins of the lip flat, not surrounding the column; flowers patent . . . 13
13a. Column with a ventral keel . . . *Cochleanthes*
13b. Column without ventral keel . . . *Pescatoria*
14a. Pseudobulbs homoblastic . . . 15
14b. Pseudobulbs heteroblastic . . . 16
15a. Flowers pendent, >5 cm wide; callus a single, high, fleshy keel . . . *Warrea*
15b. Flowers patent, <3 cm wide; horseshoe-shaped . . . *Warreopsis*
16a. Inflorescence single-flowered . . . *Stenotyla*
16b. Inflorescence few- to many-flowered . . . 17
17a. Inflorescence simultaneously many-flowered (>15 flowers); lip anchor-shaped, 5-lobed . . . *Cryptarrhena*
17b. Inflorescence few-flowered (up to 6 flowers simultaneously open); lip 3-lobed, not anchor-shaped . . . *Galeottia*

REFERENCES—E. A. Christenson, Deux genres hybrids naturels chez les Zygopetalinae. Richardiana 6(3): 136–138. 2006. C. H. Dodson, *Benzingia hirtzii*. Icon. Pl. Trop. Ser. 2, 5: pl. 406. 1989. T. Neudecker, ×*Ackersteinia dodsonii*, un nuevo híbrido intergenérico en la Subtribu Huntleyinae. Orquideología 19(2): 25–28. 1994. C. H. Dodson & C. Luer, 225(2). Orchidaceae. Genera *Aa-Cyrtidiorchis*. *In* G. Harling & L. Andersson (eds.). Flora of Ecuador 76: 1–345. 2005. C. H. Dodson & G. A. Romero, Revalidation of the genus *Benzingia* (Zygopetalinae: Orchidaceae). Lindleyana 10(2): 74. 1995. F. Pupulin, Contributions to a reassessment of Costa Rican Zygopetalinae. The genus *Kefersteinia* Rchb.f. Ann. Naturhist. Mus. Wien. 103B: 525–555. 2001. F. Pupulin, ×*Bensteinia ramonensis*, a new natural hybrid in the Zygopetalinae (Orchidaceae). Selbyana 28(2): 112–116. 2007.

×**Bensteinia** E. A. Christenson, Richardiana 6: 137. 2006. Type species: ×*Bensteinia dodsonii* E. A. Christenson (based on ×*Ackersteinia dodsonii* Neudecker 1994, *nom. inval.*, *emend.* Dodson & Luer, 2005).

Herb epiphytic, cespitose, pendent, without pseudobulbs, the abbreviated stem enclosed by 4–5 imbricating sheaths, the upper ones foliaceous. **Leaves** petiolate, conduplicate, narrowly elliptic to oblanceolate, acuminate, dark gray-green. **Inflorescence** lateral, from the axil of the lower sheaths, 1-flowered; peduncle terete, patent to pendent, provided with a conduplicate bract near the base. **Floral bract** double, conduplicate, the external one widely ovate, the internal bractlet ligulate, much smaller. **Ovary** pedicellate, cylindric-subclavate. **Flower** proportionately large, not completely spreading, the sepals pale white or creamish white, flecked or spotted reddish purple, the petals white or creamish white, sparsely to heavily spotted and blotched with purple, the lip white or cream, spotted purple, the spots forming nectar guides along the callus and usually more dense toward the apex of lamina. **Dorsal sepal** narrowly elliptic to oblong-elliptic, acute to acuminate, concave. **Lateral sepals** narrowly elliptic-lanceolate to oblong-ovate, acute, spreading, concave, conduplicate-folded toward the base. **Petals** elliptic to obovate, acute or rounded, sometimes apiculate. **Lip** obscurely 3-lobed, elliptic-obovate, obtuse, sometimes slightly twisted on one side, the apex straight or abruptly reflexed, the apical margins crenulate, the basal margins erect toward the column; disc with a low, 2- or 3-lobed, irregularly toothed callus, born at the base or toward the middle of the lamina. **Column** semiterete, straight, clavate, footed, the ventral surface sometimes sparsely woolly, with or without a infrastigmatic keel; the stigma transverse, narrow. **Anther cap** ovate-elliptic, cucullate, 2-celled. **Pollinia** 4, subsigmoid, in 2 pairs of different size, on a short stipe, ventrally provided with an indistinct to broad, hyaline viscidium.

A Neotropical hybrid genus of two nothospecies ranging from Costa Rica to Ecuador, with a single taxon recorded from Costa Rica. Taxa of *Bensteinia* occur as epiphytes in premontane to lower montane, cloud, evergreen, wet to extremely wet forests at 1000–1500 m. Flowering has been recorded from May to October. Although the habit of the natural hybrids is strongly reminiscent of *Benzingia* in gross morphology, the flower of *Bensteinia* markedly differs from that of *Benzingia*, showing a genetic influence of *Kefersteinia* in the red-purple spotting on the petals and the lip, the finely undulate margins of the lip midlobe, and the morphology of the pollinarium. The shape of the callus, however, is similar to the laminar plate of *Benzingia*. No sampling of ×*Bensteinia* was available for molecular analysis.

×**Bensteinia ramonensis** Pupulin, Selbyana 28(2): 113. 2007. Type: Costa Rica. Alajuela: San Ramón, Ángeles, Reserva Biológica Alberto M. Brenes, 10°13′08.5″N 84°35′48.4″W, 900–1000 m, Saino trail, tropical wet, transition to premontane wet forest, 25 September 2005, flowered in cultivation at Jardín Botánico Lankester, 7 October 2005, *D. Bogarín 1923* (holotype, CR-Spirit). Figure 1 (Voucher: *Bogarín 1923*).

Herb epiphytic, cespitose, without pseudobulbs, the abbreviated stem enclosed by 4–5 imbricating sheaths, the upper ones foliaceous. **Leaves** petiolate, conduplicate, narrowly elliptic-oblanceolate, acuminate, dark gray-green, 8.5–20 × 0.9–1.5 cm. **Inflorescence** lateral, from the axil of the lower sheaths, 1-flowered; peduncle terete, patent to pendent, to 3 cm long, provided with an ovate, conduplicate bract, 5 mm long, near the base. **Floral bract** double, conduplicate, the external one widely ovate, 4 mm long, the internal bractlet ligulate, 5 mm long. Ovary to 1.5 cm long including the pedicel. **Flower** proportionately large, the sepals pale creamish white, flecked reddish purple, the petals creamish white, heavily spotted and blotched with purple, the lip cream white, spotted purple, the spots forming 5–7 nectar guides toward the apex of callus; the callus spotted purple. **Dorsal sepal** narrowly elliptic, acuminate, concave, hooked at apex, 16 × 6 mm. **Lateral sepals** narrowly elliptic-lanceolate, subacute, spreading, concave, conduplicate-folded toward the base, 20 × 5 mm. **Petals** elliptic, rounded, apiculate, 14 × 8 mm. **Lip** excentric, slightly twisted toward the right side, elliptic-obovate, obscurely 3-lobed, obtuse, the apical margin crenulate, the basal margins erect toward the column, 18 × 15 mm; disc with a low, bilobed, irregularly toothed callus, born toward the middle of the lip lamina, ca. 2 × 8 mm. **Column** straight, clavate, footed, 15 mm long, the ventral surface sparsely woolly toward the margins, provided with a low, glabrous, substigmatic keel; the stigma transverse, narrow. **Anther cap** ovate-elliptic, cucullate, 2-celled. **Pollinia** 4, subsigmoid, in 2 pairs of different sizes, on a elliptic-ovate, hyaline stipe, ventrally provided with an indistinct, subquadrate, hyaline viscidium.

DISTRIBUTION—Known only from Costa Rica.

ECOLOGY—A rare epiphyte of shaded spots in extremely wet premontane forest, at about 1000 m elevation, along the Caribbean watershed of the Tilarán mountain range in northern Costa Rica. Flowering occurs from May to October.

DISTINGUISHING FEATURES—The combination of the pendent habit, the lip excentric with respect to the bilateral symmetry of the flower, the lateral sepals straight and not hooked, the dorsal sepal subequal to the lateral sepals, the sepals and petals flecked, spotted and blotched with purple, and the lip almost completely covered by purple blotches distinguishes specimens of *B. ramonensis* from any other members of Zygopetalinae.

Benzingia Dodson

REFERENCES—C. H. Dodson & R. Escobar, *Ackermania* Dodson & Escobar. *In* C. H. Dodson & R. Escobar, Native Ecuadorian Orchids 1: 36. 1993. C. H. Dodson & R. Escobar, *Benzingia* Dodson & Chase. *In* C. H. Dodson & R. Escobar, Native Ecuadorian Orchids 1: 60. 1993. W. M. Whitten, N. H. Williams, R. L. Dressler, G. Gerlach, & F. Pupulin, Generic relationships of Zygopetalinae (Orchidaceae: Cymbideae): Combined molecular evidence. Lankesteriana 5(2): 87–107. 2005. Romero-González, G. A. & C. H. Dodson. A la tercera se gana. The validation of *Benzingia* (Orchidaceae: Zygopetalinae). Lankesteriana 9(3): 526–528. 2010.

Benzingia Dodson, Lankesteriana 9: 526. 2010.

Type species: *Benzingia hirtzii* Dodson. *Benzingia* Dodson, Icon. Pl. Trop. Ser. 2, 5: t. 406. 1989, *nom. invalid*. *Benzingia* Dodson ex Dodson, Lindleyana 10: 74. 1995, *nom. invalid.*

Syn.: *Chondrorhyncha* sect. *Stenioides* Senghas & Gerlach, Orchidee (Hamb.) 42: 282. 1991. Type species: *Chondrorhyncha caudata* Ackerman.

Ackermania Dodson & R. Escobar, Orquideología 18: 202. 1993, *nom. illeg., non Ackermannia* Pat. 1902. Type species: *Chondrorhyncha cornuta* Garay.

F. Pupulin. *Benzingia*. Pp. 467–469 *in*: A. M. Pridgeon, P. J. Cribb, M. W. Chase & F. Rasmussen (eds.). Genera Orchidacearum, volume 5. Epidendroideae (Part Two). Oxford University Press.

Epiphytic, cespitose, pendent **herbs**, without pseudobulbs. **Roots** terete, filiform, produced from the short rhizome. *Stem* abbreviated, enclosed by 5–10 imbricating sheaths, inflated toward the base, provided with scarious, hyaline margins, the upper ones foliaceous. **Leaf** conduplicate, articulate, membranaceous, irregularly wavy, lanceolate to elliptic-oblong, acute to acuminate, abaxially carinate, narrowed at the base into an indistinct to short, conduplicate petiole, gray-green, the abaxial surface paler, the adaxial surface papillose. **Inflorescence** lateral, 1–2 per shoot, single-flowered, produced from the axil of the lower sheaths; the peduncle terete, slender, suberect to pendent, provided with 1–2 distant, triangular-ovate, conduplicate bracts; floral bract double, conduplicate, shorter than ovary, the external one widely ovate, often acuminate, loose, the subopposite internal bractlet narrowly ligulate. **Flowers** relatively large, resupinate or not, spreading or slightly campanulate, the sepals and petals white to clear orange-yellow, often tinged darker toward the apex, rarely sparsely spotted with reddish brown; the lip whitish cream to pale orange, mostly spotted or blotched with reddish brown, apically usually solid orange-yellow, the callus orange or red-purple. **Dorsal sepal** free, lanceolate-oblong to narrowly elliptic-ovate, obtuse to acute, often concave. **Lateral sepals** lanceolate to ovate, sometimes subfalcate, acute, the lateral margins sometimes inrolled-folded toward the base. **Petals** oblong-elliptic to broadly elliptic, acute to

abruptly subacuminate, apically slightly revolute. **Lip** articulate with the column foot, concave, ovate to suborbicular, sometimes obscurely 3-lobed, the base often deeply tubular-saccate, the apex rounded to abruptly caudate, sometimes deflexed or with falcate, lateral teeth, the distal margins entire to irregularly erose-crisped, the proximal margins sometimes erect to flank the column; disc with a low, fleshy, longitudinal ridge from the base to about the middle of the lip, apically 2- to 4-toothed, or a fleshy, transverse, bilobed plate. **Column** straight to slightly arched, with a distinct foot, usually slightly dilated at apex into inconspicuous stigmatic wings, sometimes adaxially puberulent-pilose toward the base, the stigma transverse, narrow. **Anther cap** cucullate, ovate-elliptic, flattened, 2-celled. **Pollinia** 4, in 2 subequal pairs, on a short stipe and a triangular-ovate, hyaline viscidium.

A Neotropical genus of eight species ranging from Costa Rica to Andean South America, from Colombia to Peru, with a single species recorded from Costa Rica. Species of *Benzingia* occur as epiphytes of shady places, often on the trunks of trees, in premontane to cloud, evergreen, extremely wet forests at 700–1500 m, along the Caribbean watershed of Central American mountain ranges and the eastern slopes of the Andes in South America. Flowering has been recorded most of the year. *Benzingia reichenbachiana* (Schltr.) Dressler is pollinated by *Euglossa heterosticta*, and the other species of the genus are presumed to be pollinated by male euglossine bees.

Species of *Benzingia* were previously assigned to the genera *Ackermania* Dodson & R. Escobar, *Chondrorhyncha* Lindl., and *Stenia* Lindl. The group is rather diverse in floral morphology. Flowers are patent or pendulous; they are not resupinate in the type species (*B. hirtzii* Dodson ex Dodson) but usually resupinate in the remaining taxa (although truly pendent and not resupinate flowers may probably function in much the same way). Most of the species lack the false spur formed by the reflexed, inrolled lateral sepals, but they are a characteristic feature of *B. reichenbachiana* (Schltr.) Dressler. Some of the species (previously assigned to *Ackermania* plus *Chondrorhyncha caudata*) have deeply saccate lips, enfolding the column, while in others the lip is only slightly concave and the column mostly exposed. These differences suggest different systems of pollination or distinct sites of pollinarium deposition, the gullet-flower of *B. reichenbachiana* probably exhibiting a nectar-deceit pollination syndrome, whereas the rest of the genus is likely pollinated by male euglossine bees looking for fragrance rewards. When compared to the high diversity in floral patterns, the similarities in vegetative architecture among the species of *Benzingia* are striking. The plants of *Benzingia* are usually truly pendent, and most possess narrow, fan-shaped growths with leaves that are distinctively glaucous gray-green, with the upper surface having a sparkling appearance. This is explained by the papillose epidermal cells of the adaxial leaf blade, which are smooth in all the other genera of the *Huntleya* clade. These vegetative synapomorphies are supported by molecular data (Whitten *et al.*, 2005) that indicate that *Benzingia*, *Ackermania*, *Chondrorhyncha caudata* Ackerman, and *C. reichenbachiana* Schltr. must be treated as a single genus in spite of their floral morphologies. In the cladistic analysis of combined DNA sequence data, *Benzingia* forms a highly supported clade, sister to *Euryblema* Dressler (which some of the species resemble in having a wide, laminar callus) and successively sister to *Stenia* Lindl. and *Daiotyla* Dressler.

Benzingia reichenbachiana (Schltr.) Dressler, Lankesteriana 9: 527. 2010. Type: Costa Rica. [Alajuela: San Ramón], Cataratas, blühend Marz-August, *Endrés 557* (W-R!). *Chondrorhyncha reichenbachiana* Schltr., Repert. Spec. Nov. Regni Veg. 17: 15. 1921. *Benzingia reichenbachiana* Dressler, Lankesteriana 5: 93. 2005, *nom. invalid. Chondrorhyncha lamellata* Rchb.f., Ms. ined. (W-R!). *Zygoeptalum lamellatum* Rchb.f., Ms. ined. (W-R!). Figure 2 (Voucher: *Pupulin et al. 74*, USJ).

Epiphytic, cespitose, pendent **herbs**, to 30 cm tall. **Leaves** 5–7, conduplicate, articulate, membranaceous, irregularly wavy, narrowly elliptic to elliptic-oblong, acute to acuminate, abaxially carinate, narrowed at the base into a conduplicate petiole to 1 cm long, gray-green, the abaxial surface paler, the adaxial surface papillose, 15–30 × 1.5–2.2 cm. **Inflorescence** lateral, pendent, single-flowered, produced from the axil of the lower sheaths; the peduncle terete, slender, provided with 1–2 distant, triangular-ovate, conduplicate bracts, to 4 cm long; floral bract double, conduplicate, shorter than pedicellate ovary, the external one widely ovate, loose, the internal bractlet narrowly ligulate. Pedicellate **ovary** subclavate, strongly nerved, to 1.5 cm long including the pedicel. **Flowers** large, gullet-shaped, the sepals and petals cream, the lip pale yellow, blotched orange in the throat and spotted with red-purple up to the distal third. **Dorsal sepal** lanceolate-elliptic to elliptic-oblong, obtuse, shortly apiculate, porrect, strongly concave, 12.5–15.0 × 4–6 mm. **Lateral sepals** reflexed, narrowly lanceolate-ligulate, obliquely acute, concave toward the base, the inner basal margin convolute, 18–21 × 4.5–6.0 mm. **Petals** obliquely rhombic-obovate, acute, porrect, gently revolute at apex, the base decurrent on the column foot, 18–20 × 8–10 mm. **Lip** ovate-elliptic to obovate, emarginate, with a short claw, the distal margins crenulate, 1.9–2.5 × 14–18 mm; callus subbasal, a fleshy, flattened blade extending to the middle of the lip, bilobed in front, apically denticulate, provided with a low central keel distally ending in a short, rounded knob. **Column** slender, straight, to 9 mm long, with a distinct, puberulent foot about 7 mm long, forming an acute chin, widened and fleshy toward the apex and around the stigma, the clinandrium shallowly cucullate, entire; rostellum 3-dentate, the central tooth longer. **Anther cap** cucullate, broadly elliptic, compressed, 2-celled. **Pollinia** 4, in 2 pairs of different sizes, narrowly obovate, complanate-subconcave, on a transversely rectangular stipe; viscidium definite, shield-like.

DISTRIBUTION—Distributed from Costa Rica to Colombia.

ECOLOGY—Plants of *B. reichenbachiana* are common epiphytes from premontane wet forests, restricted to the Caribbean watershed of Costa Rican cordilleras. Flowering occurs from March to June and sporadically throughout the year.

DISTINGUISHING FEATURES—*Benzingia reichenbachiana* is unique for its truly pendent habit with gray-green, dark, prismatic leaves, flowers with strongly reflexed lateral sepals, and lip provided with a broad, laminar, irregularly dentate callus occupying the proximal half.

Schlechter described *Chondrorhyncha reichenbachiana* from *Endrés 557*, a plant Reichenbach thought about publishing as *Condrorhyncha lamellata* or *Zygopetalum lamellatum*. Plates of both the concepts were prepared for Reichenbach's *Xenia Orchidacea*, but they were never published.

Chaubardiella Garay

REFERENCES—L. A. Garay, El complejo *Chondrorhyncha*. Orquideología 4(3): 139–152. 1969. C. H. Dodson, *Chaubardiella* Garay. *In* R. Escobar (ed.), Native Colombian Orchids 1: 36. Editorial Colina, Medellín, 1990. D. E. Mora & J. T. Atwood. *Chaubardiella*. Icon. Pl. Tropic. 14: sub pl. 1410–1411. 1992. D. W. Roubik & P. E. Hanson, Orchid Bees of Tropical America: Biology and Field Guide. Instituto Nacional de Biodiversidad, Santo Domingo de Heredia, Costa Rica. 2004. F. Pupulin, *Chaubardiella* Garay. *In* F. Pupulin (ed.), Vanishing Beauty—Native Costa Rican Orchids 1: 96–97. Editorial de La Universidad de Costa Rica, San José, 2005. W. M. Whitten, N. H. Williams, R. L. Dressler, G. Gerlach, & F. Pupulin. Generic relationships of Zygopetalinae (Orchidaceae: Cymbideae): Combined molecular evidence. Lankesteriana 5(2): 87–107. 2005. F. Pupulin, *Chaubardiella*. Pp. 469–471

in: A. M. Pridgeon, P. J. Cribb, M. W. Chase & F. Rasmussen (eds.). Genera Orchidacearum, volume 5. Epidendroideae (Part Two). Oxford University Press.

Chaubardiella Garay, Orquideología 4: 146 (1969). Type species: *Chaubardia tigrina* Garay & Dunsterv [= *Chaubardiella tigrina* (Garay & Dunsterv.) Garay].

Epiphytic, cespitose **herbs** without pseudobulbs, rarely with pseudobulbs completely hidden by the leaf bases (excluding Costa Rican taxa). **Roots** terete, filiform to thick, produced from the short rhizome. **Stem** abbreviated, enclosed by 3–5 imbricating sheaths, the upper ones foliaceous. **Leaf** conduplicate, articulate, membranaceous, elliptic-oblong to narrowly obovate, acute to subacuminate, abaxially sharply carinate, narrowed at the base into a short to distinct, conduplicate petiole, dark green, the adaxial surface sometimes waxy. **Inflorescence** lateral, 1–3 per shoot, single-flowered, produced from the axil of the lower sheaths; the peduncle terete, slender, pendent, provided with 1–2 basal, long, tubular-imbricating, apically loose, scarious bracts; floral bract double, conduplicate, the external one widely ovate to suborbicular, scarious, loose, longer than ovary, the subopposite internal bractlet lanceolate, appressed to the base of the lip. **Flowers** large, nonresupinate, spreading or slightly campanulate, uniformly creamy white or yellow (in Costa Rica), or yellowish tan to tan brown, or pale lavender to purple, often spotted or blotched dark brown, or with transverse dark purple markings or purple-brown stripes, the markings on the lip usually darker. **Dorsal sepal** free, oblanceolate-elliptic to obovate, acute to acuminate, rarely apiculate. **Lateral sepals** lanceolate-elliptic to oblanceolate, sometimes subfalcate, obtuse to subacuminate, apically often slightly reflexed. **Petals** spreading or variously porrect over the column, oblanceolate to broadly obovate-spathulate, acute to abruptly subacuminate, apically slightly revolute. **Lip** articulate with the column foot, strongly concave at the base, the distal portion of the blade usually flattened, subquadrate to widely ovate, rarely puberulent, the base cuneate-rounded, sessile, the apex acute to rounded-emarginate, the distal margin entire to irregularly crenulate; disc with a fleshy, raised, fan-shaped or horseshoe-shaped, sometimes many-ridged, transverse plate, from the base to about the middle of the lip. **Column** straight, with a foot, slightly dilated at apex into inconspicuous stigmatic wings, sometimes densely pubescent, provided with a low, rounded, median ridge below the stigma, the stigma transverse, narrow. **Anther cap** cucullate, ovate to subrectangular, flattened, 2-celled. **Pollinia** 4, in 2 subequal pairs, on a quadrate stipe and an obovate-rhombic, curled, hyaline viscidium.

A Neotropical genus of eight to nine species ranging from Costa Rica to Peru and Guyana in South America, with the highest diversity in Colombia and Ecuador. The species occur as epiphytes in shady habitats, often growing on the trunk and the oldest, mossy branches of trees, in warm tropical, premontane to cloud, evergreen, extremely wet forests at elevations of 400–1800 m. Flowering has been mostly recorded from June to December. As understood today, *Chaubardiella* is characterized mostly by the pendent, nonresupinate flowers appressed to the substratum, the lip concave at the base with the distal half flattened, the laminar, transverse callus, the column provided with a short foot, and the characteristic, hooked viscidium curling after removal. The only known pollinator of *Chaubardiella* is *Euglossa cibelya* (Roubik & Hanson, 2004), and presumably all the species of the genus are pollinated by male euglossine bees. The hook-shaped viscidium places the pollinarium at the base of one of the legs of the pollinator (Dodson, 1990; Roubik & Hanson, 2004; Whitten *et al.*, 2005). Molecular analyses carried out by Whitten and collaborators (2005) strongly support the monophyly of *Chaubardiella*, excluding a few species that are included in *Stenia* Lindl. In the combined analysis of DNA data sets, *Chaubardiella* is part of a clade that includes the strictly South American *Aetheorhyncha* Dressler and *Ixyophora* Dressler and is successively sister to the mostly South American *Pescatoria* Rchb.f. and *Warczewiczella* Rchb.f.

Key to the Species of *Chaubardiella*

1. Spread lip broadly ovate, the callus minutely papillose; flowers greenish cream . . . . . *C. pacuarensis*
1a. Spread lip broadly subquadrate, the callus glabrous; flowers yellow . . . . . *C. subquadrata*

Chaubardiella pacuarensis Jenny, Orchideen (Hamburg) 40: 91. 1989. Type: Costa Rica. [Turrialba]: road by Río Pacuare near Turrialba, *R. Jenny 3* (holotype, G). Figure 3 (Voucher: *Pupulin 2438*, JBL-Spirit).

Epiphytic, cespitose **herbs**, to 25 cm tall. **Roots** thick, about 2 mm in diameter. **Stem** completely hidden by the imbricating sheaths. **Sheaths** strongly conduplicate, the basal ones provided with scarious margins, to 2 cm long, the upper one foliaceous. **Leaves** 3–5, the conduplicate base 1.5–2.0 cm long, the blade elliptic-oblanceolate, acuminate, strongly carinate abaxially, 10–21 × 1.2–2.8 cm. **Inflorescence** basal, 1-flowered, peduncle to 4 cm long, provided with 2–3 triangular, acute bracts. **Floral bracts** in pairs, the outer one infundibular, broadly ovate, acute, to 8 × 7 mm, the inner lanceolate-elliptic, 10 × 3–4 mm. **Ovary** and pedicel terete-subclavate, to 5 mm long. **Flower** nonresupinate, pendent, translucent white to greenish cream. **Dorsal sepal** oblanceolate, obtuse, distinctly concave toward the apex, 21–30 × 11–14 mm. **Lateral sepals** oblanceolate, obtuse, slightly falcate, 22–30 × 12–15 mm. **Petals** obovate-spatulate, the broadly obtuse apex sometimes emarginate, slightly concave distally, 20–28 × 12–15 mm. **Lip** cochleate, broadly ovate when spread, the apex truncate to emarginate, deeply concave, the lateral margins slightly undulate, provided with a basal, laminar, broad semicircular, minutely papillose callus, the apex irregularly crenulate, narrowly U-shaped in natural position, 15–26 × 13–26 mm. **Column** semiterete, subtruncate at apex, widest in the central portion, 8–10 × 5–7 mm, with 2 rounded to elliptic, fleshy wings to about 3 mm below stigma, forming an indistinct, concave foot at the base; rostellar teeth filiform-acuminate. **Anther cap** cucullate, subrectangular, flattened, 2-celled. **Pollinia** 4, oblong-clavate, in 2 pairs of different sizes, on a quadrate stipe and an obovate-rhombic, curled, hyaline viscidium.

DISTRIBUTION—Mora and Atwood (1992) cite this species for Panama, but I am not aware of any documented specimen collected outside Costa Rica, where *C. pacuarensis* is endemic.

ECOLOGY—Plants of *C. pacuarensis* are apparently rare, small to medium-size epiphytes from wet, tropical and premontane wet forests at elevations of 400–1400 m, with populations restricted to the Caribbean watershed of the Cordillera Central and the Cordillera de Talamanca. Flowering has been recorded from October to December, corresponding to a short dry season on the Caribbean of Costa Rica.

DISTINGUISHING FEATURES—Vegetatively indistinguishable from *C. subquadrata*, *C. pacuarensis* may be recognized by the white flowers and the ovate shape of the lip when spread; the basal callus is minutely papillose.

Chaubardiella subquadrata (Schltr.) Garay, Orquideología 4: 149. 1969. *Kefersteinia subquadrata* Schltr., Repert. Sp. Nov. Regni Veg. Beih. 19: 300. 1923. *Chondrorhyncha subquadrata* (Schltr.) L. O. Williams, Ceiba 5: 194. 1956. Type: Costa Rica. [Alajuela]: Umgebung von San Ramón, Jahre 1921, *G. Acosta s.n.* (holotype, B, destroyed; tracing by R. Mansfeld of Schlechter's drawing of the holotype, designated here as the lectotype, AMES 40057). *Stenia chasmatochila* Fowlie, Orch. Dig. 29: 344–347. 1965. *Chaubardiella chasmatochila* (Fowlie) Garay, Orquideología 4: 148. 1969. Type: Costa Rica, *C.H. Horich s.n.* (holotype, LA). Figure 4 (Voucher: *Pupulin 3007*, not preserved, photo).

Epiphytic, cespitose **herbs**, to 20 cm tall. **Roots** thick, 2–3 mm in diameter. **Stem** completely hidden by the imbricating sheaths. **Sheaths** strongly conduplicate, provided with scarious margins, to 2.5 cm long, the upper one foliaceous. **Leaves** 3–5, dark green, the conduplicate base to 2 cm long, the blade oblanceolate, abruptly short-acuminate, strongly carinate abaxially, 7–15 × 2.0–3.5 cm. **Inflorescence** basal, 1-flowered, peduncle to 5 cm long, provided with 2 triangular, acute bracts. **Floral bracts** in pairs, the outer one infundibular, broadly ovate, subacute, to 9 × 7 mm, the inner lanceolate-elliptic, 10 × 4–5 mm. **Ovary** and pedicel terete-subclavate, to 5 mm long. **Flower** nonresupinate, pendent, yellow. **Dorsal sepal** oblong-obovate, obtuse-subrounded, convex, slightly concave toward the thick apex, 19–22 × 8–11 mm. **Lateral sepals** oblanceolate, obtuse, slightly falcate, convex, 19–23 × 8–10 mm. **Petals** obovate, obtuse, basally convex, slightly concave distally, 16–20 × 10–14 mm. **Lip** cochleate, subquadrate when spread, the apex truncate to shortly excise, deeply concave, provided with a basal, discoid, flabellate-semicircular callus, the apex irregularly crenulate, U-shaped in natural position, with a deep grove in front of it, 16–18 × 16–18 mm. **Column** semiterete, subtruncate at apex, widest in the central portion, 6–7 × 4–5 mm, with 2 subrectagluar to broadly rectangular, fleshy wings to about 3 mm below stigma, forming an indistinct foot at the base; rostellar teeth filiform-acuminate. **Anther cap** cucullate, subrectangular, flattened, 2-celled. **Pollinia** 4, oblong-clavate, in 2 pairs of different size, on a quadrate stipe and an obovate-rhombic, curled, hyaline viscidium.

DISTRIBUTION—The species is known from Costa Rica to Ecuador.

ECOLOGY—A rare species, collected in only a few localities, *C. pacuarensis* grows epiphytically in the shade of the canopy understory. In Costa Rica, it is restricted to the basal belt and the premontane wet forests of the Tilarán and Talamanca ranges (likely including the Central Volcanic range) at elevations of 600–1000 m. Flowering has been recorded in Costa Rica from July to October (rainy season), but cultivated specimens also flower in February (dry season).

DISTINGUISHING FEATURES—*Chaubardiella subquadrata* is easy to recognize by its bright yellow, nonresupinate flowers; it differs from *C. pacuarensis* also by the shape of the lip, subquadrate when spread, and the glabrous callus. Mora and Atwood (1992) accepted the name of *C. chasmatochila* (based on *Stenia chasmatochila*) for this taxon, but the copy of Schlechter's drawing of the holotype of *Kefersteinia subquadrata*, sent by Dr. R. Mansfeld to Prof. Ames at Harvard in 1934, leaves no doubts about the identity of this species. The drawing, selected here as the lectotype, clearly shows the subquadrate outline of the lip, shortly excise at apex, and the flabellate callus cited in the protologue.

Chondroscaphe (Dressler) Senghas & G. Gerlach

REFERENCES—R. L. Dressler, Die Gattung *Chondrorhyncha* in Panama mit zwei neun Arten: *Chondrorhyncha crassa* und *Chondrorhyncha eburnea*. Orchidee (Hamb.) 34(6): 220–226. 1983. R. L. Dressler, Sobre el género *Chondroscaphe*, con dos especies nuevas de América Central, *Chondroscaphe atrilinguis* y *C. laevis*. Orquideología 22(1): 12–22. 2001. K. Senghas & G. Gerlach, *Chondroscaphe* (Dressl.) Sengh. & Gerl. *In* R. Schlechter, Orchideen, ed. 3, 1/B(27): 1655–1658. 1993. W. M. Whitten, N. H. Williams, R. L. Dressler, G. Gerlach, & F. Pupulin, Generic relationships of Zygopetalinae (Orchidaceae: Cymbideae): Combined molecular evidence. Lankesteriana 5(2): 87–107. 2005. F. Pupulin, R. L. Dressler, & H. Medina. A revision of the white-flowered species of *Chondroscaphe* (Orchidaceae: Zygopetalinae). Orch. Dig. 72(1): 32–51. 2009. F. Pupulin. *Chondroscaphe*. Pp. 478–481 *in*: A. M. Pridgeon, P. J. Cribb, M. W. Chase & F. Rasmussen (eds.). Genera Orchidacearum, volume 5. Epidendroideae (Part Two). Oxford University Press.

Chondroscaphe (Dressler) Senghas & G. Gerlach in R. Schlechter, Orchideen, ed. 3, 1/B(27): 1655. 1993. Type species: *Zygopetalum flaveolum* Lind. & Rchb.f. [= *Chondroscaphe flaveola* (Lind. & Rchb.f.) Senghas & G. Gerlach]. *Chondrorhyncha* Lindl. sect. *Chondroscaphe* Dressler, Orchidee (Hamb.) 34: 221. 1983.

Epiphytic, cespitose **herbs** without pseudobulbs or occasionally with reduced pseudobulbs, completely hidden by the leaf sheaths. **Roots** terete, thick, flexuous, produced from the abbreviate rhizome. **Stem** completely enclosed by 5–8 imbricating sheaths provided with scarious margins, the upper ones foliaceous. **Leaves** conduplicate, articulate, membranaceous, oblanceolate to narrowly oblanceolate-ligulate, acute to acuminate, abaxially carinate, narrowed at the base into a conduplicate petiole, usually dark green. **Inflorescence** lateral, 1 or more per shoot, single-flowered, produced successively on a relatively long cincinnus partially or completely hidden within the axil of the lower sheaths; the peduncle terete, suberect to archly pendent, provided with 1–2 basal, tubular-infundibuliform, papery bracts; floral bract double, conduplicate, papery, shorter than the ovary, the external one elliptic-lanceolate to broadly ovate, acute, the subopposite internal bractlet narrowly ligulate. **Flowers** resupinate, large, mostly subpendent, the sepals and sepals white to whitish cream to yellow, the lip white to yellow, often flushed yellow basally, sparsely spotted and blotched with purple at the base up to the distal thickening, the basal callus white or yellow variously spotted with purple, the distal callus usually spotted purple. **Dorsal sepal** free, lanceolate-elliptic to elliptic, acute to subacuminate, basally reclinate over the column, distally usually erect, rarely concave-reclinate. **Lateral sepals** lanceolate-elliptic to elliptic, frequently asymmetrical-subfalcate, acute to acuminate, mostly abruptly reflexed, rarely spreading, inrolled-folded toward the base, forming a short chin together with the column foot. **Petals** inserted along the margins of the column foot, oblanceolate to obovate, subacute to obtuse, minutely apiculate, usually gently revolute at apex, the apical margins undulate to crenulate to deeply lacerate. **Lip** articulate with the column foot, subsessile or with a inconspicuous claw, entire to obscurely or distinctly 3-lobed, elliptic to obovate, the base rounded, the apex emarginate to retuse, gently to abruptly deflexed, the lateral lobes and the proximal margins erect, flanking the column, the distal margins undulate-crisped, often highly fimbriate; disc with a small basal, bilobed, laminar callus, and a distal, often rugose, callous thickening. **Column** straight, with a distinct foot, dilated toward the apex into slightly protruding, rounded stigmatic wings, the ventral surface flat, the stigma transverse, narrow, the acicular rostellum flanked by pararostellar arms. **Anther cap** cucullate, narrowly obovate to obovate, flattened, 2-celled. **Pollinia** 4, in 2 superposed pairs of different size, narrow, on a small, obovate, or wide-subquadrate stipe, and a distinct, elliptic, hyaline viscidium.

Chondroscaphe is a Neotropical genus of some 14 species ranging from Costa Rica and Panama to Venezuela and from Colombia to Peru along the Andean regions, with the highest diversity in Colombia and Ecuador and a second dispersal center in Costa Rica. Gross flower morphology in the taxa native from southern Central America is largely uniform, and the number of described taxa exceeds the actual number of species. The species of *Chondroscaphe* are shade-loving epiphytes of premontane wet and cloud forests, where they establish on large branches and trunks covered with mosses, mostly between 800 and 1500 m, rarely ranging to almost 2000 m. Successive flowering sporadically occurs throughout the year, with a flowering peak during the rainy season. The actual pollinators of *Chondroscaphe* are unknown, but the species are likely visited by euglossine bees in search of nectar, attracted by the false spur formed by the lateral sepals swept back and revolute at the base.

In creating *Chondrorhyncha* sect. *Chondroscaphe*, Dressler (1983) mentioned several features characteristic of the group, such as the inflorescences born successively on a comparatively long cincinnus, the thick and rigid ventral throat of the flower, the presence of a second, distal callus on the lip, the well-developed stipe of the pollinarium, the stipe attached to

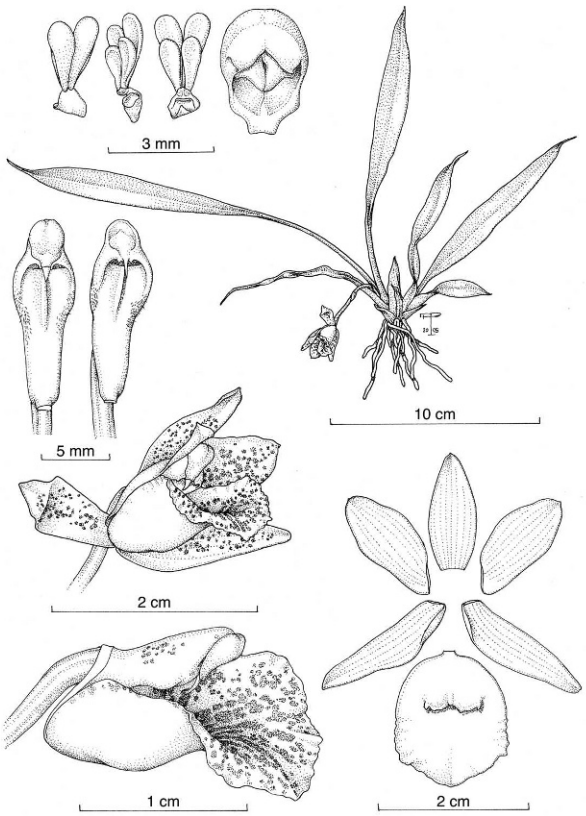


Figure 1.

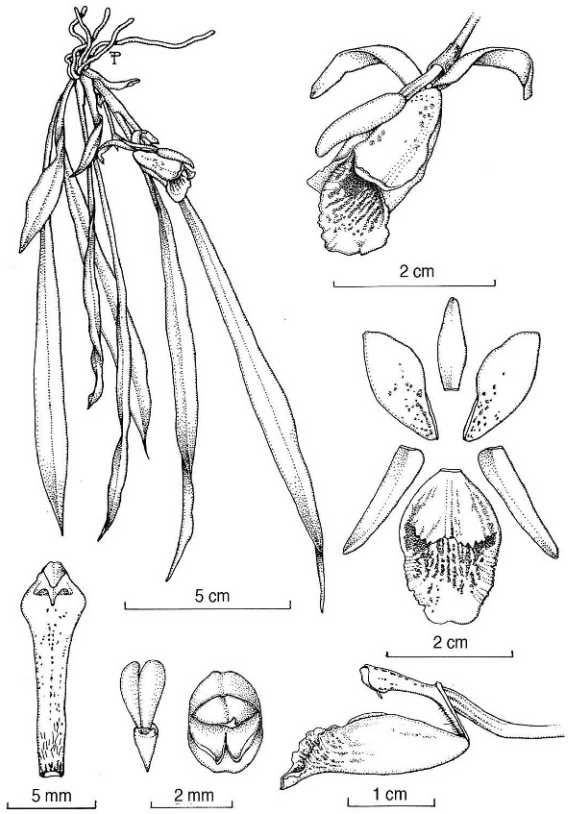


Figure 2.

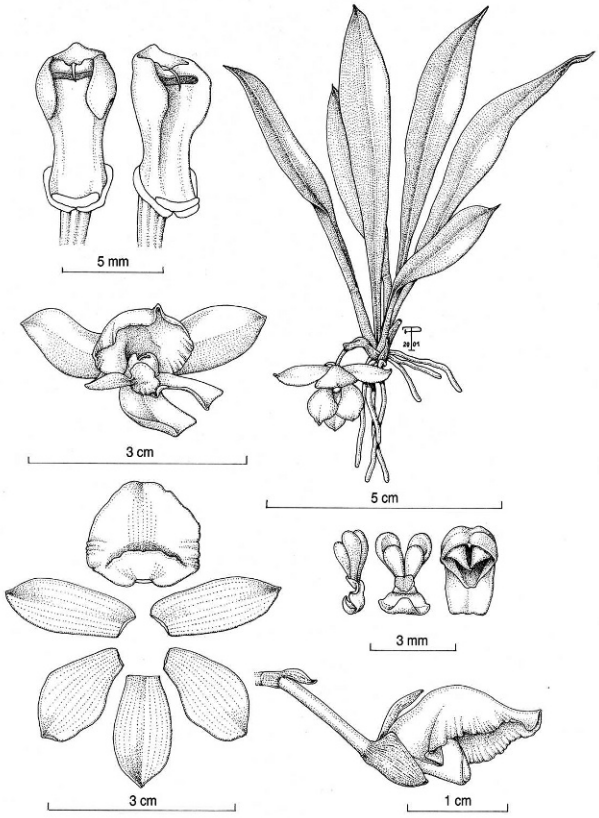


Figure 3.

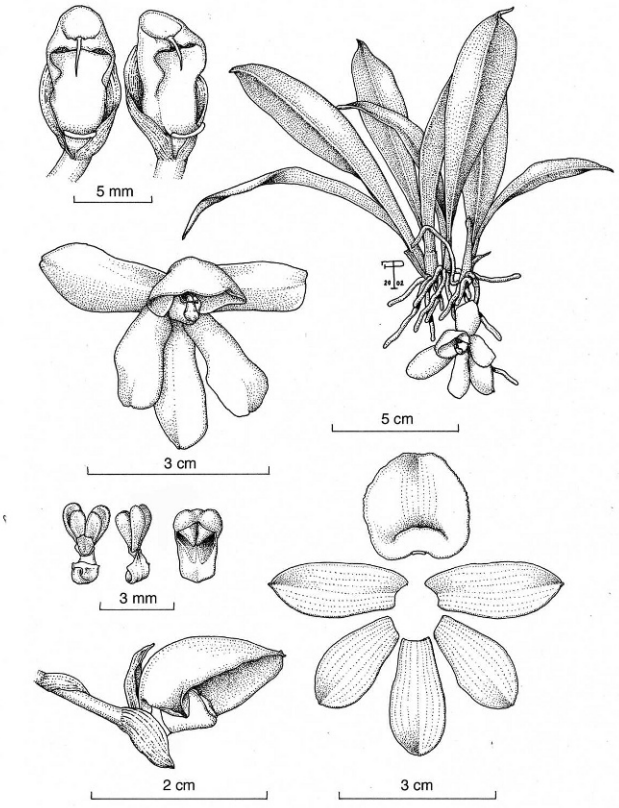


Figure 4.

FIG. 1. ×*Bensteinia ramonensis* (all the illustrations: F. Pupulin). FIG. 2. *Benzingia reichenbachiana*. FIG. 3. *Chaubardiella pacuarensis*. FIG. 4. *Chaubardiella subquadrata*.

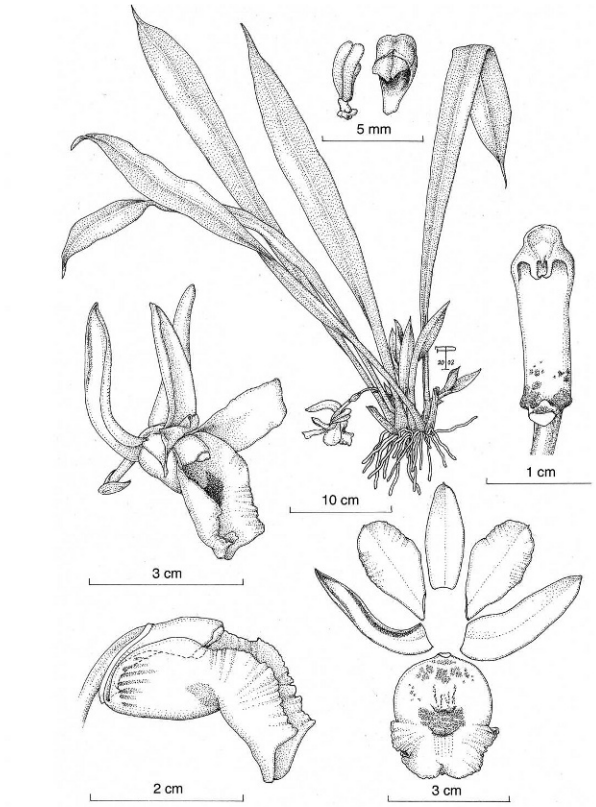


Figure 5.

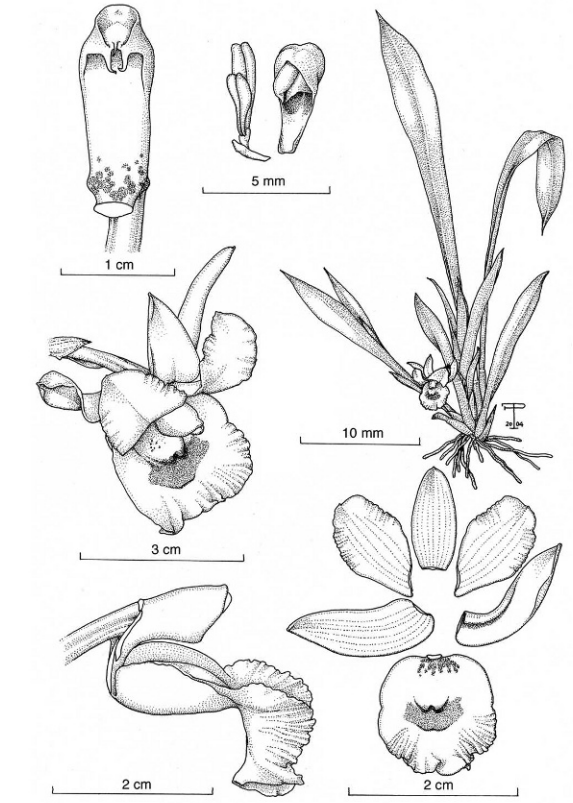


Figure 6.

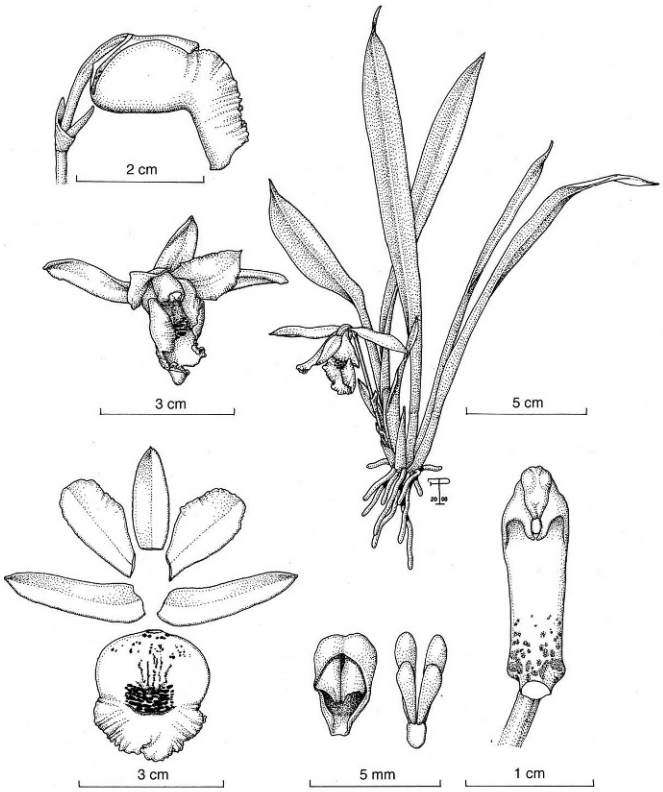


Figure 7.

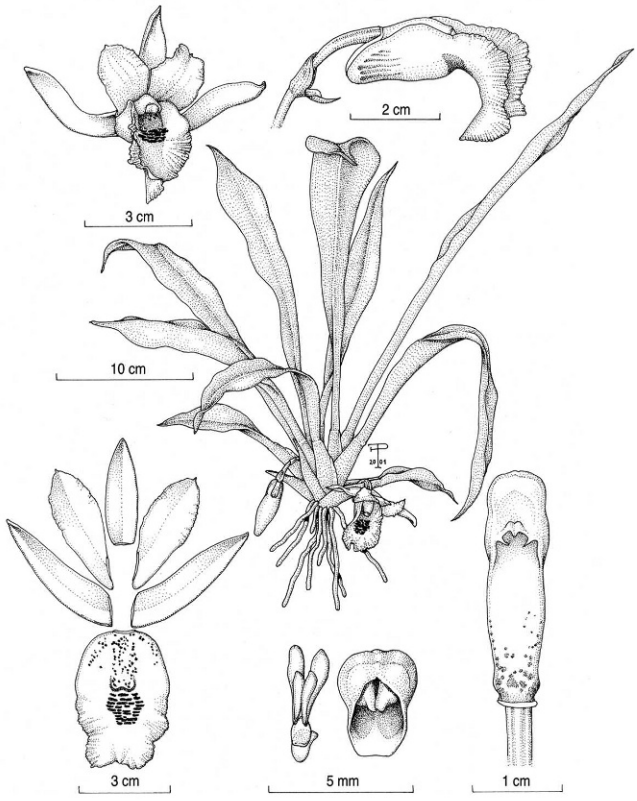


Figure 8.

FIG. 5. *Chondroscaphe bicolor*. FIG. 6. *Chondroscaphe bicolor*. FIG. 7. *Chondroscaphe bicolor*. FIG. 8. *Chondroscaphe atrilinguis*.

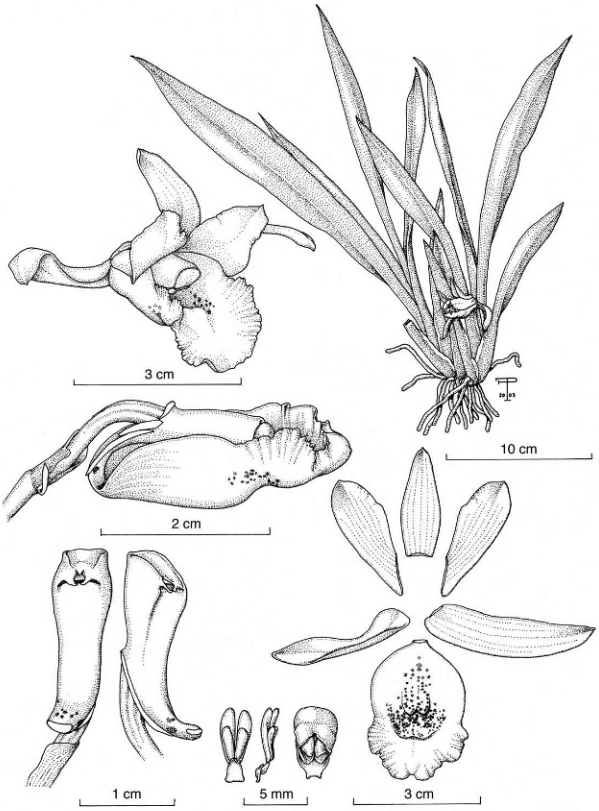


Figure 9.

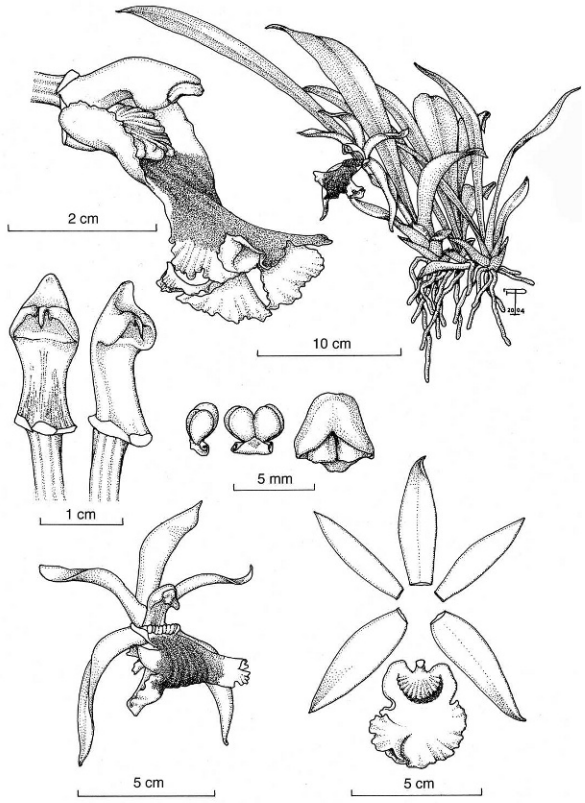


Figure 10.

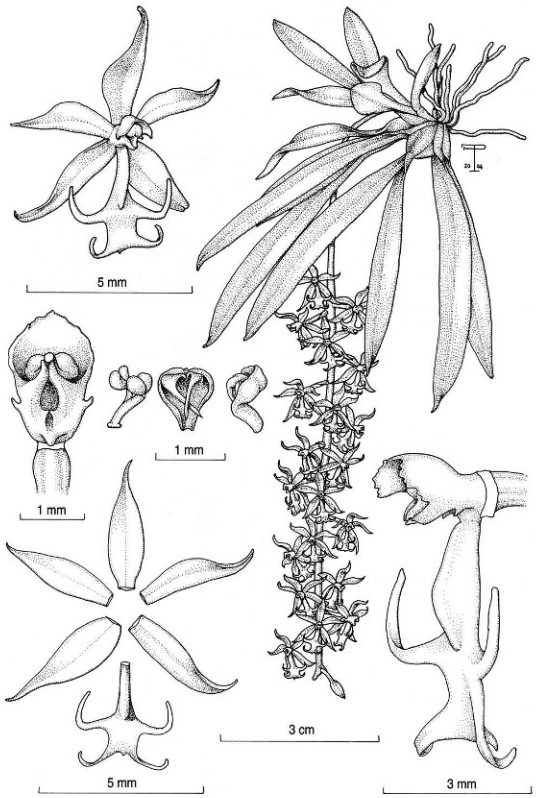


Figure 11.

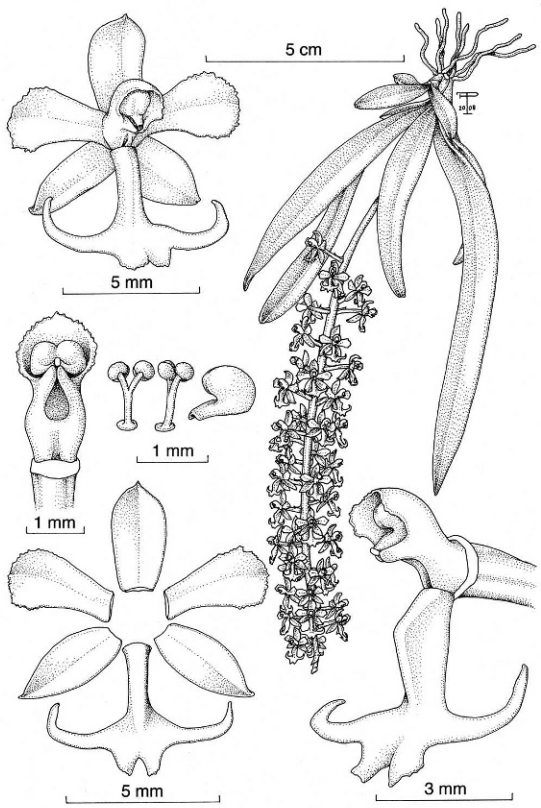


Figure 12.

FIG. 9. *Chondroscaphe yamilethiae*. FIG. 10. *Cochleanthes aromatica*. FIG. 11. *Cryptarrhena guatemalensis*. FIG. 12. *Cryptarrhena lunata*.

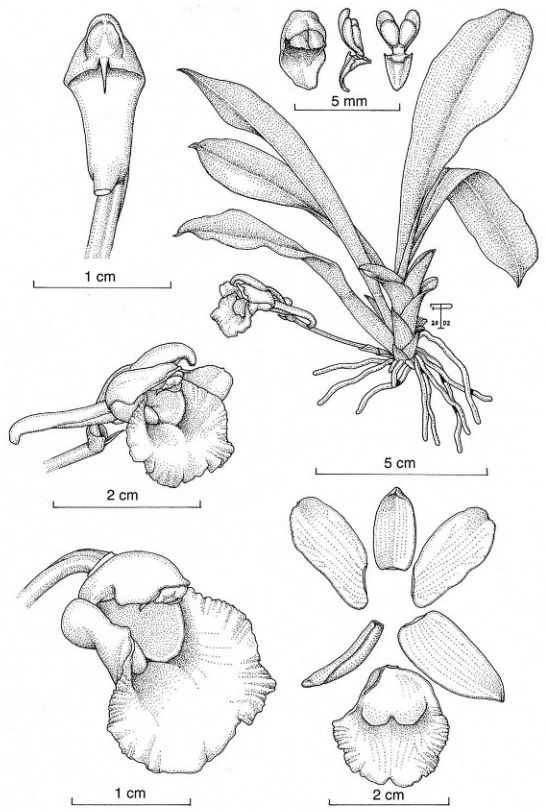


Figure 13.

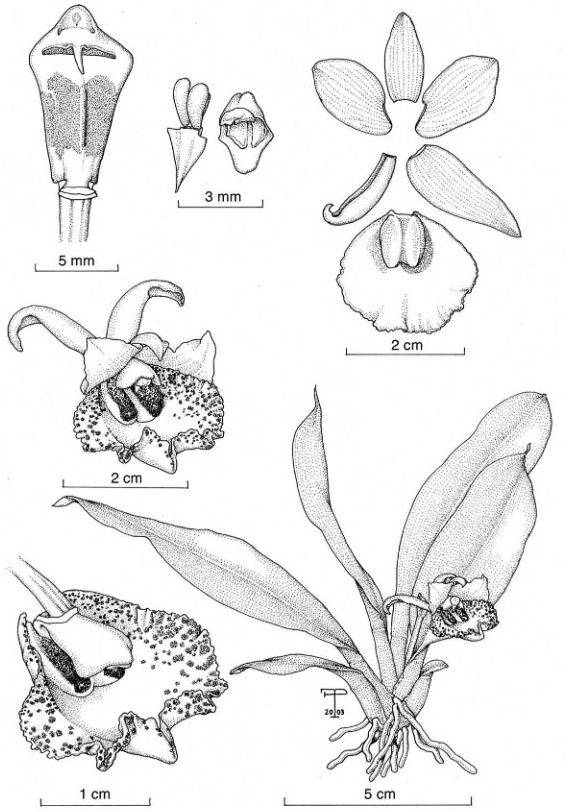


Figure 14.

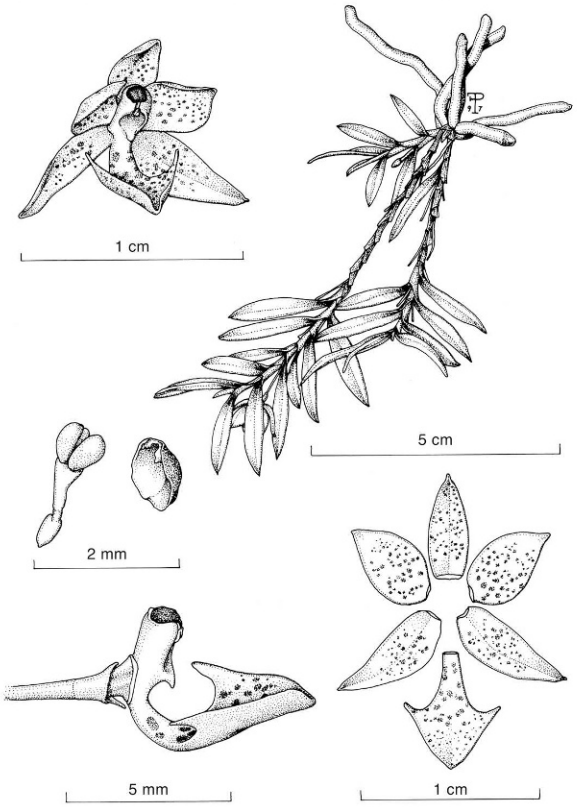


Figure 15.

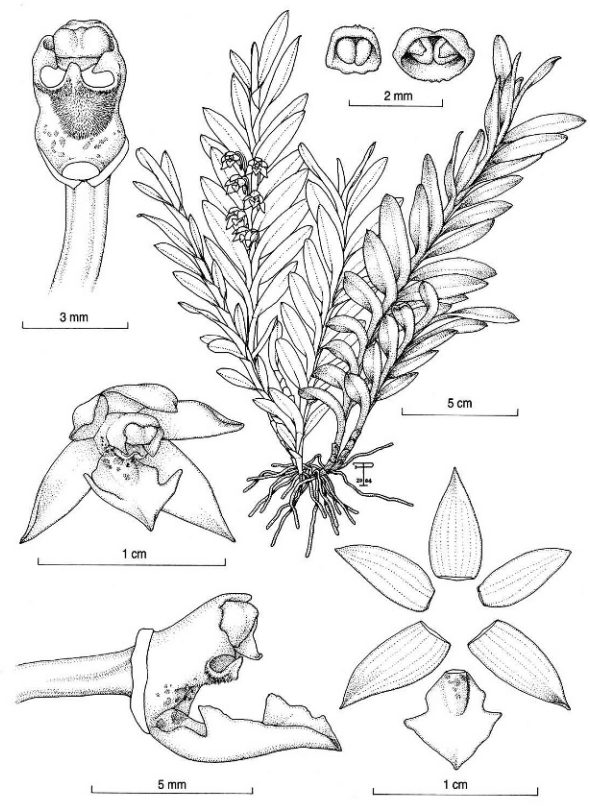


Figure 16.

FIG. 13. *Daiotyla albicans*. FIG. 14. *Daiotyla crassa*. FIG. 15. *Dichaea panamensis*. FIG. 16. *Dichaea glauca*.

the upper surface of the viscidium, and the presence of pararostellar teeth. According to these characters, *Chondroscaphe* was named, as a section of *Chondrorhynhca*, to include both the fringed-lip species close to *Chondrorhyncha flaveola* Rchb.f. and the white-colored species allied to *C. bicolor* Rolfe. In 1993, when Senghas and Gerlach elevated the section *Chondroscaphe* to generic rank, they did not include the mostly Central American species of the *C. bicolor* complex. In 2001, describing two new Central American species of *Chondroscaphe*, Dressler offered further morphological evidence supporting the inclusion of the *C. bicolor* group in *Chondroscaphe*. The combined molecular analysis carried out by Whitten and collaborators (2005) strongly supported a broad circumscription of *Chondroscaphe*. In the cladistic analysis of combined DNA data sets, *Chondroscaphe* (including the *C. bicolor* group) formed a strongly supported branch, sister to the clade of *Warczewiczella* Rchb.f., *Pescatoria* Rchb.f., *Chaubardiella* Garay, *Ixyophora* Dressler, and *Aetheorhyncha* Dressler.

Key to the Species of *Chondroscaphe*

1. Pararostellar lobes of the column ligulate, abruptly inflexed at apex (rarely divergent) . . . . . *C. bicolor*
1a. Pararostellar lobes of the column triangular 2
   2. Flower large (the lip to 45 mm long); basal portion of the lip slightly convex in outline; column widest at apex, adaxially puberulent . . . . . *C. atrilinguis*
   2a. Flower medium in size (the lip to 33 mm long); basal portion of the lip deeply convex in outline; column widest around the stigmatic area, glabrous . . . . . *C. yamilethiae*

Chondroscaphe atrilinguis Dressler, Orquideología 22(1): 16. 2001. Type: Panama. Bocas del Toro. Floreció en cultivo, 8 Sep. 2000, *R.L. Dressler 6289* (holotype, MO). Figure 8 (Voucher: *Pupulin 1454*, USJ).

Epiphytic, cespitose **herbs**, to 40 cm tall. **Roots** 1.5–3 mm in diameter. **Stem** completely hidden by the imbricating sheaths. **Sheaths** strongly conduplicate, provided with scarious margins, to 6 cm long, the upper one foliaceous. **Leaves** 5–7, the conduplicate base 4.5–6 cm long, the blade oblanceolate, acuminate, 18–37 × 2.2–4 cm. **Inflorescence** basal, 1-flowered, peduncle to 4.5 cm long. **Floral bracts** in pairs, the outer one infundibular, elliptic, acute, to 11 × 10 mm, the inner elliptic, 10 × 3–4 mm. **Ovary** and pedicel terete, to 2.7 cm long. **Flower** with sepals and petals cream to pale greenish, the petals and lip cream, the throat of the lip and the column foot spotted purple. **Dorsal sepal** narrowly elliptic, acute, to 33 × 11 mm. **Lateral sepals** lanceolate, acute, the basal margins incurved, to 42 × 11 mm. **Petals** elliptic-ovate, acute, apiculate, 30 × 13–14 mm. **Lip** elliptic-ovate, acute or apiculate, 38–45 × 26–31 mm; the lateral lobes erect, entire, keeled, enfolding the column; the blade with crenulate-subfimbriate margins; basal callus rounded to shallowly retuse, glandular, reaching 18–20 mm from the base, the free apex 3–4 × 9 mm; distal callus rounded, oblong, rugose, 8–10 × 5–7 mm. **Column** terete, subquadrate toward apex, widest above stigma, 18–20 × 6 mm, with slightly spreading wings to about 5 mm below stigma, ventral surface puberulent, column foot 6–7 mm long, with subapical tooth, rostellar teeth narrowly triangular, introrse, pararostellar lobes narrowly triangular-subfalcate. **Anther cap** cucullate, ovate, 2-celled. **Pollinia** 4, in 2 pairs of different sizes, oblong-clavate, on a suborbicular stipe; viscidium elliptic-peltate.

DISTRIBUTION—Costa Rica and Panama.

ECOLOGY—A large epiphyte from premontane wet forests at elevations of 800–1200 m, *C. atrilinguis* is apparently restricted to the Caribbean watershed of the mountains of Costa Rica and western Panama. Flowering has been recorded in May–June and in September–November, corresponding to the rainy season in southern Central America.

DISTINGUISHING FEATURES—*Chondroscaphe atrilinguis* has the largest flowers in the group, one-third larger than any other species. The clinandrium, wider than the stigmatic area, and the broad viscidium distinguish this species.

Chondroscaphe bicolor (Rolfe) Dressler, Orquideología 22(1): 22. 2001. Type: Costa Rica. Without specific locality, *Pfau s.n.* (holotype, K). *Chondrorhyncha bicolor* Rolfe, Bull. Misc. Inform. Kew 1894 (95): 393. 1894. *Chondrorhyncha endresii* Schltr., Repert. Sp. Nov. Regni Veg. 17: 14. 1921. *Chondroscaphe endresii* (Schltr.) Dressler, Lankesteriana 3(3): 28. 2002. *Chondrorhyncha umbonata* Rchb.f., *nom. herb.* (W Rchb-Orch 49751 ≡ type of *Chondrorhyncha endresii* Schltr.). Type: Costa Rica. Ohne nähere Standortsangabe, *A.R. Endrés 166* (holotype, W; drawing of the holotype, AMES; drawings of the plant that served as the holotype, W). *Chondroscaphe laevis* Dressler, Orquideología 22(1): 20. 2001. Type: Costa Rica. Alajuela: San Ramón, Reserva Biológica A. M. Brenes, floreció en cultivo en Jardín Botánico Lankester, 15 May 1998, *G. Hoffmann s.n.* (holotype, MO; isotype, US). Figures 5–7 (Vouchers: *Pupulin 3509*, USJ; *Pupulin 3525*, JBL-Spirit; *Pupulin 2423*, JBL-Spirit).

Epiphytic, cespitose **herb**, to 50 cm tall. **Roots** 1.5–2.3 mm in diameter. **Stem** completely hidden by the imbricating sheaths. **Sheaths** strongly conduplicate-ancipitous, provided with scarious margins, to 5–7 cm long, the upper one foliaceous. **Leaves** 3–7, the conduplicate base 4–5 cm long, the blade oblanceolate to narrowly oblanceolate-ligulate, acuminate, 16–45 × 1.3–2.5 cm. **Inflorescence** basal, 1-flowered, peduncle to 8 cm long. **Floral bracts** in pairs, the outer one infundibular, ovate, acute, to 9 × 6 mm, the innner elliptic-lanceolate, 9 × 2.5–3 mm. **Ovary** and pedicel terete, to 2.1 cm long. **Flower** white to cream, the petals and lip white, the throat of the lip and the column foot spotted purple. **Dorsal sepal** narrowly elliptic, acute, to 18–30 × 6–9 mm. **Lateral sepals** elliptic to elliptic-oblanceolate, acute, the basal margins incurved, to 32 × 11 mm. **Petals** elliptic-obovate, acute, apiculate, 18–25 × 8–10 mm. **Lip** broadly elliptic-ovate to subquadrate-obovate, subentire to obscurely 3-lobed, retuse, 22–32 × 20–30 mm; the lateral lobes erect, entire, enfolding the column; the blade with crenulate-subfimbriate margins; basal callus bilobed, ending in 2 rounded to subtriangular teeth, puberulent-scurfy, reaching 13–15 mm from the base, the free apex 2.0–2.5 × 6 mm; distal callus rounded, rugose or (rarely) glabrous, 4 × 9 mm. **Column** terete, cuspidate toward apex, widest around stigma, 10–13 × 6 mm, with obscure, rounded wings to about 3 mm below stigma, column foot 6–7 mm long, with subapical tooth, rostellar teeth narrowly triangular-acuminate, pararostellar lobes ligulate, abruptly convergent apically. **Anther cap** cucullate, ovate, 2-celled. **Pollinia** 4, in 2 pairs of different size, oblong, on a subquadrate stipe; viscidium elliptic.

DISTRIBUTION—Costa Rica and Panama.

ECOLOGY—Plants of *C. bicolor* are frequent epiphytes from climax vegetation in premontane wet forests at elevations of 900–1200 m, restricted to the Caribbean watershed of Costa Rica and Panama mountain ranges. Flowering begins at the end of the dry season in March–June, with a second flowering peak in October–November, during the rainiest months in southern Central America.

DISTINGUISHING FEATURES—*Chondroscaphe bicolor* may be distinguished by the ligulate, apically inflexed (rarely divergent) pararostellar lobes of the column, a feature that it shares only with *C. venezuelana*. Originally described on the basis of a poorly preserved specimen (K 79618), *C. bicolor* has been at the center of a taxonomic puzzle. Dressler (2002) considered it a "lost species," not corresponding to any other Central American taxon, whereas Pupulin (2005d) noted that,

from an analysis of the holotype, several "anomalous" features of *C. bicolor* were attributable to Rolfe's interpretation and that the type was essentially indistinguishable from Costa Rican populations treated as *C. endresii*. Rolfe himself determined as *C. bicolor* another Costa Rican specimen received from Charles H. Lankester (*Lankester 516-13*, K); this better-preserved plant well corresponds to the later concept of *C. endresii*, also described from Costa Rica (*Endrés 166*, W). The shape of the lip, provided with an oblong, thick, apically bilobed callus, which Schlechter used to characterize his *C. endresii*, is identical to that of *C. bicolor*. The drawing of the rostellum of this species, made by Endrés, clearly illustrates the characteristically ligulate, abruptly introrse stigmatic arms, perfectly corresponding to the morphology of the column of *C. bicolor*. *Chondroscaphe laevis* was described from a specimen originally collected on the Caribbean slopes of the Tilarán mountain range in northern Costa Rica. Another collection by Hoffmann from the type locality (perhaps part of the same specimen from which the holotype was prepared) and grown at LBG has a distinctly verrucose distal thickening of the lip, and specimens of *C. bicolor* were collected in several opportunities at the type locality of *C. laevis*.

Chondroscaphe yamilethiae Pupulin, Vanishing Beauty 1: 111. 2005. Type: Costa Rica. Puntarenas: Buenos Aires, Holán, 1200–1300 m, collected by C. Arguedas, 2000, flowered in cultivation in the collection of J. Cambronero in San Isidro de Pérez Zeledón, 20 Apr. 2003, *F. Pupulin 4701* (USJ). Figure 9 (Voucher: *Pupulin 4701*, USJ).

Epiphytic, cespitose **herb**, to 35 cm tall. **Roots** 2.0–2.5 mm in diameter. **Leaves** 5–7, the conduplicate base 4–5 cm long, the blade narrowly oblanceolate, acuminate, 10–30 × 1.8–4.0 cm. **Inflorescence** basal, 1-flowered, peduncle to 4 cm long. **Floral bracts** in pairs, the outer one infundibular, ovate, 9 × 6 mm, the innner ligulate, 5 × 2 mm. **Ovary** and pedicel terete, 1.8 cm long. **Flower** not completely spreading, white, the inner part of the lip and the column foot spotted purple. **Dorsal sepal** elliptic-lanceolate, acute, minutely apiculate, 25 × 10 mm. **Lateral sepals** narrowly elliptic-ligulate, subfalcate, acute, minutely apiculate, the basal margins recurved, 38 × 9 mm. **Petals** oblong, obtuse, minutely apiculate, the distal margins crenulate, 30.0 × 11.5 mm. **Lip** elliptic-ovate, obscurely 3-lobed, 33 × 25 mm, shortly emarginate, deeply keeled just to the attachment of the distal lobe, the keel strongly convex in profile; the lateral lobes erect, entire, enfolding the column; the median lobe transversely elliptic, the margins crenulate-subfimbriate; basal callus bilobed, reaching 17 mm from the base, the teeth cuspidate, with free apex, sparsely glandular, 7.5 × 6.5 mm; distal callus rounded, emarginate, slightly rugose, 5 × 11 mm. **Column** terete, subquadrate toward apex, 19 × 6 mm, with obscure wings to about 5 mm below stigma, column foot 7 mm long, rostellar teeth triangular, pararostellar lobes acicular, falcate. **Anther cap** cucullate, ovate, 2-celled. **Pollinia** 4, in 2 pairs of different sizes, oblong-subsigmoid, on a ovate-triangular stipe; viscidium suborbicular.

DISTRIBUTION—Known only from Costa Rica.

ECOLOGY—Uncommon, large epiphytes from the premontane and lower montane rain forests on the Pacific slopes of Cordillera de Talamanca, plants of *C. yamilethiae* are usually found on primary branches. Flowering has been recorded mostly at the beginning of the dry season, during the months of December and January.

DISTINGUISHING FEATURES—*Chondroscaphe yamilethiae* can be distinguished among species of the *C. bicolor* group by the nonreflexed lateral sepals, the deeply convex abaxial surface of the lip, and reduced size of the rostellum and the pararostellar arms. The morphology of the pollinarium is similar to that of *C. atrilinguis*, but the latter has a distinctive, broad column and an elliptic-subrectangular lip.

Cochleanthes Raf.

REFERENCES—R. E. Schultes & L.A. Garay, On the validity of the generic name *Cochleanthes* Raf. Bot. Mus. Leafl. Harvard Univ. 18: 321–327. 1954. J. A. Fowlie, Ecology notes: *Cochleanthes flabelliformis*. Amer. Orch. Soc. Bull. 30: 797–799. 1961. J. A. Fowlie, An annotated checklist of the genus *Warscewiczella*. Orch. Dig. 33: 224–231. 1969. J. D. Ackerman, An orchid flora of Puerto Rico and the Virgin Islands. Mem. New York Bot. Gard. 73: 1–203. 1995. R. L. Dressler, Precursor to a revision of the *Chondrorhyncha* complex. Orquideología 21: 233–255. 2000. F. Pupulin, *Cochleanthes* Raf. *In* F. Pupulin (ed.), Vanishing Beauty—Native Costa Rican Orchids 1: 132–133. Editorial de la Universidad de Costa Rica, San José. 2005. W. M. Whitten, N. H. Williams, R. L. Dressler, G. Gerlach, & F. Pupulin, Generic relationships of Zygopetalinae (Orchidaceae: Cymbideae): Combined molecular evidence. Lankesteriana 5(2): 87–107. 2005. F. Pupulin, Genera Zygopetalinarum, 2—The genus *Cochleanthes*. Orch. Rev. 114: 202–210. 2006. F. Pupulin. *Cochleanthes*. Pp. 481–484 *in*: A. M. Pridgeon, P. J. Cribb, M. W. Chase & F. Rasmussen (eds.). Genera Orchidacearum, volume 5. Epidendroideae (Part Two). Oxford University Press.

Cochleanthes Raf., Flora Tellurica 4: 45 (1836). Type species: *Cochleanthes fragrans* Raf., *nom. illeg.* (*Zygopetalum cochleare* Lindl.) = *Epidendrum flabelliforme* Sw.

Syn.: *Zygopetalum* Hook. Sect. *Cochleare* Rchb.f., Walp. Ann. Bot. Syst. 6: 682. 1853.

Epiphytic, cespitose **herbs** without pseudobulbs, rarely with pseudobulbs completely hidden by the leaf bases. **Roots** terete, thick, produced from the short rhizome. **Stem** short, enclosed by 6–7 imbricating sheaths, provided with hyaline margins, the upper ones foliaceous. **Leaf** conduplicate, articulate, membranaceous, oblanceolate to narrowly elliptic-obovate, acute to acuminate, abaxially carinate, narrowed at the base into an indistinct, conduplicate petiole, grass green. **Inflorescence** lateral, single-flowered, produced from the axil of the lower sheaths; the peduncle terete, spreading to suberect, provided with 1–2 conduplicate bracts; floral bract double, conduplicate, shorter than ovary, the external one loose, widely ovate, the subopposite internal bractlet narrowly lanceolate to ligulate. **Flowers** resupinate, usually strongly and sweetly scented (rarely unscented in autogamous populations), the sepals and petals pale greenish cream to pale green, the lip whitish cream, with a large, violet-purple median band or basally veined with violet or purple, apically sometimes solidly violet, the callus white or spotted purple-violet. **Dorsal sepal** free, lanceolate-elliptic, acute to acuminate, slightly reflexed at the base. **Lateral sepals** basally adnate to the column foot, lanceolate-elliptic, acute to acuminate, strongly inrolled-folded toward the base. **Petals** oblanceolate to obovate, acute. **Lip** clawed, articulate with the column foot, 3-lobed (sometimes obscurely), pandurate or suborbicular-flabellate, the base cordiform, notched-bilobed and often reflexed at apex, the apical margins undulate to crisped; disc with a semilunate, multiseriate callus, composed by many low, radiating, rounded ridges, protruding apically into rounded keels, the central ones longer. **Column** slightly curved, clavate to dilated at apex into rounded stigmatic wings, provided with a distinct foot, the ventral surface basally provided with a low, rounded keel, with transverse, narrow stigma. **Anther cap** cucullate, ovate to transversely elliptic, 2-celled. **Pollinia** 4, in 2 subequal pairs, on a stipe scarcely distinct from the triangular or elliptic-ovate, hyaline viscidium.

The genus includes two species ranging from Mexico and the West Indies to northern South America. Species of *Cochleanthes* occur as epiphytes of shady places in warm, tropical and premontane, evergreen wet forests at elevations of 200–1200 m. The plants flower mostly during the rainy season, often producing two to three flowers in succession. Self-pollinating forms, mostly with unscented flowers (Fowlie 1961; Ackerman 1995), are frequent in the West Indies,

whereas in Central and South America the plants are usually exogamous. *Cochleanthes aromatica* is pollinated by male euglossine bees of the genera *Euglossa* and *Eulaema*, on which the pollinarium is placed behind the head.

Schultes and Garay (1954) assigned to *Cochleanthes* all the species previously described under *Warscewiczella* Rchb.f., but the morphology of the flower is different in the two groups. The latter genus was revised in 1969 by J. Fowlie, who distinguished it from *Cochleanthes* mainly on the basis of the lip callus, free laterally and at the apex (vs. solidly attached to the labellum at the base, anteriorly and laterally) and composed of radiating, digitate ''promontories'' (vs. a series of adjacent plates distally attached to the lip) and the lack of a longitudinal, ventral keel on the column (prominent in *Cochleanthes*). Studies based on comparison of DNA sequences (Whitten et al., 2005) show that *Cochleanthes* is only distantly related to *Warscewiczella*, as suggested by Fowlie, and sister to the other species of the *Huntleya* clade provided with pseudobulbs included in *Stenotyla* Dressler. The genus can be characterized by the relatively large plants and flowers, the lip flat or only slightly concave, not enfolding the column, provided with a rounded, multiseriate callus laterally fused with the lip, and the column with a ventral keel.

Cochleanthes aromatica (Rchb.f.) Schultes & Garay, Bot. Mus. Leafl. Harvard Univ. 18: 323. 1954. Figures 5–8. Type: ''Mittelamerika'' (W, not located). *Zygopetalum aromaticum* Rchb.f., Bot. Zeit. (Berlin) 10: 668. 1852. *Warscewiczella aromati*ca (Rchb.f.) Rchb.f., Walp. Ann. Bot. Syst. 6: 654. 1852. *Chondrorhyncha aromatica* (Rchb.f.) P. H. Allen, Ann. Missouri Bot. Gard. 36: 85. 1949. *Zygopetalum wendlandii* Rchb.f., Beitr. Orch. Centr.-Amer. 74. 1866. Type: Costa Rica: in montis Irazu [Irazú volcano] pede, ex horto Herrenhusano, *H. Wendland s.n.* (W-R!) *Bollea wendlandiana* hort. ex Gard. & For. 1: 315. 1888. *Warscewiczella wendlandii* (Rchb.f.) Schltr., Beih. Bot. Centralbl. 36(2): 494. 1918. Figure 10 (Voucher: *Pupulin 1137*, not preserved).

Epiphytic, cespitose **herb** without pseudobulbs, the abbreviated stem with 6–7 imbricating sheaths, the upper ones foliaceous. **Leaf** conduplicate, articulate, membranaceous, oblanceolate to narrowly elliptic-obovate, acute, abaxially carinate, narrowed at the base into an indistinct, conduplicate petiole, grass green, 18–40 × 2–5 cm. **Inflorescence** lateral, stout, from the axil of the lower sheaths, 1-flowered; peduncle terete, suberect, to 15 cm long. **Floral bract** double, conduplicate, the external one loose, widely ovate, the subopposite internal bractlet ligulate. **Ovary** terete, to 2.7 cm long including the pedicel. **Flower** strongly and sweetly scented, the sepals and petals pale greenish cream to pale green, the lip whitish cream with a large, violet-purple median band, the callus white. **Dorsal sepal** free, lanceolate-elliptic, acuminate, slightly reflexed at the base, 45–55 × 13–16 mm. **Lateral sepals** basally adnate to the column foot, lanceolate-elliptic, acute to acuminate, strongly reflexed-folded toward the base, 45–55 × 15–17 mm. **Petals** obovate, acute, 40–45 × 9–11 mm. **Lip** with a short claw, articulate with the column foot, 3-lobed, pandurate, 40–45 × 28–38 mm, the base cordiform, notched-bilobed and often reflexed at apex, the apical margins strongly crisped; disc with a semilunate, multiseriate callus, composed by 14–18 low, radiating, rounded ridges, protruding apically into rounded keels, the central ones longer, ca. 10 × 18 mm. **Column** slightly curved, clavate, ca. 20 mm long, with transverse, narrow stigma, the ventral surface basally provided with a low, rounded keel. **Anther cap** cucullate, ovate, 2-celled. **Pollinia** 4, in 2 subequal pairs, on an elliptic-ovate, hyaline viscidium.

DISTRIBUTION—The species is distributed from Costa Rica to Panama.

ECOLOGY—*Cochleanthes aromatica* is a relatively common epiphyte native from the warm, tropical and premontane wet forests, at elevations between 400 and 1200 m. Flowering has been recorded from July to December, with a peak during September and October, corresponding to the rainiest months in Costa Rica.

DISTINGUISHING FEATURES—The large plants and flowers; pandurate, distinctly 3-lobed lip, flat to slightly convex, not enfolding the column, provided with a large purple blotch in the center; a rounded, multiseriate callus, laterally fused with the lip; and the column with a ventral keel easily distinguish *C. aromatica* among Costa Rican Zygopetalinae.

Cryptarrhena R.Br.

REFERENCES—R. L. Dressler, Orphan orchids II. *Cryptarrhena*—A new tribe, Cryptarrheneae. Orquídea (México) 7(4): 286–288. 1980. R. L. Dressler, The Orchids: Natural History and Classification. Harvard University Press, Cambridge, Massachusetts. 1981. R. L. Dressler, Phylogeny and Classification of the Orchid Family. Dioscorides Press, Portland. 1993. E. A. Christenson, Mesoamerican orchid studies V: A synopsis of *Cryptarrhena* R. Br. Lindleyana 8(3): 163–165. 1993. D. L. Szlachetko, Systema Orchidalium. Fragm. Fl. Geobot. Suppl. 3: 1–152. 1995. F. Pupulin, *Cryptarrhena* R.Br. *In* F. Pupulin (ed.), Vanishing Beauty—Native Costa Rican Orchids 1: 164–165. Editorial de la Universidad de Costa Rica, San José. 2005. W. M. Whitten, N. H. Williams, R. L. Dressler, G. Gerlach, & F. Pupulin, Generic relationships of Zygopetalinae (Orchidaceae: Cymbideae): Combined molecular evidence. Lankesteriana 5(2): 87–107. 2005. F. Pupulin. *Cryptarrhena*. Pp. 484–486 *in*: A. M. Pridgeon, P. J. Cribb, M. W. Chase & F. Rasmussen (eds.). Genera Orchidacearum, volume 5. Epidendroideae (Part Two). Oxford University Press.

Cryptarrhena R.Br., Edwards's Bot. Reg. 2: t. 153. 1816. Type species: *Cryptarrhena lunata* R.Br.

Clinhymenia A.Rich. & Galeotti, Compt. Rend. Acad. Sci. Par. 18: 512. 1844. Type species: *Clinhymenia pallidiflora* A.Rich. & Galeotti.

Orchidofunckia A.Rich. & Galeotti, Ann. Sci. Nat., Bot., Ser. 3, 3: 24. 1845. Type species: *Orchidofunckia pallidiflora* A.Rich. & Galeotti.

Epiphytic, cespitose **herbs** with short, sometimes pseudobulbous stem. **Roots** terete, flexuous, produced at the base of the new shoots or near pseudobulbs. **Pseudobulbs**, when present, heteroblastic, ovoid, compressed, often cryptic, 1- to 2-leaved at apex, concealed by few to numerous (to 17) foliaceous sheaths. **Leaves** conduplicate, distichous, membranaceous to coriaceous, elliptic to elliptic-oblanceolate, subobtuse to acute, rarely shortly acuminate, sometimes abaxially provided with a distinct keel along midnerve, narrowed at the base into an indistinct to short, conduplicate petiole, clear green. **Inflorescence** lateral, a many- (to 30) flowered raceme produced from the axils of the lower leaves or from the base of the mature pseudobulb, usually longer than leaves; the peduncle terete, arched to pendent, basally provided with 2–4, membranaceous, oblong-lanceolate, conduplicate, loose bracts; floral bracts narrowly lanceolate, acute to acuminate, shorter or subequal to the ovary. **Flowers** resupinate, the sepals and petals pale green to greenish yellow, the lip white or yellow. **Dorsal sepal** free, lanceolate-elliptic to elliptic-oblanceolate, acute to acuminate, usually concave, reclinate over the column. **Lateral sepals** lanceolate-elliptic to elliptic-oblanceolate, acute to acuminate, sometimes reflexed at the base. **Petals** narrowly elliptic or lanceolate-elliptic to oblong-subspatulate, acuminate to rounded-apiculate, the apex sometimes minutely and irregularly denticulate. **Lip** adnate to the base of the column, 3-lobed, provided with a linear, long, narrow, laterally compressed, keeled claw; the lateral lobes narrowly linear-falcate, acuminate, the apex retrorse; the midlobe subquadrate, apically bilobed, sometimes apiculate, the distal lobes triangular or narrowly falcate, spreading. **Column** semiterete, arcuate, basally provided with a distinct, ventral tooth, apically dilated into a well-developed, hooded,

irregularly crenulate or entire clinandrium, provided with oblong, obtuse, porrect stigmatic wings and sometimes with a second pair of basal, small, triangular, acute arms; the stigma elliptic-ovate, protruding. **Anther cap** cucullate, obovate, strongly geniculate, 2-celled. **Pollinia** 4, flattened, in 2 subequal pairs on 2 cylindrical, partially joined caudicles, and an elliptic viscidium.

Cryptarrhena is a genus of three to four species widespread in tropical America, ranging from Mexico to Brazil, Peru, Bolivia, and the West Indies. The species of the genus occur as epiphytes in warm, tropical to premontane wet forests, from sea level to about 1000 m. Flowering has been recorded mostly from January to May, but in Costa Rica, *C. guatemalensis* regularly flowers during the rainy season, from July to November. Two species are recorded from Costa Rica.

The genus was originally assigned by Schlechter to the Ornithocephalinae on the basis of the four rounded pollinia, but in the genera close to *Ornithocephalus*, these are borne on an elongate stipe, whereas in *Cryptarrhena* the "stalks" are actually caudicles formed within the anther, joined before reaching the viscidium. Dressler revised the phylogenetic affinities of the genus in 1980, considering that details of the perianth (i.e., the anchor-shaped lip), column (with a hooded clinandrium), and pollinarium (without a stipe) were so unlike those of other members of Maxillarieae that tribal status as tribe Cryptarrheneae was warranted (Dressler, 1980, 1981). Dressler resurrected his subtribe Cryptarrheninae, including it within Maxillarieae, mostly on the basis of the *Maxillaria*-type seeds of *Cryptarrhena*, suggesting the genus was probably derived from some primitive member of Maxillarieae (Dressler, 1993). The same phylogenetic placement was adopted by Szlachetko (1995), who included subtribe Cryptarrheninae within Maxillarieae; however, he noted that *Cryptarrhena* presents several unique characteristics never found in other "vandoid" orchids. In his scheme of possible relationships within the subfamily Vandoideae, Cryptarrheninae is sister to the clade of Maxillarieae + Dichaeae + Oncidieae/Ornithocephaleae/Telipogoneae and successively sister to Zygopetaleae. The combined molecular analysis of the Maxillarieae carried out by Whitten and collaborators (2000) supported the inclusion of the morphologically anomalous *Cryptarrhena* within a monophyletic Zygopetalinae. This conclusion was later confirmed by the evaluation of the phylogenetic relationships of the subtribe Zygopetalinae through parsimony analysis of combined DNA sequence data (Whitten et al., 2005). In the combined cladogram, *Cryptarrhena* is strongly supported as monophyletic but isolated on a long branch, basal to *Dichaea* and the *Huntleya* clade, its placement remaining unresolved. However, in most of the shortest trees, *Cryptarrhena* is sister to the *Huntleya* clade.

Key to the Species of *Cryptarrhena*

1a. Plant with pseudobulbs, leaves membranaceous; lip white, with 4 lateral lobes, apiculate . . . . . *Cryptarrhena guatemalensis*

1b. Plant without pseudobulbs, leaves coriaceous; lip orange-yellow, with 2 lateral lobes, bilobed at apex . . . . . *Cryptarrhena lunata*

Cryptarrhena guatemalensis Schltr., Repert. Spec. Nov. Regni Veg. 10: 253. 1911. Type: Guatemala. Epiphytisch im schattigen Urwald bei Culigüitz, ca. 350 m, blühend im Aug. 1904, *H. von Türckheim II 1047* (holotype, B, destroyed; tracings of Schlechter's drawings of the holotype, including habit, selected here as the lectotype, AMES 24888; Schlechter's analysis of a flower from the holotype, published by Mansfeld, 1931: pl. 77, fig. 308). *Cryptarrhena quadricornu* Kraenzl., Pflanzenr. IV. 50(Heft 80): 314–315. 1922. Type: Costa Rica. Schwule, niedrig gelegene Gegenden an der atlantischen Seite, *Endrés s.n.* (holotype, W-R). Figure 11 (Voucher: *Pupulin 2957*, USJ).

Epiphytic, cespitose, pseudobulbous **herbs**, to 15 cm tall. **Roots** terete, flexuous, produced from the rhizome. **Pseudobulbs** heteroblastic, ovoid, compressed, sometimes cryptic, 1.2–1.5 × 0.5–0.8 cm, 1- to 2-leaved at apex, concealed by few to numerous (to 17) foliaceous sheaths. **Leaves** conduplicate, distichous, membranaceous, elliptic to elliptic-oblanceolate, acute to acuminate, narrowed at the base into an indistinct, conduplicate petiole, clear green, 5–8 × 0.5–1.0 cm. **Inflorescence** lateral, a many- (to 30) flowered raceme produced from the base of the mature pseudobulb, 9–15 cm long; the peduncle terete, arched to pendent, basally provided with 2–4, membranaceous, oblong-lanceolate, conduplicate, loose bracts to 5 mm long; floral bracts narrowly lanceolate-setaceous, acuminate, subequal to the ovary, 7 × 2 mm. **Flowers** small, resupinate, the sepals and petals pale green, the lip white. **Dorsal sepal** free, lanceolate-elliptic, attenuate, concave, slightly reclinate over the column, 5–7 × 1.5–2.5 mm. **Lateral sepals** lanceolate-elliptic, acuminate-attenuate, sometimes slightly reflexed at the base, 5–7 × 1.5–2.0 mm. **Petals** narrowly elliptic-lanceolate to ovate-lanceolate, attenuate, 5–7 × 1.5–2.5 mm. **Lip** adnate to the base of the column, 5-lobed, 5–6 × 5–6 mm across recurved lateral lobes, provided with a linear, long, narrow, laterally compressed, keeled claw ca. 3 mm long; the lateral lobes narrowly linear-falcate, acuminate, the apex retrorse, to 3.5 mm long; the midlobe subquadrate, apiculate. **Column** semiterete, arcuate, 2 mm long, basally provided with a distinct, ventral tooth, apically dilated into an irregularly crenulate clinandrium, provided with oblong, obtuse, porrect stigmatic wings and a second pair of basal, small, triangular, acute arms; the stigma elliptic-ovate, protruding. **Anther cap** cucullate, ovate, strongly geniculate, 2-celled. **Pollinia** 4, flattened, in 2 subequal pairs on 2 cylindrical, partially joined caudicles, and an elliptic viscidium.

DISTRIBUTION—The species ranges from Guatemala to Peru and to Guyana and Brazil.

ECOLOGY—An uncommon epiphyte from the tropical and premontane wet forests at 300–1000 m elevation, *C. guatemalensis* has been recorded from both the watersheds of the Continental Divide. Flowering has been mostly recorded during the rainy season, from July to November.

DISTINGUISHING FEATURES—The pseudobulbous plant, the pendent, many-flowered inflorescences, and the characteristic lip with 4 linear-falcate, apically retrorse lobes are features distinguishing the species. I designated here as the lectotype the tracing of Schlechter's drawings of the holotype kept at the AMES herbarium over the illustration published by Mansfeld (1931) because the drawing at Harvard includes the habit of the plants, clearly showing the distinct pseudobulb. As noted by Christenson (1993), pseudobulb development has no particular taxonomic utility, considering that in juvenile plants and immature shoots of *C. guatemalensis*, the pseudobulb may be apparently absent. In consideration of the phylogeographic affinities of Costa Rican Zygopetalinae, I refrain here from including into the synonymy of *C. guatemalensis* both the South American *Cryptarrhena acrensis* Schltr. and *C. ghillanyi* Pabst, originally described from Peru and Brazil, respectively.

Cryptarrhena lunata R.Br., Bot. Reg. 2: t. 153. 1816. Type: Jamaica. Received by Messrs. Lee and Kennedy and flowered in one of their hothouses, *Lee & Kennedy s.n.*

(holotype, K). *Clinhymenia pallidiflora* A. Rich. & Galeotti, Compt. Rend. Acad. Sci. Par. 18: 512. 1844, *nom. nud. Orchidofunckia pallidiflora* A. Rich. & Galeotti, Ann. Sci. Nat., Bot., ser. 3, 3: 24. 1845. *Cryptarrhena pallidiflora* (A. Rich. & Galeotti) Rchb. f., Bot. Zeitung (Berlin) 10: 766. 1852. Type: Mexico. Oaxaca: 1000 m, *Galeotti 5298* (holotype, P; isotype, W-R). Figure 12 (Voucher: *Carmona s.n.*, not preserved; photo, USJ).

Epiphytic, cespitose **herbs** without pseudobulbs, to 20 cm tall. **Roots** terete, flexuous, produced at the base of the new shoots. **Leaves** conduplicate, distichous, coriaceous, linear-lanceolate to narrowly oblanceolate, subobtuse to acute, 5–20 × 0.7–1.5 cm, suberect to pendent, abaxially provided with a distinct keel along midnerve, narrowed at the base into an indistinct, conduplicate petiole, clear green. **Inflorescence** lateral, a many- (to 35) flowered raceme produced from the axils of the lower leaves, to 25 cm long; the peduncle terete, arched, basally provided with 2–4, scarious, oblong-lanceolate, amplexicaul, inflated bracts, 1.5 × 0.3 cm; floral bracts narrowly triangular-lanceolate, acuminate-attenuate, shorter than the pedicellate ovary, 3–6 × 1.5 mm. **Flowers** resupinate, the sepals and petals greenish yellow, the lip orange-yellow. **Dorsal sepal** free, elliptic-oblanceolate, acute, erect, concave toward the apex, abaxially carinate, 4–5 × 1.5–2.0 mm. **Lateral sepals** elliptic to elliptic-oblanceolate, acute, reflexed at the base, 4–5 × 1.5–2 mm. **Petals** cuneate, oblong-subspatulate, rounded-apiculate, the apex minutely and irregularly denticulate, 3–4 × 1.5–2.0 mm. **Lip** adnate to the base of the column, 3-lobed, 3.5–5.0 × 5.0–6.5 mm, provided with a linear, long, narrow, laterally compressed, broadly triangular, keeled claw; the lateral lobes narrowly linear-falcate, acuminate, the apex retrorse, to 3 mm long; the midlobe transversely subrectangular, apically bilobed, the distal lobes narrowly lanceolate to triangular, short, slightly divergent. **Column** stout, semiterete, arcuate, 2.5 mm long, apically dilated into an entire clinandrium, provided with oblong, obtuse, projecting stigmatic wings; the stigma elliptic-ovate, protruding. **Anther cap** cucullate, obovate, provided with a distal, linear projection, strongly geniculate, 2-celled. **Pollinia** 4, flattened, in 2 subequal pairs on 2 cylindrical, partially joined caudicles, and an elliptic viscidium.

DISTRIBUTION—The species is distributed from Mexico to Colombia and the West Indies.

ECOLOGY—A rare epiphyte from the tropical wet forests at 0–700 m elevation, *C. lunata* has been recorded from both the Caribbean watershed of the northern and central cordilleras and from both sides of the Talamanca range. Flowering occurs mostly during the dry season, from January to May, but sporadic flowerings have been recorded in other months.

DISTINGUISHING FEATURES—The plants with coriaceous leaves, abaxially keeled, the pendent, many-flowered inflorescences, and the orange-yellow lip with 2 linear-falcate, lateral lobes and 2 small apical lobes distinguish *C. lunata* from other Costa Rican Zygopetalinae.

Daiotyla Dressler

REFERENCES—L. A. Garay, Orquídeas Colombianas nuevas o críticas. Decena III. Orquideología 4: 153–161. 1961. J. A. Fowlie, A revision of the Central American species of *Chondrorhyncha* and *Kefersteinia*, including the description of a new species from Costa Rica. Orch. Dig. 30: 79–82. 1966. R. L. Dressler, Precursor to a revision of the *Chondrorhyncha* complex. Orquideología 21: 233–255. 2000. F. Pupulin, Die Orchideen flora Mittelamerika—Ergänzungen (Teil 1). Additamenta ad orchideologiam mesoamericanam, 1. Die Orchidee 54: 467–477. 2003. F. Pupulin, *Chondrorhyncha* Lindl. *In* F. Pupulin (ed.), Vanishing Beauty—Native Costa Rican Orchids 1: 100–109. Editorial de la Universidad de Costa Rica, San José. 2005. W. M. Whitten, N. H. Williams, R. L. Dressler, G. Gerlach, & F. Pupulin, Generic relationships of Zygopetalinae (Orchidaceae: Cymbideae): Combined molecular evidence. Lankesteriana 5(2): 87–107. 2005. F. Pupulin, Genera Zygopetalinarum, 1—The genus *Daiotyla* Dressler. Orch. Rev. 114: 144–149. 2006. F. Pupulin. *Daiotyla*. Pp. 486–489 *in*: A. M. Pridgeon, P. J. Cribb, M. W. Chase & F. Rasmussen (eds.). Genera Orchidacearum, volume 5. Epidendroideae (Part Two). Oxford University Press.

Daiotyla Dressler, Lankesteriana 5: 92. 2005. Type species: *Chondrorhyncha albicans* Rolfe [= *Daiotyla albicans* (Rolfe) Dressler].

Epiphytic, cespitose **herbs** without pseudobulbs. **Roots** terete, produced from the rhizome. **Stem** abbreviated, enclosed by 4–6 imbricating sheaths, sometimes provided with hyaline margins, the upper ones foliaceous. **Leaf** petiolate, conduplicate, elliptic to widely oblanceolate, acute to acuminate, abaxially carinate, dark green, the adaxial surface shiny. **Inflorescence** lateral, single-flowered, produced from the axil of the lower sheaths; the peduncle terete, suberect, provided with 1–2 conduplicate bracts; floral bract double, conduplicate, shorter than ovary, the external one ovate-elliptic to suborbicular, the subopposite internal bractlet narrowly elliptic to ligulate. **Flowers** resupinate, proportionately large, the sepals and petals white to pale cream or yellow, the lip white, yellow or spotted with purple, the callus tinged pale yellow or purple or spotted purple. **Dorsal sepal** lanceolate-elliptic, acute, conduplicate-folded, hooked at apex. **Lateral sepals** narrowly ovate-elliptic to elliptic-lanceolate, obtuse to subacute, strongly reflexed, conduplicate-folded toward the base, abaxially slightly keeled, hooked at apex. **Petals** obovate to elliptic, rounded, sometimes apiculate. **Lip** subrhombic to broadly obovate, rounded, emarginate-bilobed, the apical margin undulate to finely crisped, sometimes infolded, the basal margins erect, flanking the column; disc with a transverse, massive, thickened, bilamellate, rounded to emarginate, sometimes erose-undulate callus, the median groove shallow. **Column** straight, subclavate to clavate, provided with a distinct foot, the ventral surface plain, with transverse stigma. **Anther cap** elliptic to ovate-rhombic, cucullate, 2-celled. **Pollinia** 4, in 2 pairs of different sizes, on a stipe scarcely distinct from the triangular, hyaline viscidium.

The genus includes four species distributed from Costa Rica to Colombia. Species of *Daiotyla* occur as epiphytes of shady places in lowland to midmontane, evergreen wet forests at 250–1800 m elevation. Once the new growth is mature, the plants flower in succession throughout the year.

Molecular data (Whitten et al. 2005) place *Daiotyla* as sister to *Stenia*, which the new genus resembles in vegetative habit, with distinctly oblong to oblanceolate, dark green leaves. The shape of the lip, however, is different from that of *Stenia*, which is deeply saccate. The genus differs from *Chondrorhyncha* mainly in the distinctly thick, two-parted callus at the base of the lip, which extends to about the middle of the blade. The large subclade to which *Daiotyla* belongs includes *Cochleanthes* and *Kefersteinia*.

Key to the Species of *Daiotyla*

1a. Flower white, the callus of the lip tinged pale yellow or blotched purple; margins of lip slightly crenulate . . . . . *Daiotyla albicans*

1b. Flower cream to pale yellow, the lip cream heavily spotted and blotched with purple, the callus spotted with purple; margins of lip crisped . . . *Daiotyla crassa*

Daiotyla albicans (Rolfe) Dressler, Lankesteriana 5: 92. 2005. Type: Costa Rica. [Without specific locality,] flowered in the collection of the Hon. Walter Rothschild, Tring Park, June 1896 (holotype, K!). *Chondrorhyncha albicans* Rolfe, Bull. Misc. Inform. Kew 1898: 195. 1898. Figure 13 (Voucher: *Pupulin 3510*).

Epiphytic, cespitose **herbs** without pseudobulbs, the stem enclosed by 5–6 imbricating sheaths, the upper ones foliaceous. **Leaf** petiolate, conduplicate, widely oblanceolate, acuminate, dark green, shiny, 8.5–20 × 2.2–3.0 cm. **Inflorescence** lateral, from the axil of the lower sheaths, 1-flowered; peduncle terete, suberect, to 6 cm long. **Floral bract** double, conduplicate, the external one widely ovate, the internal bractlet ligulate. **Ovary** to 2 cm long including the pedicel. **Flower** with sepals and petals white to pale cream, the callus of the lip tinged pale yellow or purple. **Dorsal sepal** elliptic, acute, conduplicate-folded, hooked at apex, 16 × 7 mm. **Lateral sepals** elliptic-lanceolate, subacute, reflexed, strongly conduplicate-folded, hooked at apex, 20 × 9 mm. **Petals** obovate-elliptic, rounded, 20 × 9 mm. **Lip** subrhombic-obovate, rounded, retuse, the apical margin finely crisped, the basal margins erect, 24 × 20 mm; disc with a massive, thickened, bilobed, rounded callus, apically emarginate-bilobed, ca. 6 × 10 mm. **Column** straight, clavate, footed, ca. 10 mm long, the ventral surface flat, with transverse, narrow stigma. **Anther cap** elliptic, cucullate, 2-celled. **Pollinia** 4, in 2 pairs of different sizes, on a triangular-ovate, hyaline viscidium.

DISTRIBUTION—The species is distributed from Costa Rica to Colombia.

ECOLOGY—*Daiotyla albicans* is an uncommon epiphyte, known from a few localities from Costa Rica to Colombia. In Costa Rica, it has been recorded from the temperate wet forests along the Caribbean watershed of the Tilarán, Central Volcanic, and Talamanca mountain ranges and from the Pacific slopes of the Cordillera Central, at elevations between 700 and 1600 m. Flowering has been recorded from March to December.

DISTINGUISHING FEATURES—*Daiotyla albicans* has 2 distinct states, either with completely white flowers and the callus tinged with yellow or with the callus solidly blotched with purple-red. Minor but consistent differences between the 2 morphs exist in the shape of the callus and the size of the opening formed by the callus and the ventral surface of the column, perhaps deserving taxonomic recognition. The rounded lip, with the lateral margins erect at the base to flank the column; the massive 2-lobed callus that occupies most of the basal half of the lip; and the white flowers easily distinguish this species.

Daiotyla crassa (Dressler) Dressler, Lankesteriana 5: 92. 2005. Type: Panama. Chiriquí: Fortuna Valley, north side of river near La Sierpe, 11 May 1982, flowered in cult. 20 May–July, *R.L. Dressler 6055* (holotype, US). *Chondrorhyncha crassa* Dressler, Die Orchidee 34: 222. 1983. Figure 14 (Voucher: *Pupulin 4257*).

Epiphytic, cespitose **herbs** without pseudobulbs, the abbreviated stem with 4–5 imbricating sheaths, the upper ones foliaceous. **Leaf** petiolate, conduplicate, oblanceolate to elliptic-obovate, acuminate, abaxially carinate, dark green, shiny, 6.5–12 × 2.2–3.6 cm, the petiole to 2 cm long. **Inflorescence** lateral, from the axil of the lower sheaths, 1-flowered; peduncle terete, arching, to 4 cm long. **Floral bract** double, conduplicate, loose, the external one widely ovate-elliptic, the subopposite internal bractlet narrowly elliptic-ligulate. **Ovary** subclavate, to 1.8 cm long including the pedicel. **Flower** rather large, the sepals and petals cream to pale yellow, the lip cream heavily spotted and blotched with purple, especially toward the margins and the apex, the callus cream spotted with purple, with 2 large purple blotches at apex. **Dorsal sepal** lanceolate, acute, strongly conduplicate-folded, hooked at apex, 12.0 × 5.5 mm. **Lateral sepals** elliptic-lanceolate, subacute, reflexed, strongly conduplicate-folded, hooked at apex, 17 × 7 mm. **Petals** obovate, rounded, apiculate, 14 × 8 mm. **Lip** broadly obovate, obtuse, concave, the margins crisped, infolded apically, 20 × 18 mm; disc with a bilamellate, obovate callus, apically emarginate-bilobed, thickened at the sides, ca. 13 × 8 mm, the median groove shallow. **Column** straight, clavate, ca. 7 mm long, the ventral surface flat, with transverse stigma. **Anther cap** ovate-rhombic, 2-celled. **Pollinia** 4, in 2 pairs of different sizes, on a triangular-ovate, hyaline viscidium.

DISTRIBUTION—The species is known from Costa Rica and Panama.

ECOLOGY—*Daiotyla crassa* is a rare epiphyte from the wet premontane forests of the Caribbean watershed of the Continental Divide in southern Costa Rica and Panama, at elevations between 800 and 1200 m. *Daiotyla crassa* was recorded from Costa Rica on the basis of a plant growing intermixed with specimens of *D. albicans* collected on the Caribbean side of the Talamanca range. Once the new growth is mature, the plants flower in succession throughout the year.

DISTINGUISHING FEATURES—The large, flattened lip, with the apical margins recurved, the pale creamish yellow color of the flower, and the large, bipartite callus heavily spotted and blotched with purple distinguish this species.

Dichaea Lindl.

REFERENCES—A. Cogniaux, Orchidaceae III, *Dichaea*. Pp. 484–504 *in* C. F. P. Martius (ed.), Flora Brasiliensis. 1906. R. L. Dressler, Observations on orchids and euglossine bees in Panama and Costa Rica. Rev. Biol. Trop. 15(1): 143–183. 1968. R. L. Dressler, The Orchids: Natural History and Classification. Harvard University Press, Cambridge. 1981. R. L. Dressler, Phylogeny and Classification of the Orchid Family. Dioscorides Press, Portland. 1993. R. L. Dressler & C. H. Dodson, Classification and phylogeny in the Orchidaceae. Ann. Missouri Bot. Gard. 47: 25–68. 1960. J. B. Folsom, A systematic monograph of *Dichaea* section *Dichaea* (Orchidaceae). Thesis. University of Texas, Austin. 1987. C. E. O. Kuntze, Revision of *Dichaea*. P. 171 *in* T. E. von Post (ed.), Lexicon Generum Phanerogamarum. Deutsche verlag-Anstalt, Stuttgart. 1903. K. M. Neubig, Molecular systematics of the genus *Dichaea* (Zygopetalinae: Orchidaceae). MSc Thesis, University of Florida. 2005. K. M. Neubig, N. H. Williams, & W. M. Whitten. Molecular systematics of the genus *Dichaea* (Zygopetalinae: Orchidaceae). First Scientific Conference on Andean Orchids, Gualaceo, Ecuagenera & Universidad A. Pérez Guerrero. Conference abstracts: 38. 2005. E. H. H. Pfitzer, Entwurf einer natürlichen Anordnung der Orchideen 107. 1887. E. H. H. Pfitzer, Monandrae-Dichaeinae. Pp. 206–207 *in* Engler & Prantl, Nat. Pflanzenfam. 2(6). 1888. R. Schlechter, Die Orchideen-Gruppe Dichaeinae Pfitzers. Orchis 8: 96–101. 1914. R. Schlechter, Das System der Orchidaceen. Notizbl. Bot. Gart. Mus. Berlin-Dahlem 9: 563–591. 1916. D. Szlachetko, Systema Orchidalium. Phrag. Flor. Geobot. Suppl. 3: 1–152. 1995. F. Pupulin, *Dichaea* Lindl. *In* F. Pupulin (ed.), Vanishing Beauty—Native Costa Rican Orchids 1: 204–227. Editorial de la Universidad de Costa Rica, San

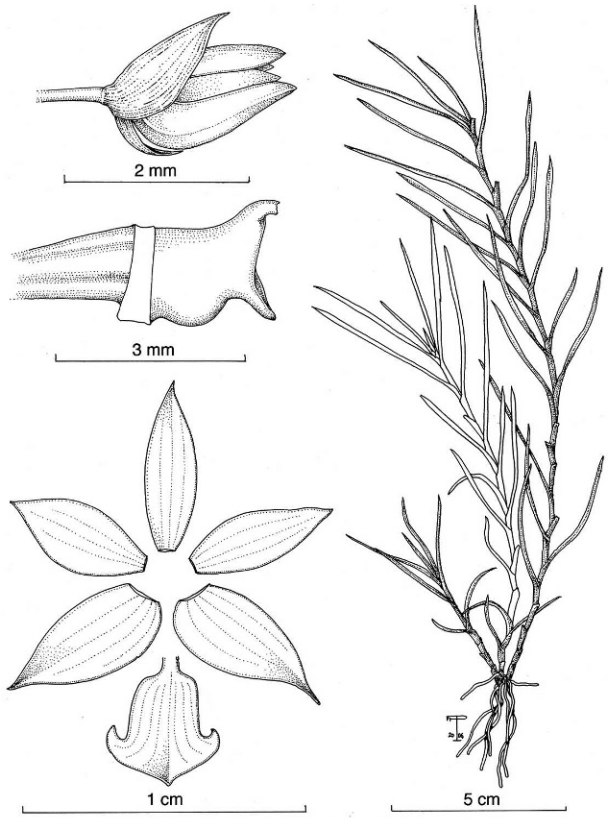


Figure 17.

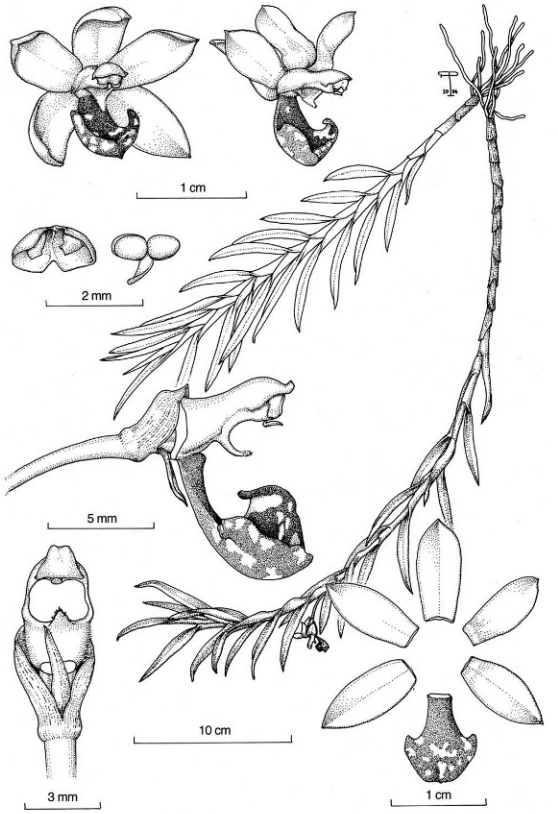
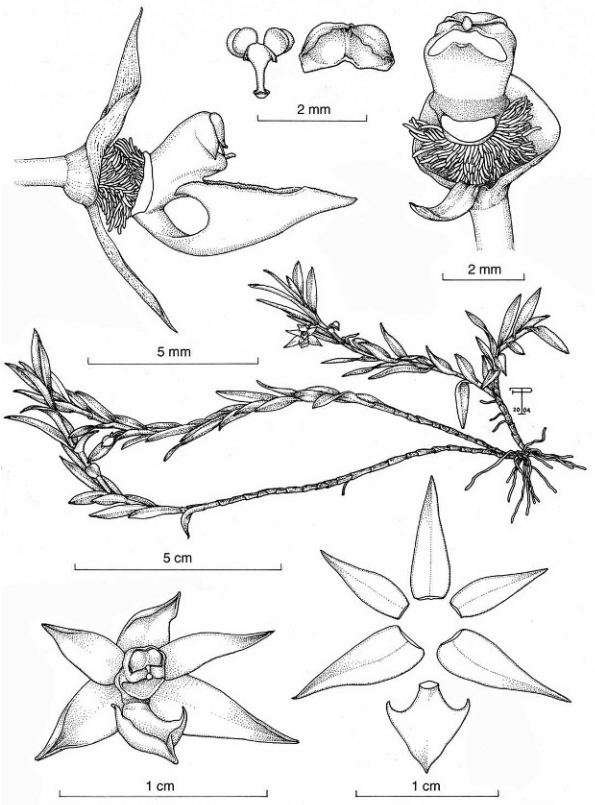


Figure 18.



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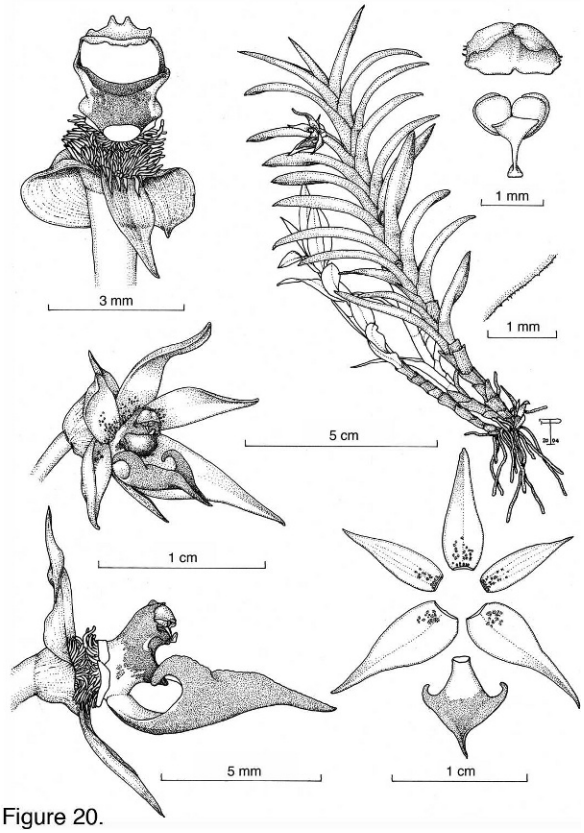


Figure 20.

FIG. 17. *Dichaea gracillima*. FIG. 18. *Dichaea trulla*. FIG. 19. *Dichaea lankesteri*. FIG. 20. *Dichaea amparoana*.

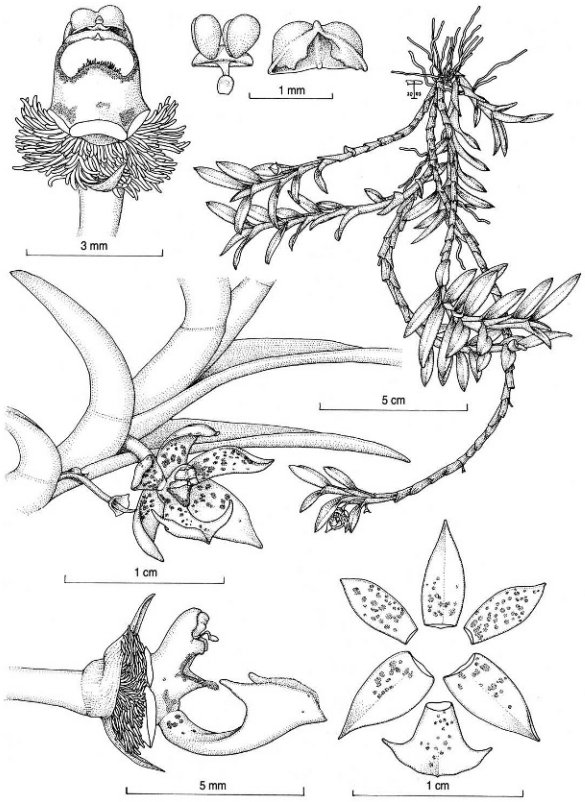


Figure 21.

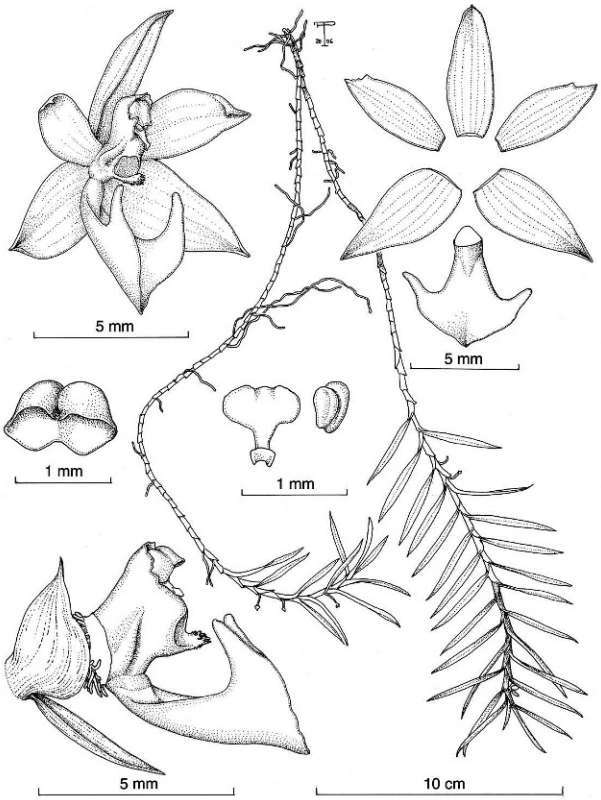


Figure 22.

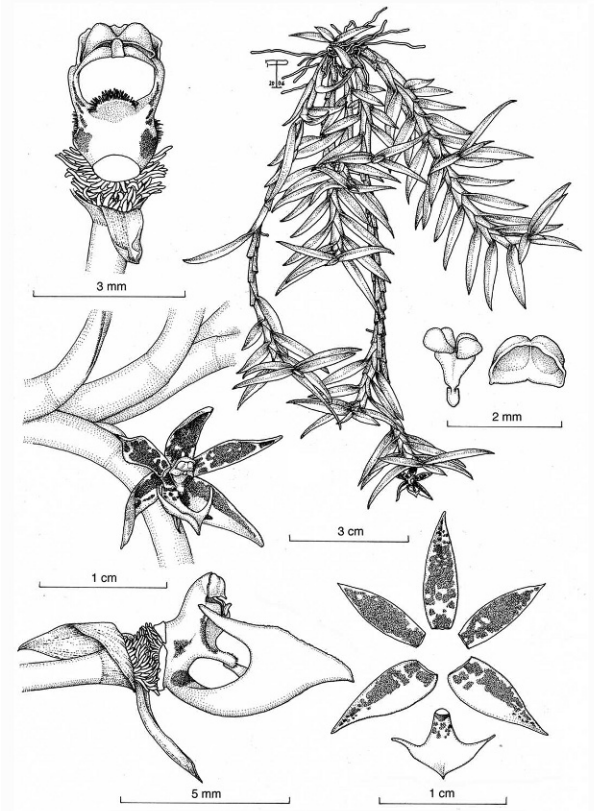


Figure 23.

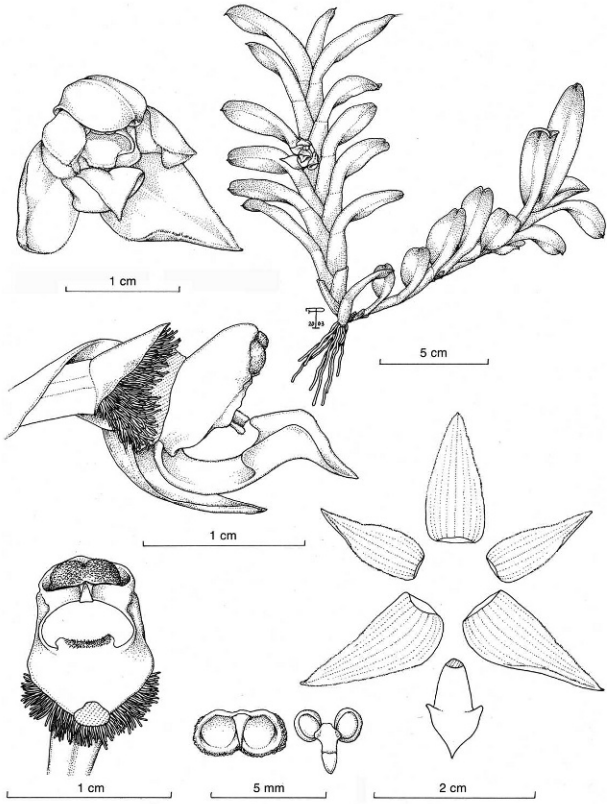
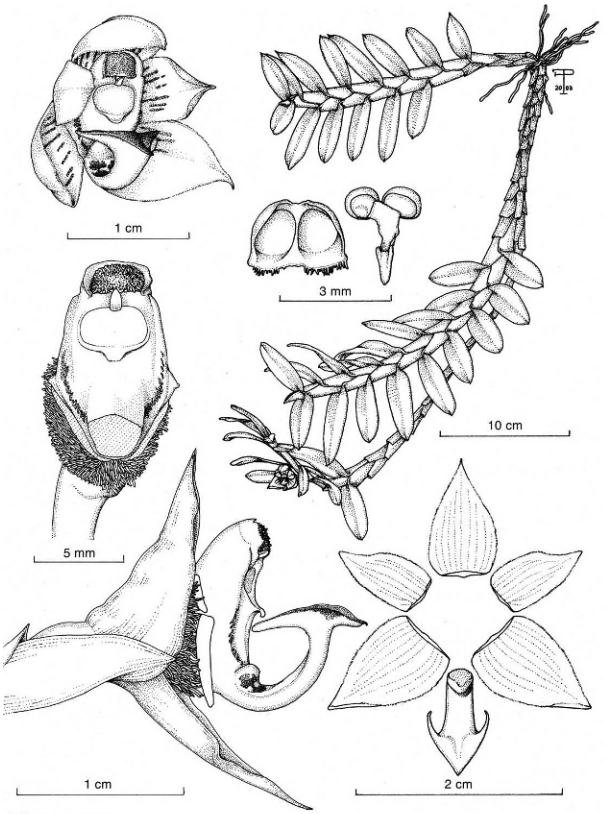


Figure 24.

FIG. 21. *Dichaea elliptica*. FIG. 22. *Dichaea gomez-lauritoi*. FIG. 23. *Dichaea acroblephara*. FIG. 24. *Dichaea fragrantissima* subsp. *eburnea*.



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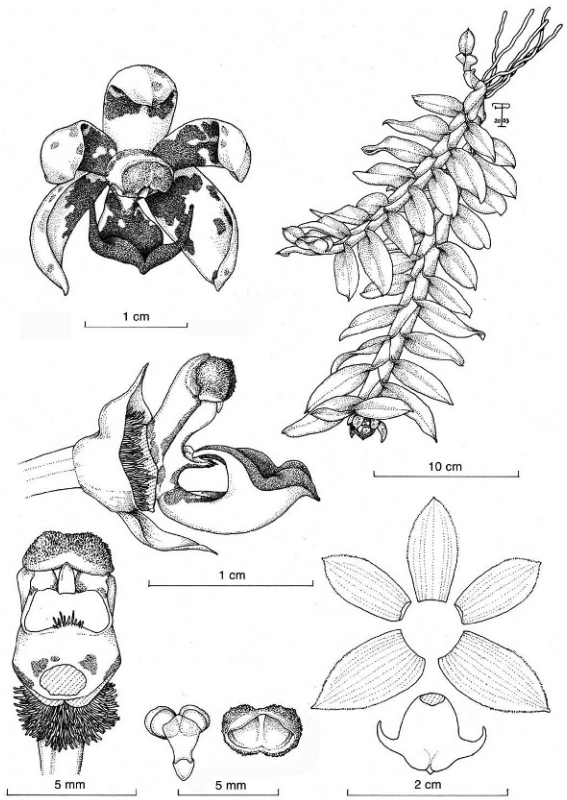

Figure 26.

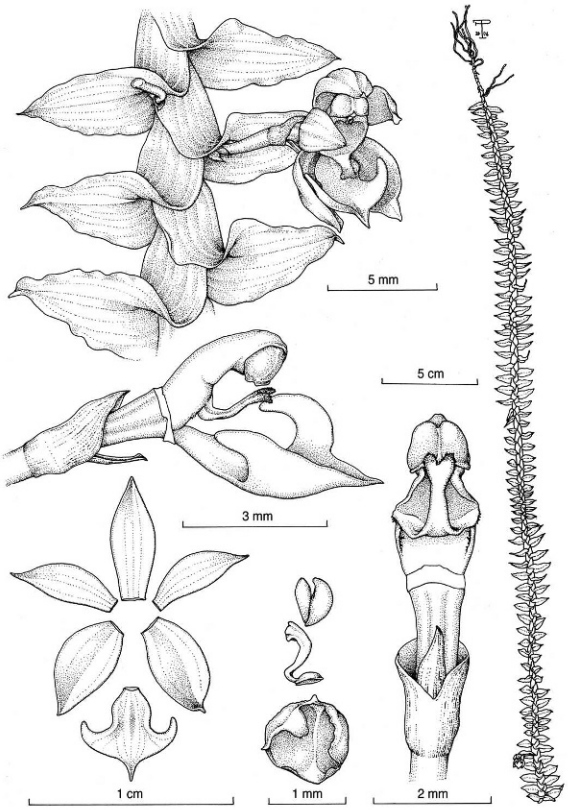

Figure 27.

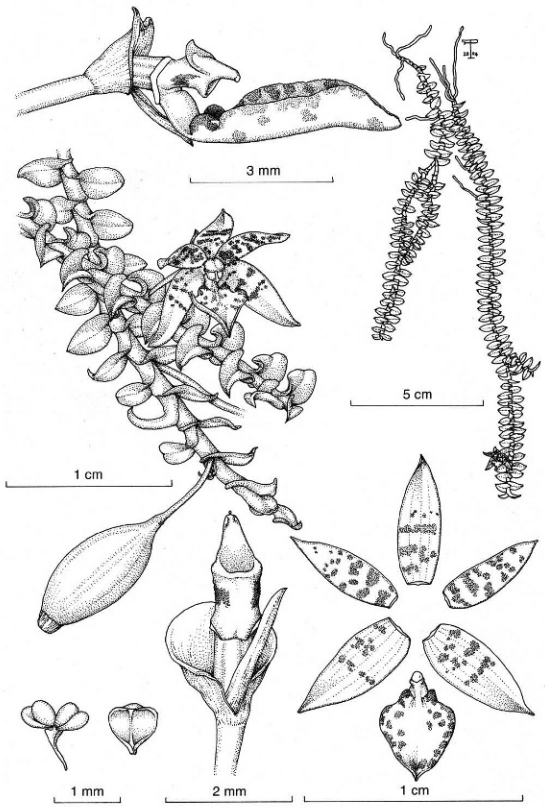

Figure 28.

FIG. 25. *Dichaea morrisii*. FIG. 26. *Dichaea globosa*. FIG. 27. *Dichaea viridula*. FIG. 28. *Dichaea tuerckheimii*.

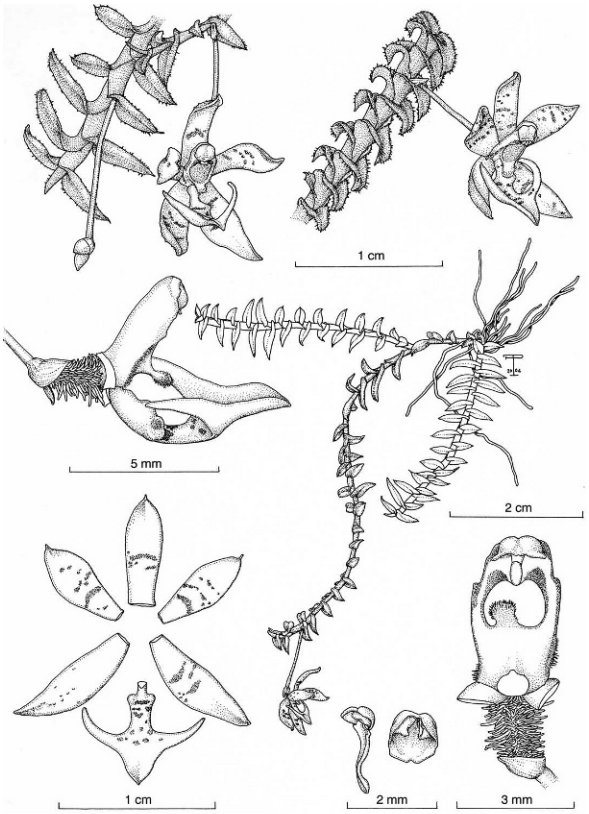

Figure 29.

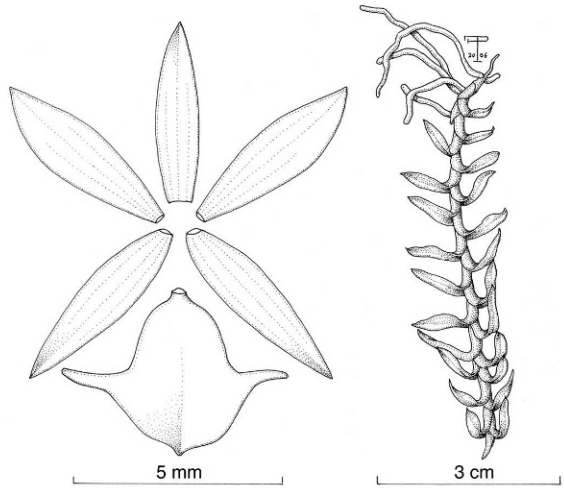

Figure 30.

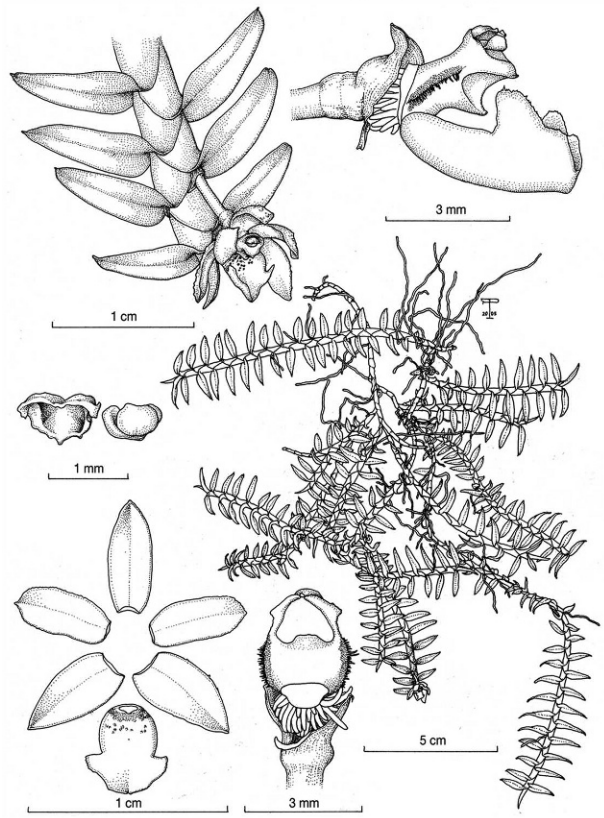

Figure 31.

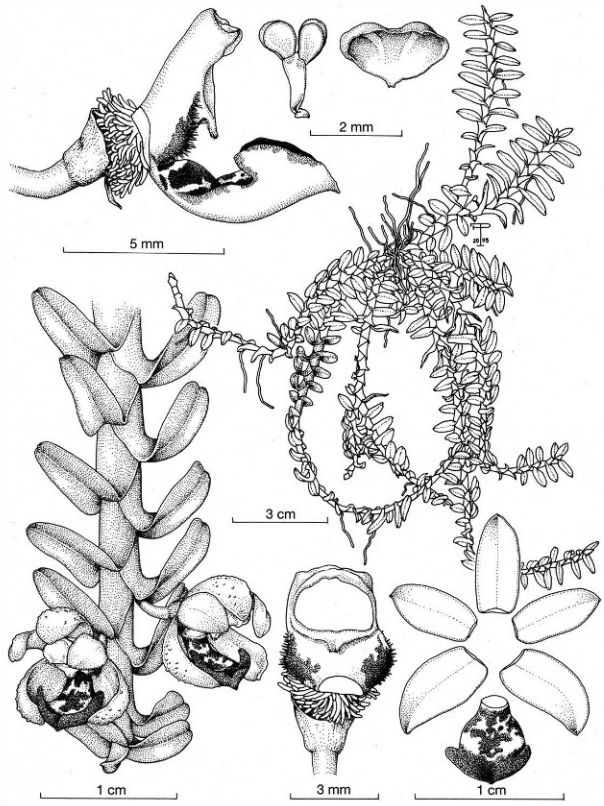

Figure 32.

FIG. 29. *Dichaea hystricina*. FIG. 30. *Dichaea acostae*. FIG. 31. *Dichaea trichocarpa*. FIG. 32. *Dichaea squarrosa*.

José. 2005. W. M. Whitten, N. H. Williams, R. L. Dressler, G. Gerlach, & F. Pupulin, 2005. Generic relationships of Zygopetalinae (Orchidaceae: Cymbideae): Combined molecular evidence. Lankesteriana 5(2): 87–107. F. Pupulin. Contributions toward a reassessment of Costa Rican Zygopetalinae (Orchidaceae). 3. A systematic revision of *Dichaea* in Costa Rica. Harvard Pap. Bot 12(1): 15–153. 2007. R. K. Brummitt. Report of the Committee for Vascular Plants. (1707). To reject *Cymbidium muricatum* Sw. (Orchidaceae). Taxon 56(4): 1290. 2007. K. M. Neubig, M., N. H. Williams, W. M. Whitten, & F. Pupulin. Molecular phylogenetics and the evolution of fruit and leaf morphology of *Dichaea* (Orchidaceae: Zygopetalinae). Ann. Bot. 104: 457–467. 2009. F. Pupulin. *Dichaea*. Pp. 489–494 *in*: A. M. Pridgeon, P. J. Cribb, M. W. Chase & F. Rasmussen (eds.). Genera Orchidacearum, volume 5. Epidendroideae (Part Two). Oxford University Press.

Dichaea Lindl., Gen. Sp. Orch. Pl. 208. 1833. Type species: *Dichaea echinocarpa* (Sw.) Lindl., *nom. illeg.* = *Dichaea pendula* (Aubl.) Cogn. (basionym: *Limodorum pendulum* Aubl.).

Dichaeopsis Pfitz., *in* Engler & Prantl Nat. Pflanzenfam. Orchid. 2(6): 206–207. 1889. Type species: not designated.

Epithecia sensu O. Kuntze, *in* T. von Post, Lex. Gen. Phan. 171 (1903); sensu Schlechter, Orchis 8: 5. 1914; *non* Knowl. & West. 1838 (= *Prosthechea* Knowl. & West.). Type species: *Epithecia glauca* Knowl. & Westc. = *Prosthechea glauca* Knowl. & Westc.

Epiphytic, cespitose or scandent **herbs** without pseudobulbs. **Roots** terete, filiform to fleshy, rarely produced only at the base of the stem, commonly also cauline, rarely branching. **Stems** 1 to several, elongate, erect to arching or laxly pendent, terete or dorsiventrally flattened, often freely branching, completely enclosed by persistent imbricating leaf-sheaths. **Leaves** distichous, articulate or not, simple, conduplicate, ovate to elliptic or lanceolate, rounded to acute, usually apiculate, abaxially carinate, the margins entire or variously microciliate toward the apex, rarely evenly ciliate, medium to dark green or gray-green to brownish, sometimes glaucous on one or both the surfaces. **Inflorescences** lateral, single-flowered, supra-axillary, produced sequentially or rarely simultaneously, emerging from the axils of the upper leaf-sheaths; the peduncle terete, straight or geniculate, basally provided with 2–3 conduplicate bractlets; floral bract double, conduplicate, shorter or longer than ovary, the external one larger, widely ovate, cucullate-funnelform, the subopposite internal bractlet narrowly lanceolate to ligulate. **Ovary** glabrous or variously muricate. **Flowers** resupinate, ringent to spreading, often strongly scented, the sepals and petals ivory white to greenish white or orange-gray, the sepals mostly flecked with purple-violet toward the base, the petals commonly heavily spotted or blotched with purple-violet, the lip white or spotted and blotched with violet, rarely solid purple, the column greenish white, commonly tinged violet on the foot and the lateral wings. **Dorsal sepal** ovate to elliptic-lanceolate, acute to subacuminate, concave toward the base, abaxially smooth or variously tuberculate, erect above the column. **Lateral sepals** obliquely ovate to elliptic-lanceolate, sometimes falcate, acute to subacuminate, concave toward the base, smooth or tuberculate. **Petals** ovate to elliptic or obovate, acute to abruptly acuminate, frequently concave. **Lip** distally 3-lobed to anchor-shaped, rarely subentire, variously clawed or infrequently sessile, usually conduplicate toward the apex, acute to rounded or truncate, often apiculate, the basal margins frequently ciliate, the distal margins irregularly microserrate; disc mostly ecallose or with a central ridge or 2 basal knobs. **Column** erect or straight, subterete, provided with a foot, commonly with basal, ciliate wings, the anther terminal, the clinandrium shallow or hooded-petaloid; the stigma rounded, the lower rim commonly projecting into a variously shaped, frequently papillose-hirsute ligule. **Anther cap** widely elliptic to ovate-rhombic, cucullate, flattened, 2-celled. **Pollinia** 4, in 2 subequal pairs, rarely united in 2 heart-shaped pollinia, on a laminar, apically expanding stipe, continuous with the elliptic, sulcate, hyaline viscidium.

Dichaea is a Neotropical genus of about 110 species distributed from Mexico to Bolivia and Argentina and the West Indies, with its greater diversity in Andean South America. Twenty-nine species are known from Costa Rica. The species of the genus *Dichaea* occur as epiphytes (rarely terrestrial) plants, restricted mostly to shady places in the understory of tropical to submontane, evergreen wet forests at 0–2500-m elevation. With a few exceptions, species of *Dichaea* are shade-loving plants, invariably growing in subdued light on the main trunk (often near the soil) and large, shaded branches of the host trees. Most of the species are completely intolerant to direct sunlight exposition, and the plants usually establish themselves on wood covered by thick layers of mosses, which ultimately cover large portions of the stems and the leaves. Species are pollinated by male euglossine bees. *Dichaea panamensis* Lindl. is pollinated by male small green *Euglossa* species (Dressler, 1968), and *D. potamophila* Folsom is pollinated by *Eulaema meriana* while scratching the base of the labellum in search for perfume (Folsom, 1987). The pollinarium is attached to the frons region of the insect's head.

In 1887, Pfitzer created the tribe Dichaeae to group species of Neotropical, pseudobulbless plants with two-ranked, duplicate leaves; one-flowered inflorescence; and four pollinia, and in 1888 he created *Dichaeopsis* for those species with articulated leaves and glabrous ovaries (Pfitzer, 1887, 1888). Dressler and Dodson (1960) assigned *Dichaea* to the monotypic *Dichaea* alliance, one of the three alliances of the Oncidiinae, distinguishing it within the subtribe by the four pollinia, the column with a short rostellum and the usually anchor-shaped lip. In 1981, Dressler included *Dichaea* in the monotypic subtribe Dichaeinae (Dressler, 1981), but he noted a strong similarity of *Dichaea* with the *Chondrorhyncha* complex and suggested its possible derivation from Zygopetalinae-like ancestors. In 1993, he definitively placed *Dichaea* in subtribe Zygopetalinae (Dressler, 1993). Szlachetko (1995) considered *Dichaea* as the only member of a monotypic subtribe Dichaeinae, one of three subtribes of ''monopodial orchids'' included in the tribe Dichaeae Pfitz., interpreted as an early and blind offshoot of the oncidioid line. Senghas (1996) accepted *Dichaea* as the monotypic member of Dichaeinae, one of the four subtribes included in an informal *Subtribusgruppe* (or *tribella*) Tetrapolliniata, distinguished within the group by the vegetative, ''pseudomonopodial'' habit and the single-flowered inflorescence. The combined molecular analysis of the Maxillarieae carried out by W. M. Whitten et al. (2005) indicated strong bootstrap support for monophyly of Zygopetalinae including *Dichaea*. These preliminary findings were confirmed by molecular work aimed at clarifying generic relationships of Zygopetalinae (Whitten et al., 2005). *Dichaea* is supported as a monophyletic group basal to the *Huntleya* grade (plants mostly without pseudobulbs and with conduplicate leaves), consecutively sister to *Huntleya* and to the rest of the so-called *Chondrorhyncha* complex.

At the infrageneric level, Pfitzer (1888) characterized the genus *Dichaea* by the presence of nonarticulate leaves and verrucose to muricate fruits, segregating those species with articulate leaves and glabrous fruits in the genus *Dichaeopsis* (Pfitzer, 1888), eventually reduced to sectional rank by Kuntze in 1903. Cogniaux (1906) retained the single genus *Dichaea*, dividing it into four sections on the basis of leaf articulation and fruit vestiture characteristics: *Eudichaea* for the taxa provided with persistent leaves and muricate fruits, *Dichaestrum* for the species with persistent leaves and glabrous fruits, *Dichaeopsis* for species with articulate leaves and glabrous ovary, and *Pseudodichaea* for the taxa with deciduous leaves and muricate ovary. In the first synopsis of the Dichaeinae,

Schlechter (1914) accepted Pfitzer's view about the existence of two separate genera within the subtribe, adopting the generic name *Epithecia* Knowl. & Westc. over *Dichaeopsis* for all the species with nonarticulate leaves. In 1923, Kränzlin published the first systematic monograph on *Dichaea*, accepting sections *Eudichaea* Cogn. (including sect. *Dichaeastrum*) and *Dichaeopsis* (Pfitz.) Cogn. and creating sect. *Maxillariopsis* for a group of species currently assigned to *Maxillaria* or some closely related genus. In 1987, James P. Folsom produced the first modern taxonomic revision of *Dichaea* section *Dichaea* (Folsom, 1987). Among the species with persistent leaves, Folsom circumscribed sect. *Dichaea* as those taxa provided with a muricate ovary, implicitly accepting the segregation of the species with smooth ovaries in sect. *Dichaeastrum*. He also excluded from his study the species allied to *D. hystricina*, which he suggested needed recognition at the sectional level. In his generic treatment of Dichaeinae, Senghas accepted *Dichaea* with two subgenera, formally validating subgenus *Epithecia* (Senghas, 1995). Recent studies by Neubig and collaborators at the University of Florida, based on molecular data, supported *Dichaea* as a monophyletic genus, with a monophyletic section *Pseudodichaea* and a highly polyphyletic section *Dichaeopsis* (Neubig, 2005; Neubig et al., 2005, 2009).

Key to the Species of *Dichaea*

1. Plants with articulate leaves, eventually deciduous; peduncle usually straight; hypochile of lip glabrous 2
1a. Plants with persistent leaves, rotting in place; peduncle usually geniculate; hypochile of lip frequently ciliate along margins . . . . . (sect. *Dichaea*) 13
2. Ovary glabrous 3
2a. Ovary muricate . . . . . (sect. *Pseudodichaea*) 6
3. Stems flattened; roots produced only at base of stem; leaves ovate-elliptic, >7 mm wide; plants often glabrous 4
3a. Stems terete; roots basal and caulinar (the latter often cryptic within leaf sheaths); leaves narrowly ligulate, <5 mm wide; plants never glabrous 5
4. Plants spreading to pendent; mature leaves <25 mm long; inflorescences produced in succession; flowers greenish white, variously spotted/blotched with purple-red; petals much wider than sepals . . . . . *D. panamensis*
4a. Plants erect; mature leaves >40 mm long; inflorescences produced simultaneously; flowers ivory white; petals smaller than sepals . . . . . *D. glauca*
5. Leaves <5 cm long; lateral sepals widely ovate-lanceolate, asymmetrical; lip to 4 mm long, clawed, the hypochile subquadrate from an abruptly rounded base; column 1.5 mm long . . . . . *D. gracillima*
5a. Leaves >7 cm long; lateral sepals elliptic, symmetrical; lip >7 mm long, sessile, the hypochile gradually obcuneate; column 4–5 mm long . . . . . *D. trulla*
6. Plants small, with leaves <40 mm long and 7 mm wide; flowers membranaceous, spreading; margins of sepals and petals glabrous 7
6a. Plants large, with leaves >50 mm long and 10 mm wide; flowers fleshy, not completely spreading; margins of sepals and petals ciliate 11
7. Stems suberect to erect, becoming arcuate with age; flowers fragrant; sepals long-acuminate; epichile as wide as long; infrastigmatic ligule glabrous 8
7a. Stems pendent; flowers faintly fragrant or scentless; sepals acute to shortly acuminate; epichile much wider than long; infrastigmatic ligule apically pubescent 9
8. Flowers ivory white, the stigmatic rim pale rose; flowers boldly blotched with purple; lateral lobes of the epichile triangular . . . . . *D. lankesteri*
8a. Flowers pale pink, spotted purple at the base of sepals and petals, the lip apically rose, the stigmatic rim purple; lateral lobes of the epichile falcate . . . . . *D. amparoana*
9. Leaves >4 (to 7) mm wide; flowers sparsely and finely spotted with pink; epichile truncate, the lateral lobes to 1.5 mm long . . . . . *D. elliptica*
9a. Leaves <3 mm wide; flowers concolorous white or boldly blotched with purple; the epichile obtuse to acute, the lateral lobes 2–3 mm long 10
10. Flowers white; sepals <6 mm long; lip clawed, 4.5 × 6.0 mm when spread, the lateral lobes rounded *D. gomez-lauritoi*
10a. Sepals and petals greenish white blotched with purple, sometimes solidly purple; sepals >6.5 mm long; lip sessile, 6.5 × 7–8.0 mm when spread, the lateral lobes acuminate . . . . . *D. acroblephara*
11. Lateral lobes of lip <2.5 mm long, oblong from obtuse angles; ligule of column subquadrate, truncate or bifid; petals sublanceolate, acute, widest basally; flowers ivory white with greenish apices . . . . . *D. fragrantissima* ssp. *eburnea*
11a. Lateral lobes of lip >2.5 (to 6) mm long, reflexed, acuminate; ligule of column triangular; petals ovate to obovate, widest distally; flowers green marked with red-purple 12
12. Petals oblong-ovate, widest near middle, acute; claw of lip ligulate, 1–3 mm wide distally, with a distinct callus at base; ligule of column porrect; sepals and petals marked with lines basally . . . . . *D. morrisii*
12a. Petals distinctly obovate, widest above middle, apiculate; claw of lip broadly obovate, 6–8 mm wide distally, without basal callus; ligule of column deflexed; sepals and petals usually blotched, rarely solid green . . . . . *D. globosa*
13. Ovary glabrous 14
13a. Ovary provided with distinct, variously shaped trichomes 15
14. Plant laxly pendent, the stems rarely branching, the leaves brownish green, undulate along margins; flowers campanulate, pale green, unspotted; lip anchor-shaped, with a central, low keel at base . . . . . *D. viridula*

14a. Plant creeping, the stems freely branching, the leaves medium green, with flat margins; flowers spreading, greenish white, spotted violet; lip ovate, with two lateral, basal calli . . . . . *D. tuerckheimii*
15. Mature plants small, <20 cm long; margins of the leaves entirely ciliate; hypochile provided with two lateral, rounded knobs . . . . . *D. hystricina*
15a. Mature plants medium to large, >20 cm long; margins of leaves glabrous, or minutely ciliate only in apical portion; hypochile variously shaped, but never with lateral knobs at base 16
16. Stems terete, the sheaths tightly clasping 17
16a. Plants usually distinctly pendent, the stems mostly oriented downward, blanketing tree trunk; stems flattened, the sheaths loose; leaves thin to subcoriaceous 19
17. Plants pendent, the stems pointing downward; leaves thin-textured; petals obovate . . . . . *D. acostae*
17a. Plants often creeping, the stems developing in all directions along tree trunk; leaves coriaceous to succulent; petals ovate to broadly ligulate 18
18. Roots <0.5 mm in diam.; leaves coriaceous; base of hypochile rounded, disk-shaped . . . . . *D. trichocarpa*
18a. Roots 1 mm in diam.; leaves succulent; base of lip cuneate . . . . . *D. squarrosa*
19. Apex of pendent stem upcurving; leaves thin-textured; flowers mostly produced below foliage; peduncle straight; lip subentire . . . . . *D. pendula*
19a. Apex of pendent stem not upcurving; leaves subcoriaceous; flowers always produced above foliage; peduncle geniculate; lip with distinct lateral lobes 20
20. Petals obovate 21
20a. Petals ovate to lanceolate-elliptic 23
21. Leaves >2 cm long; sepals abaxially aculeate; lip upcurved toward column; ligule retrorse . . . . . *D. dammeriana*
21a. Leaves <1 cm long; sepals abaxially glabrous; lip straight; ligule pointing forward 22
22. Mature plants forming intricate mats, the stems highly branching; hypochile subacute, adaxially plain . . . *D. obovatipetala*
22a. Mature plants long, pendent, the stems rarely branching; hypochile subtruncate, minutely apiculate, adaxially provided with low tubercles among the main veins toward the apex . . . . . *D. sarapiquinsis*
23. Column without infrastigmatic ligule . . . . . *D. eligulata*
23a. Column with a ligule projecting from the lower lobe of the stigma 24
24. Leaves with distinct commissural veins between main longitudinal veins 25
24a. Leaves without distinct commissural veins 26
25. Leaves medium green with 2–3 commissural veins; stems freely branching, plants forming mats; hypochile obcuneate . . . . . *D. costaricensis*
25a. Leaves dark olive-brown with many commissural veins; stems not branching; hypochile with distinct shoulders . . . . . *D. filiarum*
26. Leaves olive brown, mostly retrorse; pedicel to 20 mm long; ligule bifid at apex . . . . . *D. oxyglossa*
26a. Leaves medium green, spreading; pedicel to 14 mm long; ligule entire, acute to truncate 27
27. Flowerswith sepals and petals gray-orange, marked purple; lateral lobes of epichile spreading; ligule truncate . . . . . *D. poicillantha*
27a. Flowers with sepals and petals greenish white, often marked violet; lateral lobes of epichile retrorse; ligule acute 28
28. Leaves widely elliptic, usually overlapping; sepals spotted violet; hypochile with distinct shoulders . . . . *D. cryptarrhena*
28a. Leaves lanceolate-elliptic, not overlapping; sepals mostly concolorous, or with a few spots near the base; hypochile obcuneate . . . . . *D. similis*

Dichaea acostae Schltr., Repert. Sp. Nov. Regni Veg. Beih. 19: 306. 1923. Type: Costa Rica. [Alajuela:] Umgebung von San Ramón, im Jahre 1921, *G. Acosta s.n.* [holotype, B, destroyed; isotype, designated as the lectotype by Pupulin (2007), AMES]. Figure 30 (Voucher: *Acosta s.n.*, AMES 40542).

Epiphytic, cespitose **herbs** to 30 cm long. **Roots** basal, filiform, flexuous, glabrous. *Stems* terete, decumbent to pendent, rarely branching, 6–30 cm long, 0.2–0.3 cm wide across conduplicate sheaths. **Leaves** spaced along stem, spreading to retrorse, 8–10 × 3.2–4.0 mm, narrowly elliptic-oblong, apiculate; sheaths clasping, 5–6 × 4–5 mm. **Inflorescence** solitary, 1-flowered, subpatent, 10 mm long, provided with basal bracts. **Floral bract** double, the outer bract ovate-cucullate, ca. 2 mm long, the inner bract linear, ca. 2 mm long. **Ovary** 1.75 mm long, densely muricate. **Flower** small for the genus, not completely spreading, glabrous, blotched with violet. **Dorsal sepal** narrowly lanceolate, acute, 3-nerved, 5 × 1 mm. **Lateral sepals** obliquely narrowly lanceolate, acute to subacuminate, 3-nerved, 5 × 1.2 mm. **Petals** narrowly oblong, shortly acuminate, 4.7 × 1.5 mm. **Lip** 3-lobed, anchoriform, clawed, 4.0 × 5.5–6.0 mm when spread, the claw hemielliptic-obcuneate, 2.0 mm long, 2.5 mm wide apically, the epichile transversely elliptic, rounded, subapiculate, 2.0 × 3.5 mm, the lateral lobes linear-ligulate, rounded, spreading, 1 mm long, 0.4 mm wide at the base. **Column** 2 mm long; the clinandrium irregularly crenulate; ligule linear, minutely ciliate, 0.5 × 0.3 mm. **Pollinia** unknown.

The description was prepared from the original protologue, the drawings of the holotype, and an isotype fragment.

DISTRIBUTION—Known only from Costa Rica.

ECOLOGY—*Dichaea acostae* is probably a uncommon epiphyte in premontane rain forests, ostensibly on the Pacific watershed of the Cordillera de Tilarán in Costa Rica, at 1000–1100 m elevation. Flowering occurs at least from November to January.

DISTINGUISHING FEATURES—The terete stems, the small flowers (among the smallest of Costa Rican species of *Dichaea*), and the oblong petals, wider in the distal portion, are uncommon and diagnostic of the species.

Dichaea acroblephara Schltr., Repert. Sp. Nov. Regni Veg. Beih. 19: 71. 1923. Type: Costa Rica. [San José: Moravia,] San Jerónimo, blühend im Mai 1921, *C. Wercklé 22* (syntype, B, destroyed). Carillo [Carrillo], ca. 400 m, blühend im Juni 1909, *A. Brade & C. Brade 1173* (syntype:

B, destroyed; lectotype, tracing of Schlechter's drawing of syntype, AMES). *Dichaea standleyi* Ames, Schedul. Orchid. 9: 57. 1925. Type: Costa Rica. Limón: vicinity of Guápiles, 300–500 m, March 12, 13, 1924. On tree; flowers white and purple red. *P. C. Standley 37440* (holotype, AMES). Figure 23 (Voucher: *Pupulin 4851*, JBL-Spirit).

Epiphytic, cespitose **herbs** to to 25 cm long. **Roots** filiform, exposed at the base, hidden by the leaf sheaths along the stem, 0.5–0.6 mm in diam. **Stems** compressed, suberect, becoming pendent with age, 10–25 cm long, 0.2–0.3 cm wide across conduplicate sheaths. **Leaves** articulate with the sheaths, widely spaced along stem, spreading, subcoriaceous, green, 18–30(35) × 2–3 mm, ligulate to narrowly elliptic, acute to acuminate, the apical margins minutely pectinate-ciliate; sheaths clasping, 8–10 × 5–6 mm. **Inflorescence** solitary, 1-flowered, emerging below foliage, subpatent to pendent, to 18 mm long, provided with a basal, cylindrical bract, 3 mm long. **Floral bract** double, the outer bract widely ovate, 5 × 4 mm, the inner bract linear, acute, 4 mm long. **Pedicel** cylindric, less than 1 mm long. **Ovary** 1.3–1.5 mm long, densely muricate. **Flower** spreading, the sepals and petals greenish white blotched with purple, sometimes solidly purple, the blotches restricted to the external half of the lateral sepals, the lip white, sparsely spotted with violet at the base, the column white, marked with violet along the basal wings and the margins of the stigma; no fragrance detected. **Dorsal sepal** erect, concave, lanceolate-elliptic, subacuminate, 6.5–8.0 × 2.5–2.8 mm. **Lateral sepals** obliquely ovate-lanceolate, concave, subacuminate, 7–9 × 3.2–3.5 mm. **Petals** elliptic-lanceolate, acute to subacuminate, 7.0–7.5 × 2.3–2.5 mm. **Lip** 3-lobed, anchoriform, sessile, 5.5–6.5 × 7–8 mm when spread, the hypochile obcuneate, 2.7–3.8 mm long, 2.5 mm wide apically, the epichile widely triangular, shortly apiculate, sometimes microscopically ciliate toward apex, 3.2 × 4.0 mm, the lateral lobes narrowly triangular, acuminate, spreading to reflexed, 1.8–2.5 × 0.8–1.0 mm. **Column** erect, 3 mm long, with distinct foot, provided at the base with elliptic, rounded, ciliate wings; the clinandrium shortly cucullate, irregularly erose; ligule oblong, thickened toward the papillose-hirsute apex, 1.2 × 0.8 mm. **Anther cap** subrheniform, emarginate, 2-celled. **Pollinia** 4, in 2 superposed pairs of different sizes, on a broadly obtriangular, rounded stipe; viscidium elliptic-peltate. **Fruit** an elliptic, densely muricate capsule.

DISTRIBUTION—Known only from Costa Rica.

ECOLOGY—A rather frequent epiphytic plant, *D. acroblephara* grows in shade in tropical to premontane wet forests on the Caribbean watershed of the Cordillera Central and the Cordillera de Talamanca, at 100–1300 m elevation. Flowering occurs from February to September.

DISTINGUISHING FEATURES—The deciduous leaves, the sepals and petals strongly blotched with violet on external half of the lateral sepals, and the white lip characterize the species.

Dichaea amparoana Schltr., Repert. Sp. Nov. Regni Veg. Beih. 19: 71. 1923. Type: Costa Rica. [San José: Moravia,] San Jerónimo, 1400 m, im Jahre 1922, *C. Wercklé 103* (holotype, B, destroyed; lectotype, tracings of Schlechter's drawings of the holotype, AMES). Figure 20 (Voucher: *Bogarín 679*, JBL-Spirit).

Epiphytic, cespitose **herbs** to 20 cm long. **Roots** filiform, exposed at the base, hidden by the leaf sheaths along the stem, ca. 0.5 mm in diam. **Stems** compressed, suberect to erect, 10–20 cm long, 0.35–0.55 cm wide across conduplicate sheaths. **Leaves** articulate with the sheaths, densely spaced along stem, suberect to spreading, thin-textured herbaceous, green, 20–35(50) × 1.5–5.0(7.0) mm, linear-lanceolate, acute, the apical margins sometimes minutely serrulate-ciliate; sheaths clasping to slightly inflated, to 8.0 × 3.5 mm. **Inflorescence** solitary, 1-flowered, emerging below foliage, patent to suberect, to 14 mm long, provided with 2 basal, cucullate bracts 3 mm long. **Floral bract** double, the outer bract widely ovate, cucullate 5.5 × 4 mm, the inner bract narrowly linear-elliptic, acute, 4 mm long. **Pedicel** cylindric, less than 1 mm long. **Ovary** 1.0–1.2 mm long, densely muricate. **Flower** spreading, the sepals and petals glabrous, pale rose, minutely spotted with purple at the base, the lip rose-purple, fading white at the base, the column rose-purple, marked with purple along margins of the stigma; no fragrance detected. **Dorsal sepal** erect, slightly concave, lanceolate, subacuminate, 7–9 × 2.5–3.0 mm. **Lateral sepals** obliquely ovate-lanceolate, concave, acuminate, 7–10 × 3.5–4.0 mm. **Petals** narrowly lanceolate, acuminate, 6–8 × 2.0–2.5 mm. **Lip** 3-lobed, anchoriform, clawed, 6.0–7.5 × 5.0–6.5 mm when spread, the claw obcuneate, 2.5–3.0 mm long, 3.5–4.0 mm wide apically, the epichile widely triangular, acuminate, 4.5 × 4.0 mm, the lateral lobes narrowly falcate-triangular, acute, retrorse, 2 × 1 mm. **Column** suberect, 2.5 mm long, with distinct foot, provided at the base with elliptic, rounded, glabrous wings; the clinandrium subcucullate, entire; ligule widely transversely elliptic, glabrous, oblong, thickened toward the papillose-hirsute apex, 0.8 × 1.8 mm. **Anther cap** subrheniform, the margins sparsely ciliate, 2-celled. **Pollinia** 4, in 2 superposed pairs of different sizes, on a broadly obtriangular, rounded stipe; viscidium elliptic-peltate. **Fruit** an elliptic, densely muricate capsule.

DISTRIBUTION—Known only from Costa Rica.

ECOLOGY—*Dichaea amparoana* is an uncommon plant growing epiphytically or semiterrestrially in humus in premontane to submontane wet forests on the Caribbean watershed of the Cordillera Central, at 1300–1800 m elevation. Flowering occurs at least from January to March.

DISTINGUISHING FEATURES—This species is distinguished by the suberect habit, the densely foliated stem provided with rather short leaves, the flowers tinged by pale rose and spotted with purple, the lip with falcate-retrorse apical lobes, and the column with a glabrous, long, obtuse infrastigmatic ligule.

Dichaea costaricensis Schltr., Repert. Sp. Nov. Regni Veg. Beih. 19: 73. 1923. Syntypes: Costa Rica. [San José: Carrillo,] La Palma (?), blühend im September 1921, *C. Wercklé 77* (B, destroyed); Carrillo, blühend im Juni 1921, *C. Wercklé 39* (B, destroyed); [Moravia,] San Jerónimo, 14,000 [1400] m, auf der pazifischen Seite, im Jahre 1920, *C. Wercklé s.n.* (B, destroyed); lectotype, tracing of Schlechter's drawing of a syntype, collection data not noted: AMES). Figure 38 (Voucher: *Pupulin 4797*, USJ).

Epiphytic, cespitose **herbs** to 20 cm long. **Roots** exposed basally, hidden by leaf sheaths along the stem, flexuous, glabrous, ca. 1 mm in diam. **Stems** subterete, scandent to pendent, freely branching, 6–20 cm long, 0.3–0.5 cm wide across conduplicate sheaths. **Leaves** closely spaced along stem, spreading, green, thick-herbaceous, sparsely cross-veined, 4–10 × 2–5 mm, elliptic-lanceolate, obtuse to rounded, minutely apiculate, the apical margins microscopically fimbriate; sheaths tightly clasping the stem, to 4 × 3 mm. **Inflorescences** solitary, 1-flowered, emerging above foliage, patent to subpendent, 0.4–0.7 cm long, provided at the base with 2–3, tubular, hyaline bracts, about 0.5 cm long. **Floral bract** double, the outer bract triangular ovate, acuminate, 3.0 × 3.5 mm, the inner bract narrowly lanceolate-oblong, 3.5 mm long. **Pedicel** cylindric, less than 1 mm long. **Ovary** long muricate, 1 mm long. **Flower** ringent, with sepals and petals thick, grayish cream to pale green-yellow, blotched and spotted with red-purple, the sepals minutely tuberculate externally, the lip white, barred and blotched red-purple, the column white, marked with purple on the margins of wings. **Dorsal sepal** elliptic-lanceolate, acute, with a rounded apicule, 7.5–8.5 × 3.0–3.8 mm. **Lateral sepals** obliquely narrowly elliptic-lanceolate, asymmetrical, rounded-acute, 8.7–9.5 × 3.2–4.0 mm. **Petals** elliptic-oblong to oblanceolate, subacute to obtuse, 7.0–7.8 × 3.2–3.6 mm. **Lip** 3-lobed, subsessile, 8.5 × 7.0 mm when spread, the hypochile widely obcuneate-elliptic, 4.5 mm wide apically, the epichile triangular, acute, the lateral lobes triangular, acute, spreading, decurrent on the lamina, 1.5 × 0.9 mm. **Column** erect, 4.5 mm long, provided with widely elliptic, flattened, ciliate wings, the clinandrium minutely erose; ligule widely triangular, acute or subobtuse, glabrous, 0.7 × 1.1 mm. **Anther cap** transversely ovate, 2-celled. **Pollinia** 4, in 2 superposed pairs of slightly different sizes, on a narrowly obtrian-

gular, rounded stipe; viscidium elliptic. **Fruit** an elliptic capsule, muricate.

DISTRIBUTION—Known from Costa Rica and western Panama.

ECOLOGY—The species is a rather frequent epiphyte in tropical wet, premontane wet, and cloud forest on the Caribbean drainage of the Guanacaste, Tilarán, and Central Volcanic chains, at 100–1200 m elevations. Flowering occurs year-round.

DISTINGUISHING FEATURES—*Dichaea costaricensis* may be recognized by the small, scandent plants, highly branching and often forming compact mats; the thick-herbaceous leaves with scattered cross-venation (a character shared, in Costa Rica, only with *D. filiarum*); and the flowers with grayish cream base and red-purple pigmentation and the perianth parts subcoriaceous.

Dichaea cryptarrhena Rchb.f. ex Kraenzl., Pflanzenr. 4(50): 36. [March] 1923. Type: Costa Rica. Without collecting data, *A. R. Endrés 28* (holotype, W-R). *Dichaea verrucosa* Ames & C. Schweinf., Schedul. Orchid. 8: 83. 1925. Type: Costa Rica. [Cartago: Turrialba,] La Fuente, Peralta, Sep. 1923, *C. H. Lankester 918* (holotype, AMES). *Dichaea ovatipetala* Schltr., Repert. Sp. Nov. Regni Veg. Beih. 19: 266. [November] 1923. Type: Costa Rica. [Alajuela:] Bois humides à San Pedro de San Ramón, 1150 m, Nov. 1921, *A. M. Brenes 196* (holotype, B, destroyed; lectotype, AMES). Figure 44 (Voucher: *Pupulin 3595*, JBL-Spirit).

Epiphytic, cespitose **herbs** to 80 cm long. **Roots** exposed basally, hidden by leaf sheaths along the stem, flexuous, glabrous, ca. 0.4 mm in diam. **Stems** flattened, pendent, occasionally growing erect appressed to the bark, rarely branching, 15–80 cm long, 0.4–0.7 cm wide across conduplicate sheaths. **Leaves** closely spaced along stem, mostly overlapping, spreading, green, thick-herbaceous, 10–15 × 4–8 mm, elliptic to elliptic-ovate, widely obtuse to rounded, minutely apiculate, the apical margins microscopically fimbriate; sheaths tightly clasping the stem, to 10 × 6 mm. **Inflorescences** solitary, 1-flowered, emerging above foliage, patent, the peduncle geniculate, 0.8–1.4 cm long, provided at the base with tubular, papery bracts, 0.3 cm long. **Floral bract** double, the outer bract infundibuliform, ovate, acute, 3.0 × 3.2 mm, the inner bract narrowly lanceolate, acute, 2.5 mm long. **Pedicel** cylindric, to 3 mm long. **Ovary** long muricate, 2 mm long. **Flower** spreading, with sepals and petals greenish white, finely spotted with violet, the sepals externally tuberculate, the lip white, spotted with violet at the base, the apex evenly violet, the column white, marked with purple on the wings and finely spotted with violet along the sides. **Dorsal sepal** elliptic-lanceolate, acute, 8.5–11.0 × 3.8–4.0 mm. **Lateral sepals** obliquely elliptic-lanceolate, acute to shortly acuminate, 8.3–10.0 × 3.5–3.7 mm. **Petals** subfalcate, elliptic-lanceolate, somewhat asymmetrical, shortly acuminate, 8.0–9.5 × 3.6–3.8 mm. **Lip** 3-lobed, clawed, 7 × 6 mm when spread, the claw linear, basally thickened-subterete, the hypochile subquadrate, producing distinct, ciliate shoulders, 4 mm wide apically, the epichile widely ovate-elliptic, acuminate, the lateral lobes narrowly triangular-acuminate, retrorse, 1.3 × 0.6 mm. **Column** suberect, 3.5 mm long, provided with narrowly elliptic, ciliate wings, the clinandrium subpetaloid, irregularly erose; ligule narrowly triangular, acute, tomentose, 2 × 1 mm. **Anther cap** transversely subrectangular, 2-celled. **Pollinia** 4, in 2 superposed pairs of different sizes, on a obtriangular, obtuse stipe; viscidium elliptic. **Fruit** an elliptic capsule, muricate.

DISTRIBUTION—Distributed from Guatemala to Panama and Venezuela.

ECOLOGY—The species is a common and widespread epiphyte, found in premontane wet to montane cloud forest on the Caribbean drainage of the Cordilleras of Tilarán and Central Volcanic, and on the watersheds of both the Guanacaste and Talamanca chains, at 750–2000 m elevation. Flowering occurs mostly from April to June.

DISTINGUISHING FEATURES—The simple stems, branching at the apex only after destruction of the stem, and the widely elliptic, usually overlapping, rounded, grass-green leaves are useful diagnostic characters to distinguish *Dichaea cryptarrhena* even in sterile specimens. It can be distinguished from the closely related *D. poicillantha* Schltr. by the white to greenish white flowers (vs. grayed orange) and from *D. similis* Schltr. by the much larger leaves and density of violet markings on sepals and petals (reduced or absent in *D. similis*). Although many names have been applied to this species, it is uniform and unmistakable in both vegetative architecture and flower morphology.

Dichaea dammeriana Kraenzl., Pflanzenr. 4(50): 41. 1923. Type: syntypes: Colombia. Sierra Nevada de Santa Marta, *H. Smith 2773* (AMES, US, NY); Costa Rica. Without specific locality, 1868, *A. R. Endrés 66* (lectotype, AMES; isolectotypes: W-R). Figure 34 (Voucher: *Pupulin 3732*, JBL-Spirit).

Epiphytic, cespitose **herbs** to 40 cm long. **Roots** exposed basally, hidden by leaf sheaths along the stem, flexuous, glabrous, ca. 0.4 mm in diam. **Stems** slightly flattened, pendent, usually branching only after destruction of the stem apex, 12–40 cm long, 0.3–0.4 cm wide across conduplicate sheaths. **Leaves** widely spaced along stem, spreading, perpendicular to the stem, olive-green to medium brown, thick-herbaceous, 20–27 × 3–6 mm, lanceolate, becoming ligulate through the reflexion of lateral margins, acute, narrowly mucronate, the lateral margins recurved, the apical margins hispid-ciliate; sheaths loosely clasping the stem, to 8 × 7 mm. **Inflorescences** solitary, 1-flowered, emerging above foliage, patent to suberect, 0.8–1.2 cm long, the peduncle geniculate, provided at the base with 2 tubular, acute, papery bracts, 0.2 cm long. **Floral bract** double, the outer bract suborbicular, obtuse, 4.0 × 3.7 mm, the inner bract narrowly lanceolate, acute, 3.5 × 0.8 mm. **Pedicel** cylindric, ca. 1 mm long. **Ovary** long muricate, 1 mm long. **Flower** ringent to spreading, with sepals and petals externally echinate-tuberculate, greenish yellow, immaculate, the petals paler and spotted with violet, the lip greenish white to white, spotted with violet-purple, the column white, blotched with purple along the wings, the foot and the apex of stigma. **Dorsal sepal** elliptic-oblanceolate, acute, 9.5–10.5 × 4.5–5.2 mm. **Lateral sepals** obliquely elliptic-oblanceolate, slightly asymmetrical, acute to acuminate, 9–10 × 4.0–4.5 mm. **Petals** obovate, obtuse to subrounded, 8.0–9.5 × 6.5–7.0 mm. **Lip** 3-lobed, clawed, 6.5–7.5 × 8–11 mm when spread, the claw widely obcuneate, to 7 mm wide at apex, basally thickened-subtriangular, the epichile widely triangular, obtuse, the lateral lobes triangular, subacute, 2 × 2 mm. **Column** erect, dorsiventrally compressed, 5.5 mm long, provided with narrowly elliptic, ciliate wings, the clinandrium entire to minutely erose; ligule triangular, obscurely retuse, reflexed, glabrous, 1 × 2.5 mm. **Anther cap** ovate, cucullate, 2-celled. **Pollinia** 2 or 4, in superposed pairs of different sizes, on a narrow, sublinear-clavate, truncate stipe; viscidium narrowly ovate. **Fruit** an elliptic capsule, long echinate-muricate.

DISTRIBUTION—Known from Nicaragua to Venezuela and Ecuador.

ECOLOGY—A widespread but uncommon epiphyte, *D. dammeriana* is restricted in Costa Rica mostly to shaded spots in pristine vegetation in premontane wet to submontane cloud forest on the Caribbean drainage of the Tilarán and Central Volcanic chains and on both watersheds of the Cordillera of Talamanca, at 700–1400 m elevation. Flowering occurs year-round.

DISTINGUISHING FEATURES—*Dichaea dammeriana* is unmistakable in both vegetative and floral characters. The truly pendulous, rarely branching plants have well-spaced, long, and narrow leaves, perpendicular to the axis of the stem and

characteristically olive-green to medium brown, a color shared in Costa Rica only with *D. filiarum* Pupulin. The flowers of *D. dammeriana* are distinctive in having long and numerous stiff and pointed verrucae on the abaxial surface of both the sepals and petals, particularly along the midrib, and for the upcurved, concave lip, which is held against the erect column.

Dichaea eligulata Folsom, Orch. Dig. 58: 185. 1994. Type: Costa Rica. Locality of original collection unknown, growing on trees at Las Cruces [Wilson] Botanical Garden, probably collected in Costa Rica or adjacent Panama, 8 Jul. 1981, *J. P. Folsom 10261* (holotype, CR; isotype, TEX). Figure 37 (Voucher: *Pupulin 2718*, JBL-Spirit).

Epiphytic, cespitose **herbs** to 20 cm long. **Roots** exposed basally, mostly hidden by leaf sheaths along the stem, flexuous, glabrous, ca. 0.4 mm in diam. **Stems** flattened, scandent to pendent, rarely branching, 8–20 cm long, 0.2–0.3 cm wide across conduplicate sheaths. **Leaves** closely spaced along stem, not overlapping, reflexed, green, thick-herbaceous, 6–8 × 3–4 mm, lanceolate-elliptic, obtuse to subacute, long-apiculate, the apical margins minutely crenulate; sheaths clasping the stem, to 7 × 4 mm. **Inflorescences** solitary, 1-flowered, emerging above foliage, patent, the peduncle geniculate, 1.2–1.5 cm long, provided at the base with 2–3 tubular, acuminate bracts, ca. 0.4 cm long. **Floral bract** double, the outer bract widely ovate, acuminate, 2.3 × 2 mm, the inner bract narrowly elliptic-lanceolate, acute, 2.2 mm long. **Pedicel** cylindric, to 1.5 mm long. **Ovary** muricate, 1.5 mm long. **Flower** spreading, with sepals and petals greenish white, spotted and blotched with violet, the spots restricted to the external half of lateral sepals, the sepals externally sparsely tuberculate, the lip white, spotted with violet, the apex violet, the column greenish white, ventrally marked with purple at the base, on the margins and along the rim of the stigma. **Dorsal sepal** elliptic-lanceolate, acute, 7–9 × 3.0–3.5 mm. **Lateral sepals** obliquely elliptic-lanceolate, acute to shortly acuminate, 7–8 × 3.0–3.5 mm. **Petals** elliptic to elliptic-lanceolate, obtuse to subacute, shortly acuminate, 6.0–7.5 × 3.0–3.5 mm. **Lip** 3-lobed, shortly clawed, cupped, upcurving, 5 × 8 mm when spread, the claw basally thickened-subterete, the hypochile obcuneate-elliptic with indistinct, ciliate shoulders, 4 mm wide apically, the epichile widely ovate-elliptic, obtuse, the lateral lobes triangular, acute, spreading, 2 × 1 mm. **Column** erect, 3.5 mm long, provided with narrow, not protruding, straight, ciliate, ridge-like wings, the clinandrium strongly erose-lacerate; ligule almost absent, reduced to a rounded, glabrous extension of the basal stigma rim. **Anther cap** transversely subrectangular-obovate, 2-celled. **Pollinia** 4, in 2 superposed pairs of different sizes, on a ligulate, acute stipe; viscidium elliptic.

DISTRIBUTION—The species is distributed from Costa Rica to, possibly, western Panama.

ECOLOGY—An apparently rare epiphyte, *D. eligulata* is known in Costa Rica only from the premontane wet forests of the southeastern mountain chains facing the Pacific, at 400–800 m elevation. Flowering occurs from July to October.

DISTINGUISHING FEATURES—Among species of sect. *Dichaea*, *D. eligulata* may be easily recognized by the deeply erose-lacerate clinandrium and the infrastigmatic ligule reduced to the basal, rounded, glabrous portion of the protruding rim of the stigma. The lip of *D. eligulata* is characteristically concave and upcurved, a feature found in Costa Rica only in *D. dammeriana*, a distantly related species.

Dichaea elliptica Dressler & Folsom, Lankesteriana 3: 25. 2002. Type: Panama. Coclé: Aserradero El Copé, ca. 8 km N of El Copé, 800–900 m, 10 Apr. 1977, *R. L. Dressler 5641* (holotype, MO; isotype, PMA). Figure 21 (Voucher: *Pupulin 4945*, CR).

Epiphytic, cespitose **herbs** to 22 cm long. **Roots** filiform, sometimes puberulent, exposed at the base, the caulinar roots hidden by the leaf sheaths, 0.5–0.8 mm in diam. **Stems** compressed, suberect, becoming spreading-pendent with age, 9–22 cm long, 0.2–0.3 cm wide across conduplicate sheaths. **Leaves** articulate with the sheaths, widely spaced along stem, subspreading, thinly coriaceous, medium green, 13–28 × 3–7 mm, elliptic to lanceolate elliptic, acute to acuminate, the apical margins minutely pectinate-ciliate; sheaths clasping, 10–15 × 4–5 mm. **Inflorescence** solitary, 1-flowered, emerging below foliage, subpatent to pendent, to 14 mm long, provided with a basal, cylindrical, apically slightly dilated bract, 3.5 mm long. **Floral bract** double, the outer bract broadly ovate, acuminate, 4 × 3.5 mm, the inner bract linear, acute, 3 mm long. **Pedicel** cylindric, ca. 2 mm long. **Ovary** 1.0–1.3 mm long, densely muricate, the trichomes long, flexuous. **Flower** spreading, the sepals and petals white to cream, finely speckled with purple-red, the spots mostly restricted to the external half of the lateral sepals, the lip white, sparsely flecked with purple-red, the column white, marked with violet-purple along the stigmatic margins and on ligule; no fragrance detected. **Dorsal sepal** erect, slightly concave, elliptic to lanceolate-elliptic, subacuminate, 6–8.0 × 2.3–2.8 mm. **Lateral sepals** obliquely ovate-elliptic, concave, subacuminate, dorsally subcarinate, 6–8.0 × 2.5–3.5 mm. **Petals** elliptic-lanceolate to (rarely) elliptic-obovate, acute, 5.0–6.5 × 2.1–2.5 mm. **Lip** 3-lobed, anchoriform, sessile, 4.0–5.5 × 6.5–7.0 mm when spread, the hypochile broadly obcuneate, 2.0–2.6 mm long, 1.7–2.0 mm wide apically, the epichyle transversely subtriangular-lunate, broadly obtuse to truncate, shortly apiculate, 2.0–2.3 × 6.5–7.0 mm, the distal margins sometimes microciliate, the lateral lobes narrowly triangular, subacuminate, spreading to reflexed, 0.6–0.8 × 0.4–0.5 mm. **Column** erect, 2.5–3.0 mm long, with a foot; the clinandrium shallow, entire; ligule triangular, acute-rounded, papillose at apex, 0.77 × 0.90 mm. **Anther cap** subreniform-cucullate, flattened, 2-celled. **Pollinia** 4, in 2 superposed pairs subequal in sizes, on a broadly obtriangular, rounded stipe; viscidium elliptic-peltate. **Fruit** an elliptic, densely muricate capsule.

DISTRIBUTION—Distributed from Nicaragua to Ecuador.

ECOLOGY—A widespread but uncommon epiphyte in shaded places in tropical to premontane wet forests on both watersheds of the main Costa Rican mountain chains, *D. elliptica* has been recorded at elevations from 100 to 1300 m. Flowering occurs mostly during the rainy season, from July to September, but sporadic flowering has been recorded also in February and May.

DISTINGUISHING FEATURES—*Dichaea elliptica* pertains to the group of small-habit taxa of the sect. *Pseudodichaea*, characterized in part by the small flowers finely spotted with red and the subtruncate to truncate lip, the epichile wider than long.

Dichaea filiarum Pupulin, Vanishing Beauty 1: 206–207. 2005. Type: Costa Rica. Cartago: Turrialba, Monumento Nacional Guayabo, 09°56′N, 83°43′W, ca. 800 m, premontane wet forest, epiphytic in the understory forest, 9 Aug. 2003, flowered in cultivation at Jardín Botánico Lankester, 8 Oct. 2003, *F. Pupulin 4944*, *M. Pupulin*, *C. Pupulin & H. León-Páez* (holotype, USJ). Figure 39 (Voucher: *Pupulin 4944*, USJ).

Epiphytic, cespitose **herbs** to 60 cm long. **Roots** filiform, basal, 0.5–0.7 mm in diam. **Stems** compressed, pendent, few from base, 20–60 cm long, 0.5–0.8 cm wide across conduplicate sheaths, rarely branching toward the apex. **Leaves** closely spaced along stem, spreading, thick-coriaceous, dark olive green, 12–18 × 6–8 mm, broadly lanceolate, the apex shortly acuminate, abaxially apiculate, the apical margins raggedly serrulate, curled backwards, with conspicuous cross-veining; sheaths clasping, 6–8 × 5–8 mm. **Inflorescences** solitary, 1-flowered, emerging above foliage, perpendicular to stem, to 13 mm long, provided with a basal, cylindrical bract, 4 mm long. **Floral bract** double, the outer bract widely ovate, 5.0 × 3.5 mm, the inner bract narrowly oblong, 7 mm long. **Pedicel** cylindric, 2 mm long. **Ovary** 2 mm long, muricate. **Flower** large for the section, usually not completely spreading, the sepals creamy white, slightly tinged with pale pink, abaxially cream, the dorsal sepal flecked pale purple-violet, the petals pale cream, flecked violet, the lip white, heavily

barred pale violet, the column white with violet wings; no fragrance detected. **Dorsal sepal** erect, concave, narrowly elliptic-lanceolate, acute, 12 × 4 mm. **Lateral sepals** obliquely lanceolate, concave, acute, 11 × 4 mm. **Petals** oblanceolate, incurved toward apex, subacute, 10 × 4 mm. **Lip** 3-lobed, anchoriform, clawed, 8.5 × 10 mm when spread, the claw 1.5 × 1.5 mm, the hypochile subquadrate, forming distinct shoulders, 4.0 × 4.5 mm, the epichile shortly acuminate, microscopically ciliate toward apex, 3.5 × 6.0 mm, laterally producing spreading to recurved, triangular-acuminate lobes, 2.5 × 0.8 mm. **Column** erect, 5 mm long, with distinct foot, the clinandrium cucullate, irregularly crenulate, provided with widely triangular, ciliate wings; ligule oblong, glabrous, 1.5 × 0.8 mm. **Anther cap** subquadrate, retuse, 2-celled. **Pollinia** 4, in 2 superposed pairs of different sizes, on an obtriangular, apiculate stipe with the margins incurved; viscidium elliptic. **Fruit** an elliptic capsule, densely muricate, 13 × 10 mm.

DISTRIBUTION—Known only from Costa Rica.

ECOLOGY—*Dichaea filiarum* is a widespread but infrequent epiphyte of shaded spots in tropical to premontane wet forests on the Caribbean side of the Central and Talamanca mountain chains, at 500–1200 m elevation. Flowering occurs during the rainy season, from April to October.

DISTINGUISHING FEATURES—*Dichaea filiarum* pertains to a group of truly pendent species of sect. *Dichaea* native to northern and western South America. Apart from *D. costaricensis*, which has a few cross-veins between the parallel longitudinal veins of the leaves, *D. filiarum* is the only Costa Rican species having conspicuous cross-veining in its leaf blades. The cream-white sepals, slightly tinged with pale pink on the inner side and cream abaxially, as well as the dorsal sepal and the petals flecked flecked violet, are good diagnostic characters for this species.

Dichaea fragrantissima ssp. **eburnea** Dressler & Pupulin, Novon 16: 340. 2006. Type: Costa Rica. Alajuela: San Ramón, Reserva Biológica A. M. Brenes, flowered in cultivation at Jardín Botánico Lankester, 7 Jul. 2003, *M. Blanco 513* (holotype, USJ). Figure 24 (Voucher: *Blanco 513*, CR).

Epiphytic, cespitose **herbs** to 30 cm long. **Roots** filiform, 0.7–1.0 mm in diam., exposed at the base of the stem, the caulinar roots completely hidden by the leaf sheaths. **Stems** compressed, simple, suberect, becoming pendent with age, 16–30 cm long, 1.3–1.9 cm wide across conduplicate sheaths. **Leaves** articulate with the sheaths, closely spaced along stem, spreading, thinly coriaceous, oblong, obtuse, retuse or apiculate, medium green, 3.5–7.3× 0.6–1.6 cm; sheaths loose, strongly complanate, ancipitous, 10–15 × 4–5 mm. **Inflorescence** solitary, 1-flowered, emerging below foliage, subpatent to pendent, 15–20 mm long, provided with 2 basal, cylindrical, clasping bracts, to 5 mm long. **Floral bract** double, the outer bract ovate-orbicular, acuminate11–14 × 8–14 mm, the inner bract lanceolate, ca. 11 × 2 mm. **Pedicel** cylindric, 1.5 mm long. **Ovary** 1.5–1.8 mm long, densely muricate. **Flower** ringent, ivory, with greenish apices, strongly scented. **Dorsal sepal** ovate-lanceolate, narrowly acute-acuminate, concave, dorsally subcarinate, the margins hispid-ciliate, 14–16 × 4.0–6.5 mm. **Lateral sepals** obliquely ovate-lanceolate, asymmetrical, concave, acute-acuminate, dorsally subcarinate, the margins hispid-ciliate, 14–15.0 × 5.5–7.0 mm. **Petals** ovate-lanceolate, narrowly acute-acuminate, the margins hispid-ciliate, 12–14 × 4–5 mm. **Lip** 3-lobed, sagittate, sessile, 10–14 × 5–6 mm when spread, the hypochile obcuneate, ca. 5.5 mm long, 4 mm wide apically, dorsally keeled or not; the epichile triangular, acute to subacuminate, 5–6 × 5–6 mm, the lateral lobes from rounded angles triangular-oblong, to 1.2 × 1.0 mm. **Column** erect, 3.5–4.0 mm long, with distinct foot, sometimes with a rounded callus between column foot and lip; the clinandrium shallow, irregularly erose; ligule subquadrate, shallowly emarginate, minutely papillose at apex, 1.5–2.0 × 1.5–2.0 mm. **Anther cap** subreniform-cucullate, flattened, 2-celled. **Pollinia** 4, rounded, in 2 superposed pairs of different sizes, on a broadly obtriangular, truncate stipe; viscidium peltate. **Fruit** an oblong-globose, muricate capsule ca. 18 × 15 mm.

DISTRIBUTION—*Dichaea fragrantissima* ssp. *eburnea* ranges at least from Nicaragua to Panama, but specimens from Guatemala are perhaps referable to this taxon.

ECOLOGY—A common epiphyte of mature vegetation, in shaded spots in tropical to premontane wet forests at elevations ranging from 400 to 1500 m, *D. fragrantissima* ssp. *eburnea* is apparently restricted to the Caribbean watershed of the Tilarán, Central Volcanic, and Talamanca mountain chains. Flowering mostly occurs during the dry season, from December through February, with a second flowering peak in June–July.

DISTINGUISHING FEATURES—This is the most common large *Dichaea* in Costa Rica, especially in wet forests on the Caribbean slope; the subspecies is characterized by the ivory flowers with greenish apices of the sepals.

Dichaea glauca (Sw.) Lindl., Gen. Sp. Orchid. Pl.: 209. 1833. *Epidendrum glaucum* Sw., Prodr.: 124. 1788. *Cymbidium glaucum* (Sw.) Sw., Nova Acta Regiae Soc. Sci. Uppsal. 6: 71. 1799. *Dichaeopsis glauca* (Sw.) Schltr., Beih. Bot. Centralbl. 36(2): 519. 1918. *Epithecia glauca* Schltr., Orchis 9: 26. 1915, *non* Knowles & Westc., 1838. Type: Jamaica. "Lectum in arboribus versus summum jugum Montium caeruleorum Jamaicae australis," *O. Swartz s.n.* (holotype: W). *Dichaea oerstedii* Rchb. f., Bonplandia 3: 219. 1855. *Epithecia oerstedii* (Rchb. f.) Schltr., Orchis 8: 101. 1914. *Dichaeopsis oerstedii* (Rchb. f.) Schltr., Beih. Bot. Centralbl. 36(2): 519. 1918. Type: Nicaragua. Am Vulcan El Viejo, A. S. *Oersted s.n.* (holotype, W). *Dichaea willdenowiana* Kraenzl., Engl. Pflanzenr. Orchid.-Monandr.-Pseudomonopod. IV, 50(83): 46. 1923. Syntypes: Mexico: Villa Alta de Bataza, *K. T. Hartweg 516* (W); Oaxaca, Jalapa, *H. C. Galeotti 5078* (W); without locality, *C. J. W. Schiede 45* (W); *K. T. Hartweg 46* (W). Figure 16 (Voucher: *Pupulin 2226*, CR).

Terrestrial or epiphytic, cespitose **herbs** to 55 cm long. **Roots** thick, produced only at the base of the stem, to 3.5 mm in diam. **Stems** compressed-ancipitous, erect, rarely becoming arcuate-pendent with age, 12–55 cm long, 0.3–0.4 cm wide across conduplicate sheaths. **Leaves** articulate with the sheaths, widely to closely spaced along stem, subspreading, thin-herbaceous, glaucous green, 25–48(60) × 7–13 mm, oblong-elliptic, acute, shortly mucronate; sheaths clasping, 13–22 × 5–6 mm. **Inflorescences** simultaneous (to 11), 1-flowered, emerging below foliage, erect, to 25 mm long, provided with 2 basal, tubular, clasping bracts, 2.5 mm long. **Floral bract** widely ovate, acute to acuminate, amplexicaul 2.5 × 2 mm. **Ovary** subcylindric, glabrous, 10 mm long including the pedicel. **Flower** often cleistogamous, otherwise spreading and scented, ivory white to gray-white, the base of the lateral sepals sometimes blotched with pale ochre, rarely spotted with red-brown at the base of all the perianth parts. **Dorsal sepal** erect to slightly curved, concave, lanceolate-elliptic, subacuminate, 6.2–9.0 × 3.5–4.2 mm. **Lateral sepals** obliquely lanceolate-elliptic, concave, acute, shortly subacuminate, 6.5–9.0 × 3.2–4.0 mm. **Petals** elliptic-lanceolate, acute, smaller than sepals, 6.3–8.5 × 2.8–3.3 mm. **Lip** 3-lobed, sagittate, sessile, fleshy, 6.0–8.2 × 6–8 mm when spread, the hypochile obcuneate to transversely rectangular from a obcuneate base, 3–4 mm long, ca. 4 mm wide apically, the epichile triangular, acute, concave, sometimes microscopically papillose, 3.2–4.0 × 3–4 mm, the lateral lobes triangular, acute, spreading to slightly reflexed, sometimes indistinct, 1 × 0.8–1.0 mm. **Column** straight, 4–5 mm long, with a foot, minutely papillose under the stigma; the clinandrium prominent, cucullate, irregularly erose, with 2 lateral lobes projecting toward stigma; ligule triangular, acute, glabrous, apically somewhat reflexed toward the column, 1.3 × 1 mm. **Anther cap** subreniform, flattened, 2-celled. **Pollinia** 4, in 2 superposed, subequal pairs, on a narrowly obrhombic, subtruncate stipe;

viscidium elliptic-peltate. **Fruit** an elliptic-fusiform, glabrous capsule, to 2.5 × 0.8 cm.

DISTRIBUTION—Distributed from central Mexico to Costa Rica and the West Indies.

ECOLOGY—A rather uncommon plant, rarely found as an epiphyte or as a terrestrial in mosses, *D. glauca* usually occupies more exposed places when compared to other typical, shade-loving species of *Dichaea*. In Costa Rica, it has been recorded from the moist regions of the Tilarán mountain range, at elevations around 1200–1600 m. Flowering occurs from February to September.

DISTINGUISHING FEATURES—*Dichaea glauca* is unmistakable, both in plant and in flower morphology. Plants of *D. glauca* are among the few taxa in Costa Rica to present erect stems, and they are sometimes found growing terrestrially in layers of mosses or other decaying substrates. The stems are always simple, strongly flattened (ancipitous), provided with thick roots (to 3.5 mm in diam.) only at the base and with glaucous sheaths and leaves. It is also the only species in Costa Rica to produce simultaneous inflorescences. Cleistogamous flowers are often produced on individual plants otherwise able to develop flowers with fully spreading perianth; in such cleistogamous flowers, no stipe is produced, and the abaxial pair of pollinia is transformed into a unique structure.

Dichaea globosa Dressler & Pupulin, Novon 16: 340. 2006. Type: Costa Rica. San José: Pérez Zeledón, El General Valley, vicinity of San Isidro del General, 730 m, 3 Mar. 1966, *A. Molina R., W. C. Burger & B. Wallenta 18291* (holotype, F; isotype, CR). Figure 26 (Voucher: *Pupulin 3165*, JBL-Spirit).

Epiphytic, cespitose **herbs** to 50 cm long. **Roots** basal and caulinar, 0.5–1.0 mm in diam., the caulinar roots completely hidden by the leaf sheaths. **Stems** compressed, erect, becoming arcuate-pendent with age, 10–50 cm long, 16–20 mm wide across conduplicate sheaths. **Leaves** articulate with the sheaths, closely spaced along stem, spreading, subcoriaceous, medium to dark green, often adaxially glossy, 38–6.3 × 10–21 mm, elliptic-oblong, obtuse, apiculate; sheaths loose, strongly ancipitous, 30–35 × 30–38 mm. **Inflorescence** successive, 1-flowered, emerging below foliage, the peduncle straight, pendent to erect-spreading, 10–15 mm long, basally provided with 2 infundibuliform, acuminate, clasping bracts, 6–9 × 8 mm. **Floral bract** double, the outer bract broadly ovate, acuminate, 10 × 6–8 mm, the subopposite inner bractlet lanceolate, acuminate, ca. 9 × 2 mm. **Ovary** subcylindric, muricate, 2.0–2.3 mm long including the pedicel. **Flower** large, coriaceous, subglobose, with sepals and petals green, blotched and spotted with purple, rarely solid green, the lip dark purple or pinkish purple. **Dorsal sepal** curved over the column, broadly ovate, acute, concave, the margins microscopically ciliate, 11.5–15.0 × 5–10 mm. **Lateral sepals** obliquely broadly ovate, abruptly acute, apiculate, strongly concave, the margins microciliate, 12–14 × 6–9 mm. **Petals** obovate, obtuse, minutely apiculate, the margins microciliate, 10–12 × 5–7 mm. **Lip** sessile, obovate-anchoriform, conduplicate-concave, 10–13 × 10–12 mm when spread, the hypochile rounded-discoid, 7–8 mm long, 5–8 mm wide apically, the epichile transversely elliptic, rounded-subtruncate, apiculate, the distal margins thickened with a median groove, 2–4 × 12 mm, the lateral lobes narrowly triangular-falcate, acuminate, retrorse, 5–7 × 2 mm. **Column** suberect, with prominent foot, 6–7 mm long; the clinandrium shallow, entire; the stigma transversely elliptic-subrectangular; infrastigmatic ligule triangular, rounded, apically pubescent, ca. 3 × 2 mm. **Pollinia** 4, in 2 superposed, subequal pairs, complanate-rounded, on a oblong, obtuse stipe and a peltate, hyaline viscidium. **Fruit** a subglobose-oblong, muricate capsule, ca. 21 × 17 mm.

DISTRIBUTION—Known from Costa Rica and Panama.

ECOLOGY—A rather infrequent plant, *D. globosa* is found as an epiphyte mostly on shady, mossy trunks and large branches in the understory of tropical and premontane rain to moist forests, at elevations of 100–1100 (1400) m. In Costa Rica, the species is restricted to the Pacific slopes of the Cordillera de Talamanca in the central region and the General and Coto Brus valleys as well as in the Cordillera Costeña (Brunqueña) and the Golfo Dulce areas in the southern Pacific region. Flowering occurs mostly from December to June.

DISTINGUISHING FEATURES—*Dichaea globosa* is easily distinguished from *D. morrisii* by the fleshy, subtruncate lip, broad claw of the lip, and the distinctly obovate, apiculate petals. Among Costa Rican species with large plants, the subglobose flowers usually blotched with purple, the rounded hypochile and the falcate lateral lobes of the lip are diagnostic.

Dichaea gomez-lauritoi Pupulin, Harvard Pap. Bot. 12(1): 87. 2007. Type: Costa Rica. Limón: Guápiles, camino a Río Frío, bosques remanentes entres los Ríos Blanco y Corinto, 200–250 m, 8–10 Apr. 1982, "Epífita, flores blancas," *J. Gómez-Laurito 8174* (holotype, CR 89411). Figure 22 (Voucher: *Gómez-Laurito 8174*, USJ).

Epiphytic, cespitose **herbs** to 37 cm long. **Roots** filiform, exposed at the base and along the lower, naked portion of the stem, hidden by the leaf sheaths on upper stem, 0.3–0.5 mm in diam. **Stems** slightly compressed to subcylindric, pendent, 33–37 cm long, 0.13–0.18 cm wide across conduplicate sheaths. **Leaves** articulate with the sheaths, widely spaced along stem, subspreading, membranaceous, green, 32–40 × 2.5–3.0 mm, narrowly linear-elliptic, acute, the apical margins microciliate; sheaths clasping, conduplicate-ancipitous, slightly dilated toward the apex, 11–13 × 4.0–4.8 mm, distinctly flushed with pale purple-brown in dried material. **Inflorescence** solitary, 1-flowered, emerging below foliage, subpatent, 11–13 mm long, provided with a basal, lanceolate, clasping, membranaceous bract, 4.5 × 1 mm. **Floral bract** double, the outer bract widely triangular-ovate, cuspidate, 4 × 2.5 mm, the inner bract linear-lanceolate, acute, 4 mm long. **Ovary** cylindric-subclavate, 1.2 mm long, apically muricate. **Flower** spreading, white; no fragrance recorded. **Dorsal sepal** erect, concave, elliptic, obtuse, minutely apiculate, 5.5 × 2.1 mm. **Lateral sepals** obliquely ovate-elliptic, concave, subacuminate, 6.0 × 2.7 mm. **Petals** narrowly elliptic, acute, the superior margin provided with a tooth toward the apex, 5 × 2 mm. **Lip** 3-lobed, anchoriform, with a short and stout claw ca. 0.5 mm long decurrent on the lamina, entire lip 4.5 × 6.0 mm when spread, the hypochile obcuneate, 2 mm long, 3 mm wide apically, the epichile widely triangular, obtuse, 3.8 × 2.5 mm, the lateral lobes triangular-ligulate, rounded, retrorse, 2 × 0.5 mm. **Column** suberect, 2.4 mm long, provided along the basal margins with subcarinate, thickened-linear, glabrous wings; the clinandrium shortly cucullate, irregularly erose; the stigma ovate, apically emarginate; ligule short-triangular, thickened toward the papillose-hirsute apex, 0.8 × 0.5 mm. **Anther cap** subreniform, emarginate, 2-celled. **Pollinia** 4, in 2 pairs of different size, on a obpyriform-spatulate, truncate stipe; viscidium elliptic.

DISTRIBUTION—Known only from Costa Rica.

ECOLOGY—An apparently rare plant, *D. gomez-lauritoi* was collected only once in the warm, extremely wet forest of the Caribbean plains lying at the base of the steep Central Volcanic range. At the type locality, at an elevation of about 200 m, the climate is constantly rainy, and no definite dry season exists. Flowering occurs at least in April.

DISTINGUISHING FEATURES—The features of the plant and the flower have no close affinities with any of the known *Dichaea* species. The vegetative habit is almost indistinguishable from that of *D. graminoides*, a species originally described from Jamaica and recorded from Mexico, Guatemala, Belize, El Salvador, Honduras, Nicaragua, Panama, the West Indies, and northern South America, but so far never found in Costa Rica. In flower morphology, however, *D. gomez-lauritoi* is closely related to *D. acroblephara*, from which it is distin-

guished by the much smaller, concolorous white flower and the distinctly thickened area at the base of the hypochile.

Dichaea gracillima C.Schweinf., Bot. Mus. Leafl. 5(6): 98. 1938. Type: Costa Rica. [Alajuela:] Piedades de San Ramón, "Bois, Alt. 1100 m. 26-X-1925," *A. M. Brenes* (*274*) *1459* (holotype: AMES 45278; isotypes: CR 89411, NY). Figure 17 (Voucher: *Brenes (274) 1459*, AMES).

Epiphytic **herbs**, cespitose or branching near the base of the stems, to 30 cm long. **Roots** basal and caulinar, to 1.2 mm in diameter. **Stems** compressed, erect, becoming arcuate-pendent with age, 11–30 cm long, 0.1–0.2 cm wide across conduplicate sheaths. **Leaves** articulate with the sheaths, widely spaced along stem, subspreading, subcoriaceous, dark green, 35–47 × 2 mm, narrowly linear, shortly acuminate, apiculate, basally strongly conduplicate; sheaths clasping, 13–18 × 5–6 mm. **Inflorescence** successive, 1-flowered, emerging below foliage, erect-spreading, 10–12 mm long, basally provided with 2 imbricating, tubular, clasping bracts, 2 mm long. **Floral bract** double, the outer bract infundibuliform, acute, 1.5 × 1.2 mm, the subopposite inner bract narrowly linear, 1.5 mm long. **Ovary** subcylindric, glabrous, 3 mm long including the pedicel. **Flower** submembranaceous, no color recorded but apparently concolorous. **Dorsal sepal** erect, elliptic-lanceolate, strongly concave, subacuminate, abaxially carinate at apex, 5.0 × 2.2 mm. **Lateral sepals** obliquely ovate-lanceolate, asymmetrical, strongly concave, acuminate, dorsally carinate, 5.0 × 3.2 mm. **Petals** lanceolate-elliptic, acuminate, smaller than sepals, 4.2 × 2.1 mm. **Lip** clawed, obovate-anchoriform, concave, 4.0 × 3.7 mm when spread, the hypochile subquadrate from a rounded base, 2.2 mm long, 2.2 mm wide apically, the epichile broadly triangular, abruptly acute, 1.5 × 4.0 mm, the lateral lobes triangular-lanceolate, acuminate, retrorse, 0.6 × 0.5 mm. **Column** straight, apparently with a foot, ca. 2 mm long; the clinandrium entire; ligule triangular, shallowly rounded, glabrous, erect, 0.4 × 0.5 mm. **Pollinia** 4, in 2 superposed pairs of different sizes, complanate-subpyriform.

DISTRIBUTION—Known only from Costa Rica.

ECOLOGY—A rare plant, which has been found only once close to the Continental Divide in the Tilarán mountain range, at 1100 m elevation. Flowering occurs at least in October.

DISTINGUISHING FEATURES—*Dichaea gracillima* is vegetatively unmistakable, with its erect, compressed stems and the widely spaced, subcoriaceous, narrowly linear leaves reaching almost 5 cm in length. The flowers are among the smallest in the genus, with the sepals and petals 4–5 mm long. The subquadrate hypochile from a rounded base is diagnostic of the species.

Dichaea hystricina Rchb.f., Flora 48: 279. 1865. Type: Cuba [Orientali:] prope villam Monte Verdi dicta, 13 Aug. 1859, *C. Wright 1478* (holotype: W; isotype: AMES). *Dichaea ciliolata* Rolfe, Bull. Misc. Inform. Kew 1917: 83. 1917. Type: Costa Rica. [Cartago: Orosi,] near Cachí, *C. H. Lankester 12* (holotype: K). *Dichaea selaginella* Schltr., Repert. Sp. Nov. Regni Veg. Beih. 7: 202. 1920. Type: Colombia. Cauca, *M. Madero s.n.* (holotype, B, destroyed; lectotype, selected by Pupulin [2007], drawing of the holotype published by Mansfeld, 1931). *Dichaea lycopodioides* Rchb. f. ex Kraenzl., Engl. Pflanzenr. Orchid.-Monandr.-Pseudomonopod. 35. 1923, *nom. nud.* Figure 29 (Voucher: *Pupulin 3925*, JBL-Spirit).

Epiphytic, cespitose **herbs** to 18 cm long. **Roots** produced all along the stem (the adventitious roots not exposed), glabrous, flexuous, about 0.3 mm in diam. **Stems** flattened, suberect to pendent, simple to few-branched, 6–18 cm long, 0.2–0.3 cm wide across conduplicate sheaths. **Leaves** usually closely spaced along stem, spreading, sometimes not axially twisted (so the plant without a distinct "front"), medium green, the new leaves distinctly paler and bright green, subcoriaceous, narrowly elliptic to lanceolate-elliptic, acute, apiculate-mucronate, 2.0–15.0 × 1.0–4.5 mm, often varying in length along the stem, the margins evenly ciliate; sheaths loose, to 5 × 5 mm. **Inflorescence** solitary, 1-flowered, emerging below foliage, the peduncle straight, to 13 mm long, provided at the base with a triangular, acute bract, about 1.4 mm long. **Floral bract** double, the outer bract suborbicular-infundibular, acute, shorter than ovary, 1.4 × 2.0 mm, the inner bractlet narrowly lanceolate, 1.3 mm long. **Ovary** cylindric-subclavate, densely echinate, ca. 2.3 mm long including the pedicel. **Flower** spreading, the sepals and petals greenish cream flecked or finely spotted with purple, the lip white, variously suffused with pink (mostly toward the base and the lateral lobes), sparsely dotted with purple, the column greenish white, marked purple along the ribs of the stigma and the clinandrium, the ligule purple, the anther cap white; no fragrance detected. **Dorsal sepal** oblanceolate, acute, apiculate, 5.4–7.2 × 2.0–2.5 mm, abaxially provided with sparse, low warts. **Lateral sepals** obliquely elliptic to lanceolate-elliptic, asymmetrical, slightly falcate, acute to subacuminate, apiculate, concave, 7.3–8.7 × 2.3–2.8 mm, adaxially warty. **Petals** oblanceolate, acute, shortly acuminate, often recurved, 6.2–6.9 × 2.5–3.0 mm. **Lip** 3-lobed, from a fleshy claw, 6–7 × 8–9 mm when spread, the hypochile subrectangular, provided at the base with 2 lateral knobs, 2.5 mm wide apically, the epichile sagittate, acute, the lateral lobes narrowly triangular-filiform, acute, retrorse, 3.5 × 1.1 mm. **Column** suberect, to 7.5 mm long, with an indistinct foot about 0.5 mm long, provided with rectangular, ciliate wings to two-thirds of column length; the clinandrium shallow; ligule elliptic from a linear base, apically thickened-globose, rounded, papillose, 2.7 × 0.8 mm. **Anther cap** widely ovate-subquadrate, flattened, 2-celled. **Pollinia** 4, in 2 superposed pairs of different sizes, on a narrowly obtriangular-ligulate, subtruncate stipe with lightly inrolled margins; viscidium elliptic. **Fruit** an elliptic, densely muricate capsule, ca. 6 × 3 mm.

DISTRIBUTION—The species is distributed from Mexico to Venezuela and Ecuador, and the West Indies (Cuba, Hispaniola [Dominican Republic], Guadeloupe, Puerto Rico, and Trinidad).

ECOLOGY—A frequent, widespread and variable plant, *D. hystricina* is found as a shade-epiphyte on mossy trunks and large branches in the understory of premontane and submontane moist to wet forests, at elevations ranging from 400 to 1600 m. Flowering occurs mostly from June to November, but sporadic flowering has been recorded year-round.

DISTINGUISHING FEATURES—The linear-ligulate leaves provided with hairs along the margins, the muricate ovary, and the clawed lip with small lobules at the base and expanded into a sagittate lamina are diagnostic of the species. The presence of trichomes along the margins of the leaves is not uncommon in species of the genus *Dichaea*, but these are usually restricted to the apical portion of the leaf. The long hairs that cover the entire leaf margins, as well as its small habit, are useful characters for recognizing plants of *D. hystricina* in the field even when they are not in flower. Specimens of typical *D. hystricina* have freely branching, suberect to pendent stems and narrowly ovate leaves up to 1 cm long. Populations previously referred to *D. ciliolata* have erect, upcurving, rarely branching stems, with short leaves less than 5 mm long. However, no differences can be observed among the flowers produced by the two kinds of plants, and no correlation seems to exist between the shape of the plants and the morphology of flowers, which is largely uniform.

Dichaea lankesteri Ames, Sched. Orch. 4: 56. 1923. Type: Costa Rica. [San José:] Cascajal, *C. H. Lankester K353* (holotype: K; drawings of the holotype: AMES). Figure 19 (Voucher: *Pupulin 3030*, JBL-Spirit).

Epiphytic, cespitose **herbs** to 40 cm long. **Roots** filiform, exposed at the base, hidden by the leaf sheaths along the stem, ca. 0.5 mm in diameter. **Stems** compressed, suberect, becoming horizontal to pendent with age, frequently branching, 10–40 cm long, 0.35–0.50 cm wide across conduplicate sheaths. **Leaves** articulate with the sheaths and ultimately deciduous, densely spaced along stem, spreading-decurved, thin-textured, membranaceous, medium grass-green, adaxially somewhat shiny, 25–40(45) × 3.5–5.0(6.0) mm, linear-lanceolate, acute, the apical margins microscopically pectinate-ciliate; sheaths clasping, to 8.0 × 3.7 mm. **Inflorescence** solitary, 1-flowered, emerging below foliage, patent to suberect, to 17 mm long, provided with a basal, cylindric, elongate bract 5 mm long. **Floral bract** double, the outer bract broadly ovate, cucullate-concave, 6 × 5 mm, the inner bract narrowly linear-lanceolate, acute, 5 mm long. **Pedicel** cylindric, ca. 1 mm long. **Ovary** 1.0–1.3 mm long, densely hispid-muricate. **Flower** spreading, the sepals and petals glabrous, cream white, sometimes slightly flushed with pale green toward the apex of sepals, the column white, with a narrow rose stain along the proximal margin of the stigma; flowers strongly scented, the scent vanilla-like. **Dorsal sepal** erect, slightly concave, triangular-lanceolate, acuminate, 8.5–10.0 × 2.5–3.5 mm. **Lateral sepals** obliquely triangular-lanceolate, concave, acuminate, 8.5–10.0 × 3.0–4.2 mm. **Petals** narrowly lanceolate, acuminate, concave toward the base, 7–8 × 2.0–2.3 mm. **Lip** 3-lobed, anchoriform, subsessile, 6–8 × 5–7 mm when spread, the hypochile broadly obcuneate, 2 mm long, 3.5 mm wide apically, the epichile triangular, acute, 5.0–6.0 × 4.5–5.5 mm, the lateral lobes narrowly triangular-subfalcate, acute, retrorse, 2.0 × 1.5 mm. **Column** suberect, 2.3 mm long, with a foot, provided at the base with small, semielliptic, rounded, glabrous wings; the clinandrium shallow, entire; ligule transversely broadly triangular, obtuse to rounded, glabrous, the apex sometimes reflexed, 0.7 × 1.5 mm. **Anther cap** cucullate-reniform, compressed, 2-celled. **Pollinia** 4, in 2 superposed, subequal pairs, on a broadly obtriangular-oblong, truncate stipe; viscidium elliptic, hyaline. **Fruit** an elliptic, densely muricate capsule.

DISTRIBUTION—The species ranges from Costa Rica to western Panama.

ECOLOGY—*Dichaea lankesteri* is a relatively frequent epiphyte on shaded and mossy branches of the understory in very wet premontane forests on the Caribbean slopes and close to the Continental Divide along the Guanacaste, Tilarán, Central Volcanic, and northern Talamanca mountain ranges, at 1000–1800 m elevation. Flowering mostly occurs at the beginning of the rainy season, from April to July.

DISTINGUISHING FEATURES—Among *Dichaea* species of the sect. *Pseudodichaea*, *D. lankesteri* is easily recognized by the horizontal to arching-pendent mature stems, the grass-green foliage shiny on the upper surface, and the white to creamy white, immaculate, strongly fragrant flowers. It is closely related to *D. amparoana*, from which it can be distinguished by the suberect-arching (vs. erect) habit, the white flowers (vs. pale rose, spotted with pale purple), the stouter lateral lobes of the lip, and the shorter infrastigmatic ligule.

Dichaea morrisii Fawc. & Rendle, J. Bot. 48: 107. 1910; *emend. in* W. Fawcett & A. B. Rendle, Flora of Jamaica 1: 139, pl. 30, figs. 13–16. 1910, *nom. cons*. Type: Jamaica. Mt. Moses, 3500 ft, *D. Morris J. P. 2269* (syntype: BM; isosyntypes: NJ, K, W); Hardware Gap, *G. E. Nichols s.n.* (syntype: BM, isosyntypes: NJ, YALE). Figure 25 (Voucher: *Whitten 2171*, JBL-Spirit).

Epiphytic, cespitose **herbs** to 60 cm long. **Roots** filiform, 0.7–1.0 mm in diameter, exposed at the base of the stem, the caulinar roots completely hidden by the leaf sheaths. **Stems** compressed, simple, suberect, becoming pendent with age, 15–60 cm long, 0.4–0.7 cm wide across conduplicate sheaths. **Leaves** articulate with the sheaths, closely spaced along stem, spreading, membranaceous, oblong-ligulate, rounded to subacute, abaxially minutely apiculate, medium green, 3.3–6.8 × 0.8–1.5 cm; sheaths loose, strongly complanate, ancipitous, 21–28 × 17–21 mm. **Inflorescence** solitary, 1-flowered, emerging below foliage, subpatent, 21–25 mm long, provided with a basal, cylindrical, clasping, scarious bract, to 7 mm long. **Floral bract** double, the outer bract broadly triangular-ovate, acuminate, 11–13 × 9–11 mm, the inner bract lanceolate, acuminate, 15 × 5 mm. **Pedicel** cylindric, 2.5 mm long. **Ovary** 3.2–3.5 mm long, densely muricate. **Flower** ringent, the sepals and petals green, flushed white toward the base, basally striped with purple; the lip white, the hypochile boldly blotched with purple, the epichile solid violet; column white, flecked with purple on basal wings; no odor detected in Costa Rican material. **Dorsal sepal** broadly ovate, acuminate, fleshy, concave, dorsally subcarinate, the margins ciliate, 12–13 × 7–8 mm. **Lateral sepals** obliquely broadly ovate, concave, acute, dorsally carinate, the margins hispid-ciliate, 12.0–13.0 × 8.5–9.0 mm. **Petals** ovate-lanceolate, abruptly subacuminate, the margins hispid-ciliate, 10 × 5 mm. **Lip** 3-lobed, sagittate, sessile, 12 × 7 mm when spread, the hypochile linear, ca. 8 mm long, 4 mm wide apically, provided at the base with a transverse, rounded-elliptic callus; the epichile triangular-sagittate, acute, 4 × 7 mm, the lateral lobes narrowly linear, acuminate, retrorse, to 4 × 1 mm. **Column** erect, 5.0 mm long, with distinct foot, the basal margins finely ciliate; the clinandrium shallowly subpetaloid, irregularly erose; ligule triangular, obtuse-subtruncate, minutely papillose at apex, 0.8 × 1.2 mm. **Anther cap** elliptic-subreniform, cucullate, flattened, 2-celled. **Pollinia** 4, rounded, in 2 superposed pairs of different sizes, on an oblong, subacute stipe; viscidium narrowly peltate, hyaline. **Fruit** an oblong-elliptic, muricate capsule, 15 × 11 mm.

DISTRIBUTION—The distribution of *D. morrisii* ranges from the West Indies (Jamaica, Hispaniola) to Costa Rica, Panama, Colombia, and Ecuador.

ECOLOGY—Notwithstanding its wide geographic distribution, *D. morrisii* is apparently the rarest of the tall *Dichaea* species in Costa Rica, where it has been recorded in a few collections from the premontane and submontane wet forests of the Central Volcanic chain, at 900–2000 m elevation. Flowering in Costa Rica has been recorded in November and December, corresponding to the end of the rainy season.

The oldest name of *Dichaea morrisii* was Swartz's *Cymbidium muricatum*, originally published in 1789 and later emended in 1806. However, throughout its distribution range, the name *Dichaea muricata* has been widely and constantly applied to a number of species of a different group (subgenus or sect. *Dichaea*, lacking leaf abscission layers), and herbarium identifications as *D. muricata* may be found on almost any species of *Dichaea* with nonarticulate leaves. In the West Indies, the name has been used consistently to identify plants of *D. latifolia* Lindl., whereas on the mainland it has been freely applied to the most common, medium-sized member of subgenus *Dichaea* in each area. The Committee on Spermatophytes has recently approved a proposal to reject *Cymbidium muricatum*, which has been persistently used for taxa not including its type, conserving *D. morrisii* (Brummit, 2007). The large plants with leaves longer than 5 cm; the ringent, green flowers striped with purple at the base of the ciliate sepals; the ovate petals; and the claw of the lip with a distinct callus at the base easily distinguish *D. morrisii* from other species in the area.

Dichaea obovatipetala Folsom, Orch. Dig. 58: 186–187. 1994. Type: Panama. Bocas del Toro: 15 km N of border with Chiriquí, road from Fortuna to Chiriquí Grande, 100 m, 10 Apr. 1985, *J. P. Folsom 11302M* (holotype: PMA; isotypes: TEX, HNT). Figure 35 (Voucher: *Pupulin 4202*, JBL-Spirit).

Epiphytic, cespitose **herbs** to cm long. **Roots** exposed basally, the caulinar roots mostly hidden by leaf sheath, occasionally aerial, flexuous, glabrous, ca. 0.6 mm in diameter. **Stems** flattened, scandent to pendent, freely branching, often forming intricate mats, 11–30 cm

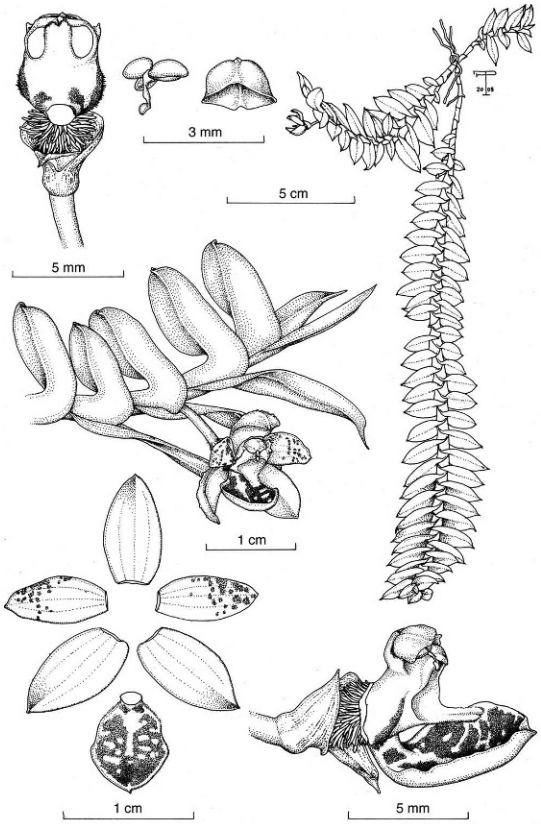

Figure 33.

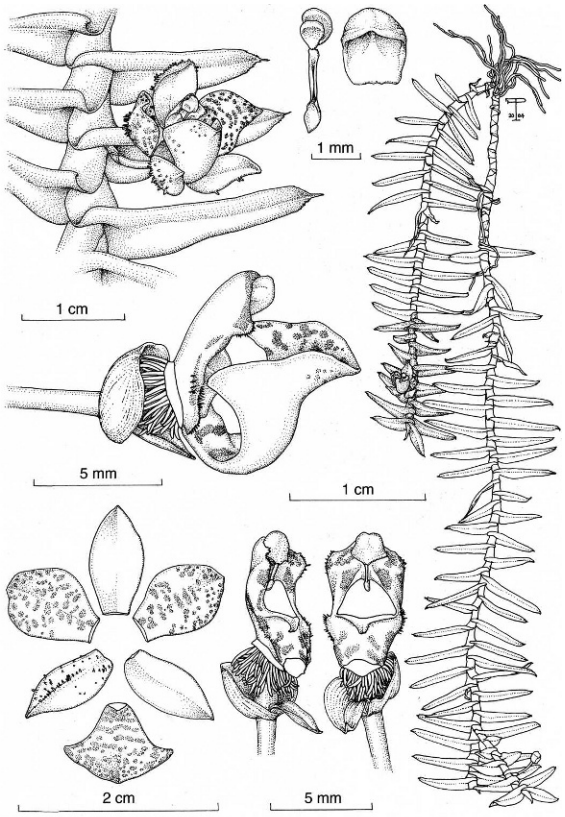

Figure 34.

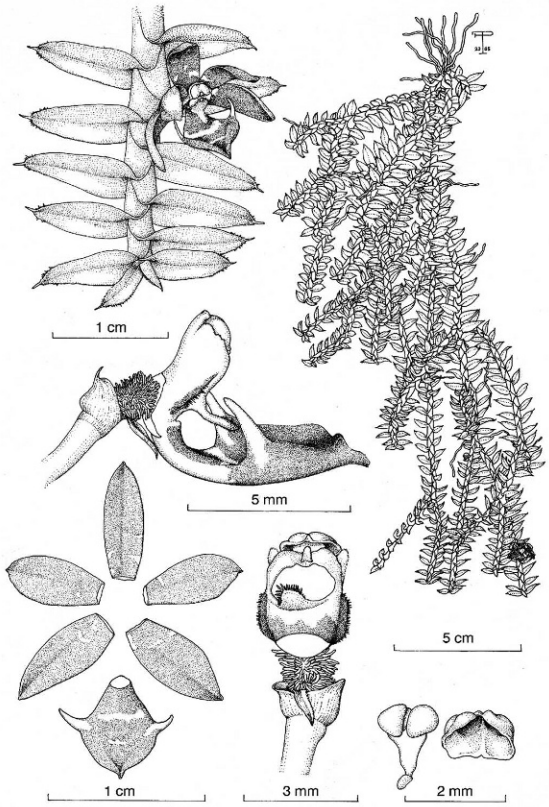

Figure 35.

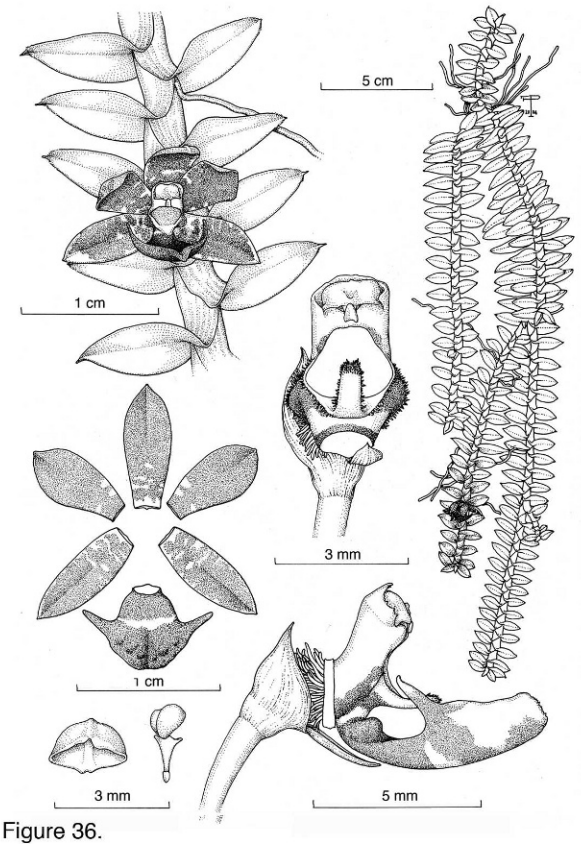

Figure 36.

FIG. 33. *Dichaea pendula*. FIG. 34. *Dichaea dammeriana*. FIG. 35. *Dichaea obovatipetala*. FIG. 36. *Dichaea sarapiquinsis*.

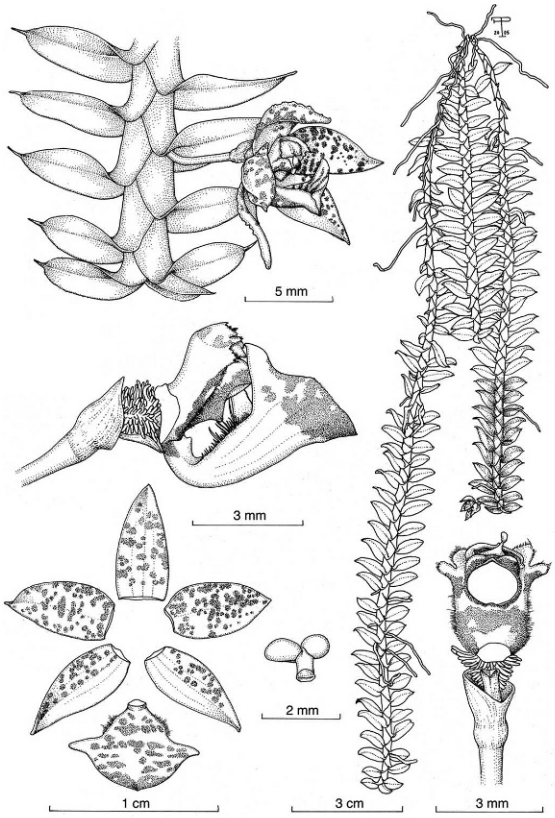

Figure 37.

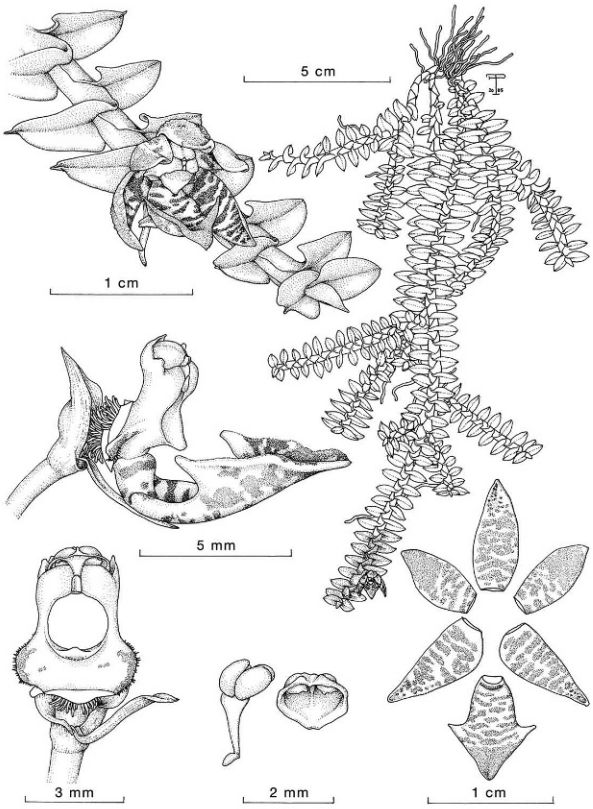

Figure 38.

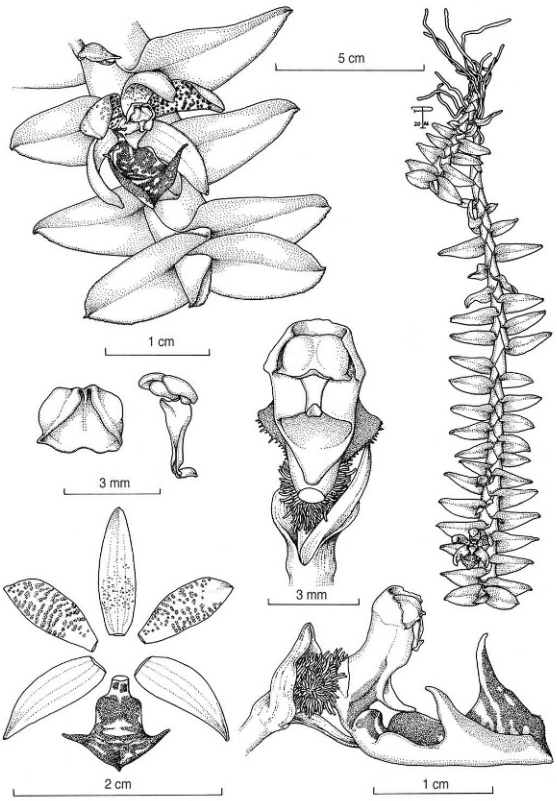

Figure 39.

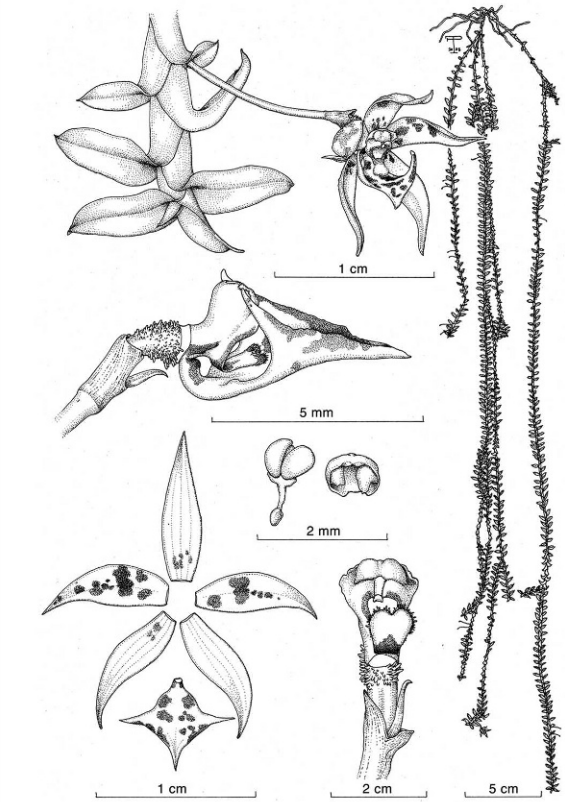

Figure 40.

FIG. 37. *Dichaea eligulata*. FIG. 38. *Dichaea costaricensis*. FIG. 39. *Dichaea filiarum*. FIG. 40. *Dichaea oxyglossa*.

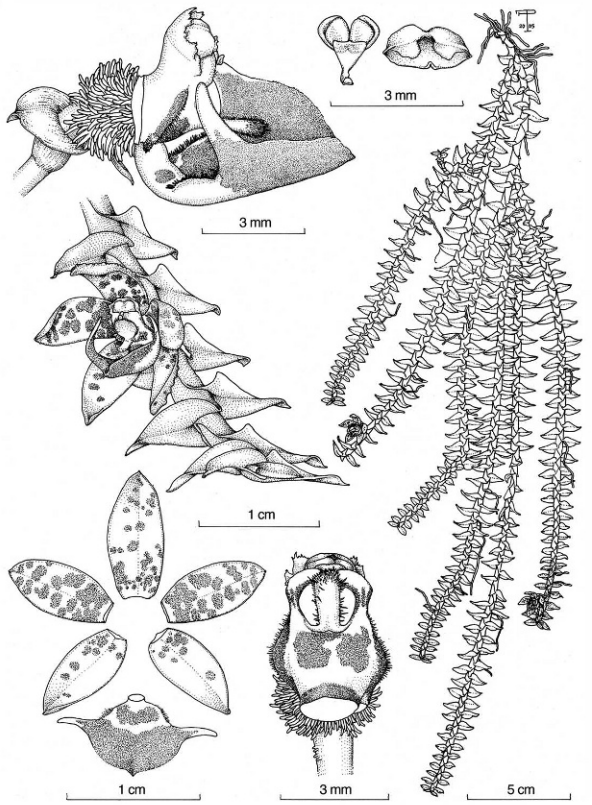

Figure 41.

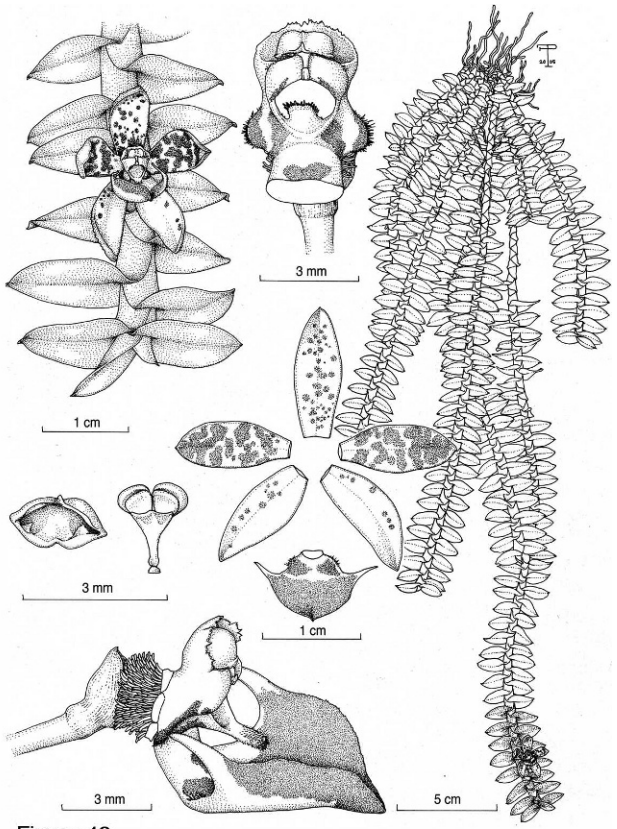

Figure 42.

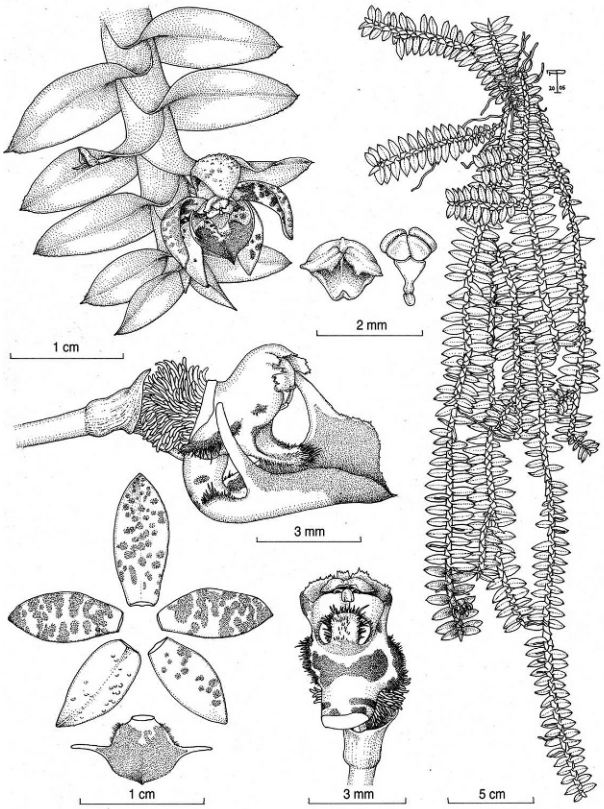

Figure 43.

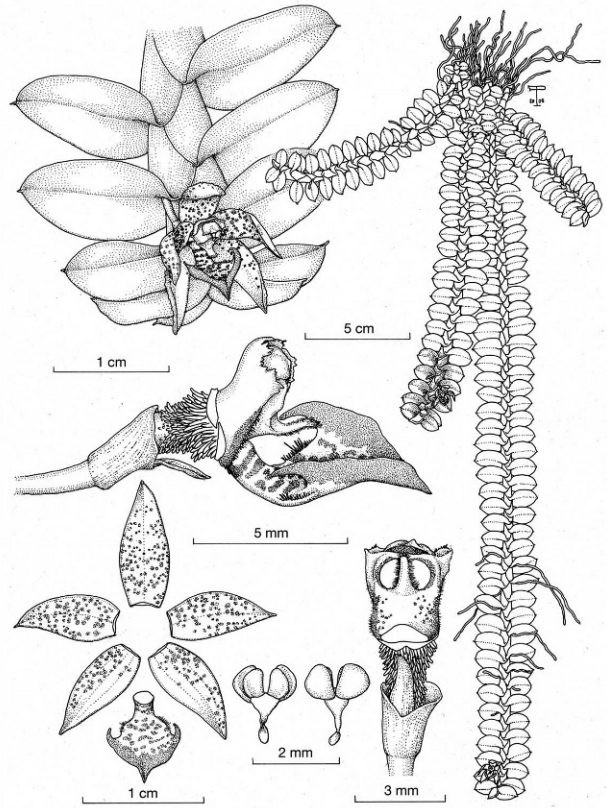

Figure 44.

FIG. 41. *Dichaea poicillantha*. FIG. 42. *Dichaea poicillantha*. FIG. 43. *Dichaea poicillantha*. FIG. 44. *Dichaea cryptarrhena*.

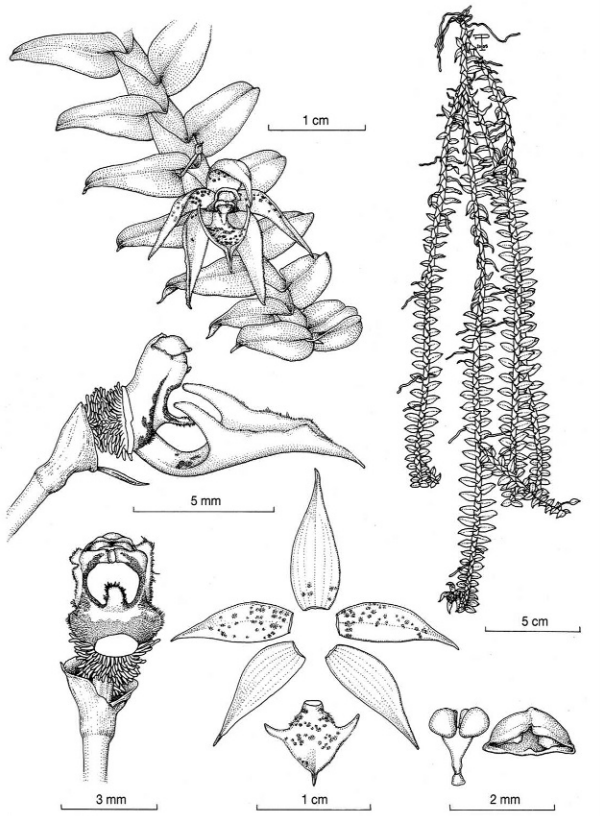

Figure 45.

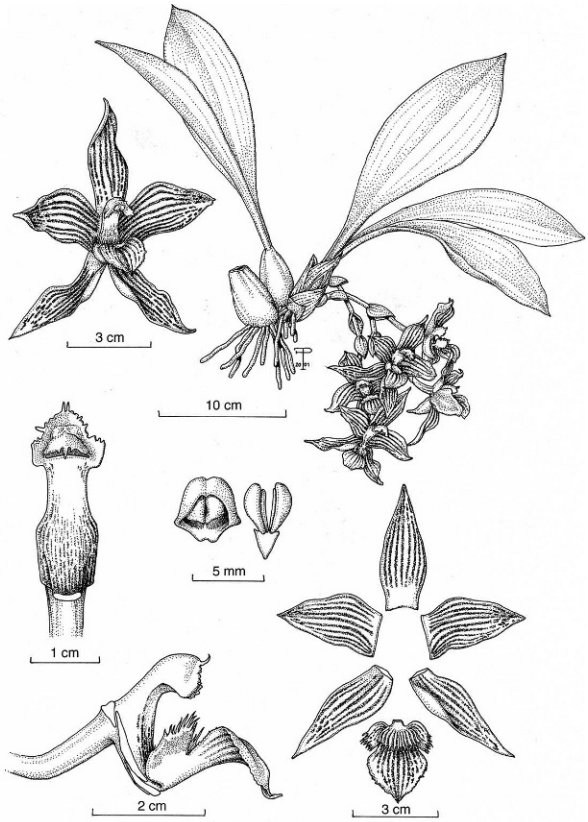

Figure 46.

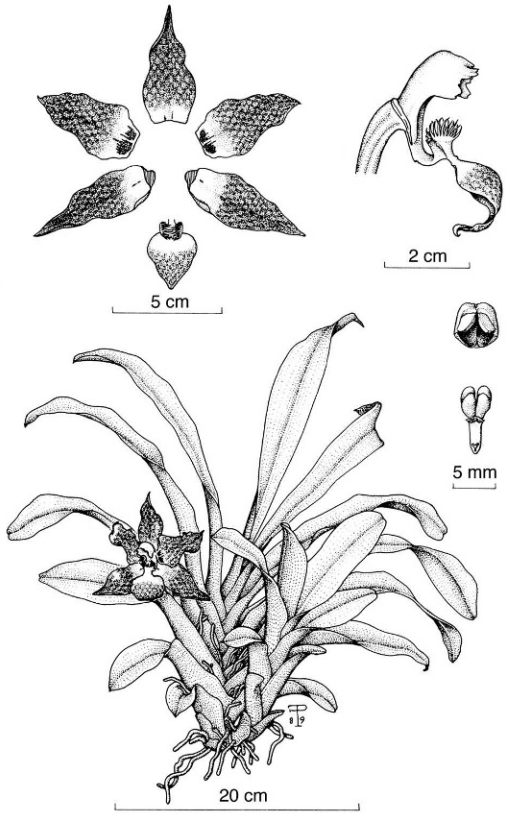

Figure 47.

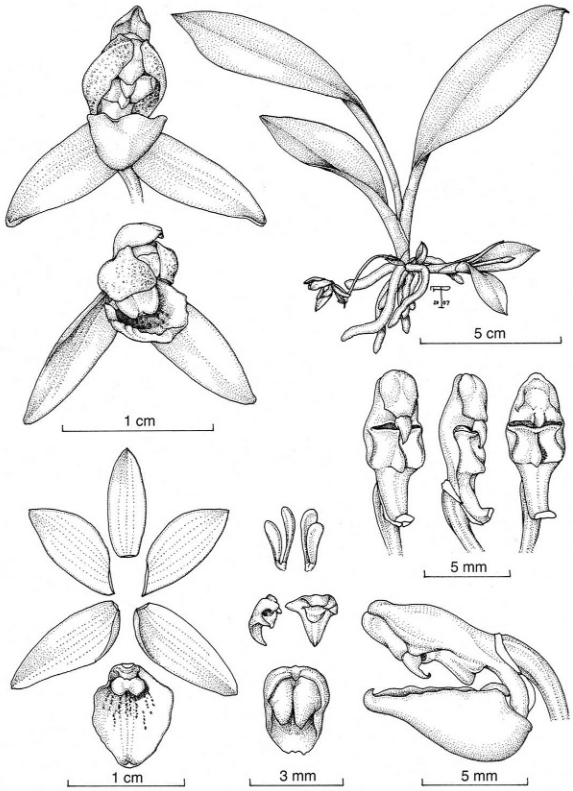

Figure 48.

FIG. 45. *Dichaea similis*. FIG. 46. *Galeottia grandiflora*. FIG. 47. *Huntleya burtii*. FIG. 48. *Kefersteinia saccata*.

long, 1.5–2.0 mm wide across conduplicate sheaths. **Leaves** widely spaced along stem, spreading, olive green, thick-herbaceous, 6–7 × 4–5 mm, ovate-lanceolate, acute, abaxially provided with a distinct apicule, the apical margins microscopically and irregularly fringed-fimbriate; sheaths compressed, loose, often pustulate, to 7 × 4 mm. **Inflorescences** solitary, 1-flowered, emerging above foliage, patent, 0.6–0.8 cm long, the peduncle geniculate, provided at the base with 2–3, tubular-compressed, sheathing bracts, about 5 mm long. **Floral bract** double, the outer bract funnel-shaped, broadly ovate-suborbicular, acuminate, 1.7–3.0 × 1.5–3.0 mm, the inner bract narrowly lanceolate-oblong, to 4 mm long. **Pedicel** cylindric, less than 1 mm long. **Ovary** long-muricate, 1 mm long. **Flower** spreading, with sepals and petals boldly blotched dark violet on a pale grayish cream background, the sepals externally minutely tuberculate, the lip white, blotched dark violet, the column white, marked with violet at the base and on the margins of wings; flowers moderately scented, the scent vanilla-like. **Dorsal sepal** elliptic-oblong, acute, with a rounded apicule, bent over the column, 7.5–10.0 × 3.5–4.0 mm. **Lateral sepals** obliquely elliptic-oblong, slightly asymmetrical, acute to shortly acuminate, 7.5–10.0 × 3.5–4.5 mm. **Petals** obovate-elliptic, acute, slightly conduplicate, 6.5–8.5 × 3.5–4.0 mm. **Lip** 3-lobed, subsessile, 6.0–7.8 × 7–8 mm when spread, the hypochile obcuneate-rounded, sometimes with indistinct shoulders, 3–4 mm long, 5 mm wide apically, the epichile triangular-ovate, rounded, apically infolded, the lateral lobes narrowly triangular-linear, acute, spreading-retrorse, 0.8 × 2.0 mm. **Column** erect, 3.7–4.3 mm long, provided with narrowly elliptic-subrectangular, flattened, ciliate wings, the clinandrium shallow, irregularly erose; ligule lanceolate-oblong, rounded-truncate, the apex shortly hispid, 1.5 × 0.6 mm. **Anther cap** transversely subrectangular, flattened, 2-celled. **Pollinia** 4, in 2 superposed pairs of different sizes, on a narrowly obtriangular, truncate stipe; viscidium elliptic, hyaline. **Fruit** an elliptic capsule, muricate.

DISTRIBUTION—The species ranges from Costa Rica to Panama.

ECOLOGY—*Dichaea obovatipetala* is a relatively common epiphyte in tropical and premontane wet forests at 400–1800 m elevation. In Costa Rica, the species is restricted to the Caribbean watershed of the Central Volcanic and Talamanca mountain ranges. Flowering has been recorded from October to February.

DISTINGUISHING FEATURES—The olive green foliage, the freely branching stems, which often form intricate mats, and the scented, almost completely violet flowers with obovate petals distinguish *D. obovatipetala* from other Costa Rican species of *Dichaea* sect. *Dichaea*. It is closely related to *D. sarapiquinsis*, which differs by the laxly pendent, rarely branching stems, the flowers not heavily blotched with violet, and the verrucose apex of the lip.

Dichaea oxyglossa Schltr., Repert. Sp. Nov. Regni Veg. Beih. 19: 267. 1923. Type: Costa Rica. [Alajuela:] Santiago de San Ramón, 1075 m, Nov. 1921, *A. M. Brenes 144* (holotype, B, destroyed; tracings of the holotype, AMES; lectotype, selected by Barringer [1984], CR). Figure 40 (Voucher: *Pupulin 2119*, JBL-Spirit).

Epiphytic, cespitose **herbs** to 70 cm long. **Roots** exposed basally, the caulinar roots hidden by leaf sheath, only occasionally aerial, flexuous, glabrous, ca. 0.5 mm in diam. **Stems** flattened, laxly pendent, rarely branching, 15–70 cm long, 0.7–1.0 mm wide across conduplicate sheaths. **Leaves** widely spaced along stem, spreading-retrorse, olive green to brownish green, thin-herbaceous, 4–7 × 2.5–3.5 mm, lanceolate-elliptic, cuneate-rounded to subacute, abaxially apiculate; sheaths compressed, apically slightly loose, to 5.5 × 2.5 mm. **Inflorescences** solitary, 1-flowered, emerging above foliage, patent, to 1.8 cm long, the peduncle geniculate, provided at the base with 2 tubular, acute, sheathing bracts, 4 mm long. **Floral bract** double, the outer bract broadly ovate, rounded-apiculate, 1.8–2.2 × 1.4–1.8 mm, the inner bract narrowly lanceolate, 1.8 mm long. **Pedicel** cylindric, ca. 1.5 mm long. **Ovary** papillose to sparsely short-muricate, 1.2 mm long. **Flower** spreading, with sepals and petals hyaline cream to greenish white, the sepals sparsely spotted with purple toward the base, the petals with large purple-violet blotches, the lip white, blotched dark violet, the column white, marked with violet on the margins of wings and on stigmatic rims; no odor detected. **Dorsal sepal** elliptic-lanceolate, acuminate, concave, bent over the column, 8.5–11.0 × 2.5–3.2 mm. **Lateral sepals** obliquely lanceolate, subfalcate, acuminate, concave, 8–11 × 2.5–3.0 mm. **Petals** elliptic-lanceolate, subfalcate at apex, acuminate, slightly concave, 7.5–10.5 × 2.5–3.0 mm. **Lip** 3-lobed, shortly clawed, 6.0–6.5 × 7.5–9.0 mm when spread, the hypochile obtriangular, provided with indistinct, rounded shoulders, 2.0 mm long, 2.8 mm wide apically, the epichile broadly triangular, apically infolded, acuminate, the lateral lobes narrowly triangular-linear, acuminate, spreading, confluent on the blade, 2.3 × 1.0 mm. **Column** suberect, 2.2–2.8 mm long, provided with narrowly semielliptic, flattened-backswept, ciliate wings, the clinandrium shallow, irregularly erose; the stigma rounded-obtrullate; the infrastigmatic ligule oblong, projecting slightly upward, apically dilated-inflated, retuse, pubescent, 1.7 × 1.1 mm. **Anther cap** transversely elliptic, flattened, 2-celled. **Pollinia** 4, in 2 superposed pairs of different sizes, on a narrowly obtriangular, apically dilated, rounded stipe; viscidium elliptic, hyaline. **Fruit** an elliptic, muricate capsule.

DISTRIBUTION—The species has been recorded from Costa Rica and western Panama.

ECOLOGY—*Dichaea oxyglossa* is apparently uncommon in shady, moist areas, in tropical and premontane wet forests at 400–1500 m elevation. In Costa Rica, the species has been recorded from the Caribbean slopes and close to the Continental Divide in the Tilarán and Central Volcanic mountain ranges and from both the watersheds of the Cordillera de Talamanca. Flowering occurs year-round, but the species flowers most frequently from April to September.

DISTINGUISHING FEATURES—The long, laxly pendent, rarely branching stems, the thin-textured, olive green leaves, the elongate peduncle, the translucent flowers with long-acuminate sepals and petals, and the apically inflated-dilated, emarginate infrastigmatic ligule are diagnostic.

Dichaea panamensis Lindl., Gen. Sp. Orch. Pl. 209: 1833. *Epithecia panamensis* (Lindl.) Schltr., Orchis 9: 25. 1915. *Dichaeopsis panamensis* (Lindl.) Schltr., Beitr. Bot. Centralbl. 36, Abt. 2: 519. 1918. Type: Panama. In Panamá et Columbia occidentali [Taboga Island], 1831, *H. Cuming 1292* (holotype: K). *Dichaea brachypoda* Rchb.f., Beitr. Orch. Centr.-Amer. 78: 1866. *Epithecia brachypoda* (Rchb.f.) Schltr., Orchis 9: 25. 115. Type: Costa Rica: [Heredia: Sarapiquí,] San Miguel, 14.5.1857, *H. Wendland s.n.* (holotype: W). Figure 15 (Voucher: *Pupulin s.n*, not preserved).

Epiphytic, cespitose **herbs** to 20 cm long. **Roots** basal, glabrous, flexuous, wider than the stem, about 2 mm in diameter. **Stems** flattened, suberect to spreading or pendent, simple, rarely producing new plantlets with roots at the nodes, 6.0–21.0 cm long, 0.15 cm wide across conduplicate sheaths. **Leaves** widely spaced along stem, oblique to spreading, medium to dark green, frequently glaucous on one or both surfaces, subcoriaceous, narrowly linear-elliptic to lanceolate, acute, apiculate, 12–20 × 3–4 mm, usually varying in length along the stem, the blade articulated to the sheath encircling the stem and ultimately deciduous; sheaths tightly clasping, to 4 × 3 mm. **Inflorescence** solitary, 1-flowered, emerging below foliage, the peduncle straight, to 15 mm long, provided at the base with 2 tubular, acute bracts, about 1.5 mm long. **Floral bract** double, the outer bract suborbicular-funnelform, obtuse, shorter than pedicel, 2 × 2 mm, the inner bract narrowly lanceolate, 2.5 mm long. **Ovary** cylindric-subclavate, glabrous, ca. 2.5 mm long including the pedicel. **Flower** ringent, rarely subspreading, the sepals and petals greenish cream spotted and/or blotched with purple, sometimes almost solidly purple, the lip creamy white, sparsely spotted with purple, mostly toward the apex, rarely solid purple, the column greenish white, flecked violet

along the margins of the stigma, anther cap purple-red; no fragrance detected. **Dorsal sepal** elliptic-lanceolate, acute, dorsally carinate, 6.0–9.0 × 2.5–3.2 mm. **Lateral sepals** lanceolate-elliptic, asymmetrical, falcate, acute, apiculate, usually upcurved in natural position, 7.5–12.0 × 3.0–4.1 mm. **Petals** obliquely ovate, shortly acute, wider than sepals, 6.0–8.5 × 4.0–5.0 mm. **Lip** 3-lobed, from a fleshy claw, 7–10 × 6–9 mm when spread, the hypochile obcuneate, sometimes provided at the base with a thickened area, 4–5 mm wide apically, the epichile broadly triangular-sagittate, obtuse to subrounded, minutely apiculate, adaxially carinate toward the apex, the lateral lobes narrowly triangular, acute, spreading-retrorse, decurrent in the lamina, 1.5 × 1.0 mm. **Column** erect, 5–6 mm long, with a distinct foot about 2 mm long, the reclined clinandrium shallow; ligule widely triangular, projecting downward, subacute, glabrous, 0.6 × 1.5 mm. **Anther cap** transversely elliptic-suborbicular, flattened, 2-celled. **Pollinia** 4, in 2 superposed pairs subequal in size, on a narrowly obtriangular-ligulate, subtruncate stipe with inrolled margins; viscidium elliptic. **Fruit** an elliptic, glabrous capsule.

DISTRIBUTION—The distribution of the species ranges from Mexico to Venezuela, Ecuador, and Brazil.

ECOLOGY—In Costa Rica, *D. panamensis* is a common species, recorded from warm tropical to premontane wet forests on both drainages of the Continental Divide, at 50–1350 m elevation, but is most commonly found between 400 and 900 m. It is a shade-loving epiphyte, occupying many different niches, with preference for old, moist branches and trunks of the understory vegetation. Flowering occurs year-round, with a peak in Costa Rica between April and June, corresponding to the beginning of the rainy season.

DISTINGUISHING FEATURES—Although amply variable in flower size and color, *D. panamensis* is vegetatively and florally unmistakable. The plants, rooting only at the base of the stems, have thick roots, and the leaves are mostly of variable length along a single stem. Leaves of *D. panamensis* are usually recorded as glaucous, but in the study area this character is variable; plants with glaucous leaves and with green leaves may be found at the same locality, and green and glaucous leaves are often present intermixed on different stems of individual specimens and sometimes also on a single stem. The flowers of *D. panamensis* vary in color from pale greenish white to almost solid purple, with any combination of purple-spotting, blotching, and flushing. However, their ringent shape (the flowers never spread out completely), the arrow-shaped lip, and the glabrous ovary make them easy to recognize.

Dichaea pendula (Aubl.) Cogn. *in* Urb., Symb. Antill. 4: 182. 1903. *Limodorum pendulum* Aubl., Hist. Pl. Guyane Franc. 2: 819–821, pl. 322. Type: French Guiana. "Habitat in sylvis Comitatus de Gêne," *Aublet s.n.* (holotype: P [sterile]; illustration of vegetative parts on plate 322 but excluding flower details, which represent mixed collections). *Epidendrum echinocarpon* Sw., Prodr. 124. 1788, *nom. illeg*. *Cymbidium echinocarpon* (Sw.) Sw., Nova Acta Reg. Soc. Sc. Uppsal. 6: 71. 1799, *nom. illeg*. *Dichaea echinocarpa* (Sw.) Lindl., Gen. Sp. Orch. Pl. 208. 1833, *nom. illeg*. *Pachyphyllum echinocarpon* (Sw.) Spreng., Syst. Veg. 3: 731. 1826, *nom. illeg*. Type: Jamaica. "Provenit ad latera saxorum arborumque inter muscos in umbrosis montium Jamaicae australis," *O. Swartz s.n.* (lectotype, selected by Pupulin [2007] W-*Rchb Orch* 25294). *Dichaea trachysepala* Schltr., Repert. Sp. Nov. Regn Veg. Beih. 27. 181. 1924. Type: Colombia. Cundinamarca: southwest of Bogotá, 2000 m, 1922, *R. Schnitter s.n.* (holotype, B, destroyed). *Dichaea echinocarpa* var. *lobata* Ames & Correll, Bot. Mus. Leafl. 11(3): 71, pl. 4, fig. 2. 1943. *Dichaea lobata* (Ames & Correll) L. O. Williams, Ceiba 1(3): 189. 1950. Type: Costa Rica. San José: La Palma, about 1600 m, *P. C. Standley 33120* (holotype: AMES 30208, *pro parte*). *Dichaea pendula* var. *swartzii* C. Schweinf., Bot. Mus. Leafl. 17(2): 161–162. 1955, *nom. illeg. Dichaea swartzii* (C. Schweinf.) Garay & Sweet, J. Arnold Arbor. 53: 397–398. 1972, *nom illeg*. Figure 33 (Voucher: *Pupulin 3024*, JBL-Spirit).

Epiphytic **herbs**, rarely terrestrial in humus embankments, cespitose, to 100 cm long. **Roots** filiform, basally exposed, glabrous, flexuous, about 0.4 mm in diam., the caulinar roots completely hidden by leaf sheaths. **Stems** flattened, pendent, apically arching to become patent-suberect, frequently branching, 15–100 cm long, 0.1 cm wide across conduplicate sheaths. **Leaves** closely spaced along stem, spreading, pale green, thin-herbaceous, the midvein neatly prominent abaxially, lanceolate, abruptly acuminate, dorsally apiculate, the apical margins irregularly and microscopically serrulate, 18–30 × 6–8 mm; sheaths loose, strongly compressed, to 7–8 × 3–4 mm. **Inflorescences** 1–2 per node, successive, 1-flowered, emerging below foliage (rarely above), the peduncle straight, to 16 mm long, provided at the base with 3 tubular, subacute bracts, the apical one subcampanulate and partially exposed, about 1.5 mm long. **Floral bract** double, the outer bract broadly ovate-infundibular, obtuse, shorter than pedicel plus ovary, 4.0 × 3.8 mm, the inner bract lanceolate-elliptic, 4.5 mm long. **Pedicel** cylindric, ca. 2 mm long. **Ovary** densely muricate, 2.5–3.0 mm long. **Flower** subspreading, the sepals and petals pale orange, the petals pale orange, distally spotted with purple, the lip white, boldly blotched with violet, with white margins, the column white, blotched with violet along the margins of the foot and the wings; no fragrance detected. **Dorsal sepal** elliptic to oblong, acute, curved over the column, dorsally carinate and sparsely verrucose, 7–8 × 3.5–4.5 mm. **Lateral sepals** elliptic to elliptic-ovate, slightly asymmetrical, acute, apiculate, dorsally carinate and sparsely verrucose, 7.5–8.0 × 3.7–4.7 mm. **Petals** elliptic, acute, with a rounded apicule, smaller than sepals, 6.3–7.5 × 3.0–3.8 mm. **Lip** thick, concave, subentire to distinctly 3-lobed, from a fleshy claw, 7.0–7.5 × 6–8 mm when spread, the hypochile broadly obcuneate, with distinct shoulders, the basal margins and shoulders microciliate, 6.5 mm wide apically, the epichile broadly triangular, obtuse, minutely apiculate, sometimes provided with short-triangular to linear-falcate, acute to long-acuminate, retrorse lateral lobes, 2–3 × 1 mm. **Column** suberect, 4.2–4.6 mm long, with a foot about 0.6 mm long, basally subterete, apically dilated into a shallow, reclined clinandrium, with entire margins, provided at the base with 2 semielliptic, narrow, flattened, ciliate wings; the stigma ovate-rounded, strongly depressed; ligule broadly linear to lanceolate, projecting forward, truncate, bifid, apically soft-hispid, 1.8 × 1.2 mm. **Anther cap** helmet-shaped, transversely elliptic, slightly flattened, 2-celled. **Pollinia** 4, suborbicular, in 2 superposed pairs of different sizes, on a narrowly obtriangular-ligulate, subtruncate stipe with inrolled margins; viscidium elliptic, hyaline. **Fruit** an elliptic, muricate capsule.

DISTRIBUTION—The species is known from Costa Rica and Panama to most of South America (Colombia, Ecuador, Bolivia, Venezuela, French Guyana, and northern Brazil) and the West Indies (Cuba, Dominica, Hispaniola, Jamaica, Guadeloupe, Martinique, and Puerto Rico).

ECOLOGY—In Costa Rica, *D. pendula* is apparently restricted to the wet premontane and submontane forest of the Tilarán, Central Volcanic, and Talamanca mountain chains, at elevations between 1200 and 2400 m. Here the plants are usually found on the trunks of old trees in deep shade. Although most of the records are from the Caribbean slopes of the northern chains, the species has been also recorded from the Pacific watershed of the Continental Divide in southern Costa Rica. In Costa Rica, flowering has been recorded from November to June, but the plants likely flower most of the year.

DISTINGUISHING FEATURES—Among Costa Rican species of the sect. *Dichaea*, the soft herbaceous, thin-textured, large leaves distinctly keeled along the midvein and the flowers

usually produced below the foliage (occasionally in pairs) are diagnostic of *D. pendula*.

Dichaea poicillantha Schltr., Repert. Sp. Nov. Regni. Veg. Beih. 19: 73–74. 1923. Type: Costa Rica. [San José: Moravia,] San Jerónimo, im Jahre 1921, *C. Wercklé 32* (holotype, B, destroyed; lectotype, designated by Pupulin [2007], tracing of Schlechter's drawing of the type, AMES). Figure 41–43 (Vouchers: *Whitten 2030*, JBL-Spirit; *Pupulin 3420*, CR; *Pupulin 2397*, JBL-Spirit, respectively).

Epiphytic, cespitose **herbs** to 90 cm long. **Roots** filiform, basally exposed, glabrous, flexuous, about 0.4 mm in diameter, the caulinar roots mostly hidden by leaf sheaths, rarely aerial. **Stems** flattened, stiffly pendent, frequently branching, 15.0–90.0 cm long, 0.1–0.15 cm wide across conduplicate sheaths. **Leaves** spreading, medium green to olive green or bronze green, soft-herbaceous to subcoriaceous, broadly ovate to elliptic-lanceolate, acute, dorsally apiculate, the margins smooth or microscopically serrulate toward the apex, 7–20 × 3–7 mm; sheaths clasping, loose at margin, compressed, to 4–10 × 2–5 mm. **Inflorescence** solitary, 1-flowered, emerging below foliage, the peduncle geniculate on emerging from sheath, 8–13 mm long, provided at the base with 3 sheathing, tubular, subacute bracts about 1.5 mm long. **Floral bract** double, the outer bract broadly ovate, clasping-infundibular, abruptly apiculate, shorter than pedicel plus ovary, 3.5–4.5 × 3–4 mm, the inner bract lanceolate, 2.5–3.0 mm long. **Pedicel** cylindric, 1.5–2.0 mm long. **Ovary** densely soft-muricate, ca. 2 mm long. **Flower** bowl-shaped to spreading, the sepals and petals pale gray-orange, sparsely spotted with violet, the lateral sepals mostly spotted in upper half, the petals pale orange, boldly blotched with violet-purple, the lip white with violet shoulders, the epichile solid violet; the column yellow-green with violet wings, marked violet along the margins of the stigma and on foot; no fragrance detected. **Dorsal sepal** oblong-elliptic to elliptic, acute to subacuminate, often curved over the column, dorsally low-tuberculate, 8.5–14.0 × 3.5–6.0 mm. **Lateral sepals** narrowly ovate to elliptic-oblong, acute to shortly acuminate, concave, dorsally low-tuberculate, 7.5–11.0 × 3.2–5.0 mm. **Petals** elliptic to oblong, bent, acute to subacuminate, with a rounded apicule, sometimes longer than sepals, 7.5–11.0 × 3.0–5.5 mm. **Lip** 3-lobed, anchoriform from a short, fleshy claw, 6.0–7.5 × 8.5–13.0 mm when spread, the hypochile squared-broadly obcuneate, with rounded, ciliate shoulders, 5.5 mm wide apically, the epichile transversely elliptic, broadly obtuse to rounded, minutely apiculate, sometimes infundibular subapically, provided with long-attenuate, spreading to slightly retrorse lateral lobes, 2–3 × 0.5 mm. **Column** suberect to erect, 3.5–4.0 mm long, with a foot about 0.7 mm long, basally subterete, apically dilated into a petaloid, erect clinandrium, with irregularly erose-denticulate margins, provided at the base with two semielliptic, basally subquadrate, flattened, densely ciliate wings; the stigma ovate-rounded to obtrullate, depressed; ligule broadly oblong, projecting forward, truncate, apically soft-hispid, 1.3–1.8 × 1.0–1.2 mm. **Anther cap** cucullate, transversely elliptic, flattened, 2-celled. **Pollinia** 4, obovate-complanate, in 2 superposed pairs of different sizes, on a narrowly obtriangular, truncate stipe; viscidium elliptic-peltate, hyaline. **Fruit** an elliptic, muricate capsule.

DISTRIBUTION—*Dichaea poicillantha* is known from Nicaragua to Panama, perhaps ranging north to Mexico.

ECOLOGY—The species is widespread in tropical to submontane wet forests at 200–2500 m elevation, where it often forms large clumps. Large populations of *D. poicillantha* are commonly found in shady areas along the Caribbean slopes and close to the Continental Divide in the Tilarán and Central Volcanic ranges as well as on both the watersheds of the Cordillera de Talamanca. No records are known from the northern volcanic chain of Guanacaste. Flowering has been recorded throughout the year, with a flowering peak during the months between May and July, corresponding to the beginning of the rainy season in Costa Rica.

DISTINGUISHING FEATURES—No isotypes, syntypes, or paratypes for this species exist. The drawing at AMES designated as the type shows the broad ligule and the labellar outline that are diagnostic characters. Three main vegetative morphs of *D. poicillantha* (according to leaf arrangement, size, shape, texture, and color) exist in Costa Rica, but variations in flower morphology are restricted mainly to flower size, relative size of sepals and petals, and the size of the petaloid clinandrium. No correlation seems to exist between morphs on the basis of vegetative characters and the corresponding flower morphology, and the species is somewhat difficult to define on the sole basis of morphological characters. Potential synapomorphies include the stiffly pendent, multibranched habit; the gray-orange background color of the sepals; the transversely elliptic, rounded-apiculate epichile provided with long, narrowly ligulate lateral lobes, almost transverse to the lip axis when spread; and the broad, truncate ligule of the column. Populations of *Dichaea muricatoides* collected near Costa Rican borders are difficult to distinguish if not inseparable from *D. poicillantha*, and I suspect that this name should be reduced under the synonymy of the former species.

Dichaea sarapiquinsis Folsom, Orch. Dig. 58: 188–189. 1994. Type: Costa Rica. Heredia: near Pto. Viejo, on trees along stream system in property adjacent to La Selva Biological Preserve, 22 May 1981, *J. P. Folsom 9999* (holotype: CR; isotype: TEX). Figure 36 (Voucher: *Pupulin 4856*, JBL-Spirit).

Epiphytic, cespitose **herbs** to 60 cm long. **Roots** filiform, exposed at the base, the caulinar roots mostly hidden by leaf sheaths, 0.4–0.6 mm in diameter. **Stems** laxly pendent, flattened, 20–60 cm long, 0.8–1.2 mm wide across conduplicate sheaths, rarely branching. **Leaves** widely spaced along stem, spreading-retrorse, thin-herbaceous, olive green, 7.0–9.0 × 3.0–3.8 mm, ovate-lanceolate, subacute, the apex shortly acuminate, abaxially apiculate, the apical margins irregularly and minutely serrulate, curled backwards, without conspicuous cross-veining; sheaths clasping, the margins free, undulate, 4.0–4.5 × 2.0–2.5 mm. **Inflorescences** solitary, 1-flowered, emerging above foliage; pedicel terete, geniculate to become perpendicular to stem, 7–11 mm long, provided with 2–3 basal, tubular, short acuminate bracts, expanding apically, 4–5 mm long. **Floral bract** double, the outer bract widely ovate, acuminate, cucullate, 2.5–3.0 × 2.5 mm, the inner bract narrowly lanceolate, 2.5 mm long. **Pedicel** cylindric, ca. 1 mm long. **Ovary** 1 mm long, densely muricate. **Flower** subspreading, the sepals cream-white, barred to boldly blotched with violet-purple, abaxially sparsely low-tuberculate, the lip almost completely violet, with a white band at the apex of the hypochile; the column white, marked with violet along wings and on the foot; no fragrance detected. **Dorsal sepal** curved over the column, concave, oblong, acute, 7.0–9.0 × 2.7–3.0 mm. **Lateral sepals** obliquely elliptic-lanceolate, concave, acute, 7–8 × 3 mm. **Petals** broadly oblanceolate, incurved toward apex, subacute, 6–7 × 3.5–4.0 mm. **Lip** 3-lobed, anchoriform, with an indistinct claw, 6.0 × 7.0–8.5 mm when spread, the claw 0.5 mm, the hypochile broadly cuneate, with indistinct, rounded shoulders, 3 mm long, 5 mm wide at apex, the epichile transversely ovate-elliptic, truncate, sometimes apiculate, low tuberculate toward apex, 3 × 7 mm, laterally producing recurved, linear-subulate, acute lobes, 2.0–2.5 × 1.0–1.3 mm. **Column** erect, 5 mm long, with distinct foot, the clinandrium shallowly cucullate, irregularly erose-crenulate, provided with rounded, flattened, ciliate wings; the stigma transversely rhombic; ligule projecting to apically curved upward, oblong, truncate, apically hispid, 1.5 × 0.5 mm. **Anther cap** broadly ovate, cucullate, flattened, 2-celled. **Pollinia** 4, in 2 pairs of different sizes, on a narrowly obtriangular, apically dilated stipe; the viscidium elliptic-peltate, hyaline. **Fruit** an elliptic capsule, densely muricate.

DISTRIBUTION—The species is endemic to Costa Rica.

ECOLOGY—Populations of *D. sarapiquinsis* are found as epiphytes in wet and warm tropical forests, mostly along rivers, between 200 and 400 m elevation, along the Caribbean plains and the basal slopes of the Central Volcanic chain. Plants grow in medium shade, mostly along water streams, where they form large populations. Flowering has been

recorded from November to May, but the plants likely flower most of the year.

DISTINGUISHING FEATURES—*Dichaea sarapiquinsis* is closely related to *D. obovatipetala*, which ranges southward to Panama. The differences between the two taxa are subtle, consisting mainly of a different organization of the stems (laxly pendent, rarely branched in *D. sarapiquinsis* vs. scandent to stiffly pendent and many-branched in *D. obovatipetala*), the shape of the lip epichile (subtruncate in *D. sarapiquinsis* vs. rounded, apically infolded in *D. obovatipetala*), and the presence in *D. sarapiquinsis* of low but distinct tubercles along the veins toward the adaxial leading edge of the lip, which are absent in *D. obovatipetala*. Among Costa Rican species of the sect. *Dichaea*, this ridging is diagnostic of *D. sarapiquinsis*.

Dichaea similis Schltr., Repert. Sp. Nov. Regni Veg. Beih. 19: 307. [November] 1923. Type: Costa Rica. [Alajuela:] Umgebung von San Ramón, im Jahre 1921, *G. Acosta s.n.* (holotype, B, destroyed; isotype, AMES [a fragment of stem]; copy of Schlechter's drawings of the type, made under the supervision by Schlechter's, AMES). *Dichaea schlechteri* Folsom, Orch. Dig. 58: 189–190. 1994. Type: Costa Rica. San José: Braulio Carrillo Park, 500–700 m, 16 Sep. 1984, *J. P. Folsom 11005* (holotype: CR; isotype: TEX). Figure 45 (Voucher: *Pupulin 4808*, JBL-Spirit).

Epiphytic, cespitose **herbs** to 60 cm long. **Roots** flexuous, glabrous, ca. 0.4 mm in diameter, exposed at the base of the stem, the caulinar roots mostly hidden by leaf sheaths, rarely aerial. **Stems** flattened, patent (when young) to pendent, rarely branching, 15–60 cm long, 0.2–0.3 cm wide across conduplicate sheaths. **Leaves** closely spaced along stem, not overlapping, spreading, green, soft-herbaceous, broadly ovate, obtuse, minutely apiculate, 6–11 × 4–9 mm; sheaths tightly clasping the stem, to 6 × 7 mm. **Inflorescences** solitary, 1-flowered, emerging above foliage, patent, the peduncle geniculate, 1.2–1.5 cm long, provided at the base with 2 tubular, papery bracts, 0.2 cm long. **Floral bract** double, the outer bract infundibuliform, ovate, shortly acuminate, shorter than ovary, 2.5 × 3.5 mm, the inner bract narrowly lanceolate, acute, 2.5 mm long. **Pedicel** cylindric, to 1.7 mm long. **Ovary** long-muricate, 2 mm long. **Flower** ringent to subspreading, with sepals and petals greenish white, spotted with violet, the sepals sparsely tuberculate externally, the lip white, speckled with violet, the column white, marked with purple on the wings and along the margins of the stigma. **Dorsal sepal** narrowly elliptic-lanceolate, acute, 6.0–12.0 × 2.5–4.0 mm. **Lateral sepals** obliquely narrowly elliptic-lanceolate, subfalcate, acute to subacuminate, 6.0–10.0 × 2.5–3.5 mm. **Petals** lanceolate, shortly acuminate, 6–10 × 3–4 mm. **Lip** 3-lobed, clawed, 5–7 × 7–9 mm when spread, the claw linear, basally thickened-subterete, the hypochile transversely elliptic-cuneate, without shoulders, the margins ciliate, 3.0–4.5 mm wide apically, the epichile triangular, apiculate, the apical margins introrse, the lateral lobes narrowly triangular-subulate, acuminate, spreading, to 3.0 × 0.8 mm. **Column** erect, 4 mm long, provided with narrowly elliptic, sparsely short-ciliate wings, the clinandrium petaloid, irregularly erose; ligule narrowly triangular-linear, truncate, tomentose, 2.5 × 0.8 mm. **Anther cap** broadly ovate, cucullate, flattened, 2-celled. **Pollinia** 4, in 2 superposed pairs subequal in sizes, on an obtriangular, obtuse-subtruncate stipe; viscidium elliptic. **Fruit** not seen.

DISTRIBUTION—The species is known from Costa Rica and Nicaragua.

ECOLOGY—Plants of *D. similis* are found as uncommon epiphytes in the submontane wet forests of the Tilarán and Central Volcanic ranges, at 500–1100 m elevation. Flowering occurs at least from January to September.

DISTINGUISHING FEATURES—*Dichaea similis* is closely related to *D. cryptarrhena*, but mature specimens of the latter species are usually recognized by their broad, thick-herbaceous, overlapping leaves and the remarkably consistent floral morphology. Plants of *D. similis* have a more scandent habit, provided with smaller leaves of a thinner substance, closely spaced along the stem but usually not overlapping. The flowers of *D. similis* have sepals and petals with few violet spots, frequently concolorous pale green, and the column has comparatively more prominent wings and a narrower ligule than *D. cryptarrhena*. Furthermore, the lateral lobes of the epichile of *D. similis* are spreading to slightly retrorse, whereas the lip of *D. cryptarrhena* has strongly retrorse-falcate to uncinate lateral lobes.

Dichaea squarrosa Lindl., Ann. Nat. Hist. 4: 384. 1840. Type: Mexico. Mountains of Tequila, *Hartweg s.n.* (holotype: K; isotype: K [drawing]). Figure 32 (Voucher: *Bogarín 254*, JBL-Spirit).

Epiphytic, cespitose **herbs** to 20 cm long. **Roots** basal and caulinar, often exposed and aerial or hidden by leaf sheaths, flexuous, minutely verrucose, to 2.2 mm in diam. **Stems** subterete, scandent to pendent (rarely suberect), freely branching, 6–20 cm long, 0.3–0.5 cm wide across conduplicate sheaths. **Leaves** widely spaced along stem, spreading-retrorse, gray-green, thick-succulent, 4–14 × 2–4 mm, lanceolate, obtuse to rounded, minutely apiculate; sheaths tightly clasping the stem, to 8 × 3 mm. **Inflorescences** solitary, 1-flowered, emerging above foliage, the peduncle geniculate, 4–7 mm long, provided at the base with a tubular, acute bract, about 2 mm long. **Floral bract** double, the outer bract widely triangular-infundibular, acute, 2 × 2 mm, the inner bract narrowly lanceolate, 2 mm long. **Pedicel** cylindric, ca. 1 mm long. **Ovary** short-muricate, 1 mm long. **Flower** commonly ringent, rarely spreading, strongly scented, with sepals and petals thick-succulent, cream-yellow to pale orange, the sepals externally tuberculate, the lip white, barred and blotched violet toward the base, apically solid violet, the column white to pale orange-yellow, marked with violet on the margins of wings and along the stigmatic rim. **Dorsal sepal** elliptic, obtuse to shortly acute, 6.7–8.0 × 3–4 mm. **Lateral sepals** obliquely broadly elliptic, asymmetrical, shortly acute, 6.8–8.0 × 4.0–4.5 mm. **Petals** elliptic-oblong, shortly subacute, 6.0–8.0 × 3.0–5.5 mm. **Lip** 3-lobed, subsessile, 5.0–5.8 × 5.7–7.1 mm when spread, the hypochile widely obcuneate-rounded, with scarcely pronounced, glabrous shoulders, 5 mm wide apically, the epichile triangular, obtuse, apiculate, the lateral lobes broadly triangular, rounded, spreading, decurrent on the lamina, 1.3 × 1.0 mm. **Column** suberect, 4.5 mm long, provided with rounded, flattened, ciliate wings, the apical clinandrium reclined, continuous with the basal wings; ligule broadly triangular, projecting downward, truncate, pubescent, 0.7 × 1.7 mm. **Anther cap** broadly cordate, 2-celled. **Pollinia** 4, in 2 superposed pairs of slightly different sizes, on a narrowly obtriangular-ligulate, broadly obtuse stipe; viscidium elliptic, hyaline. **Fruit** a muricate capsule.

DISTRIBUTION—The species has been recorded from Mexico to western Panama.

ECOLOGY—In Costa Rica, *D. squarrosa* is an uncommon epiphyte, seemingly restricted to the Caribbean, submontane wet forests of the main mountain chains at elevations between 2000 and 2500 m. Flowering occurs at least in June and July, at the end of the dry season in Costa Rica.

DISTINGUISHING FEATURES—*Dichaea squarrosa* is one of the easiest species to identify in the study area. The rounded stems and the almost linear, leathery, thick, coriaceous leaves usually allow positive determination of this species even from sterile and dried material. The leaves of *D. trichocarpa*, which also has rounded stems, are lanceolate and have a thinner substance. Moreover, the lip of *D. squarrosa* is clawed, with an obcuneate hypochile, whereas *D. trichocarpa* has a sessile lip and a rounded-discoid hypochile.

Dichaea trichocarpa (Sw.) Lindl., Gen. Sp. Orch. Pl. 202. 1833. *Epidendrum trichocarpon* Sw., Prodr. 124. 1788. *Cymbidium*

trichocarpon Sw., Nova Acta Reg. Soc. Sc. Uppsal. 6: 71. 1799; Fl. Ind. Occ. 3: 1455, emend. Type: Jamaica. "Parasiticum in truncis muscosis arborum, versus juga montium Jamaicae australis," *O. Swartz s.n.* (lectotype, designated by Pupulin [2007], W-Rchb Orch 25293). Figure 31 (Voucher: *Pupulin 3207*, JBL-Spirit).

Epiphytic, cespitose **herbs** to 50 cm long. **Roots** basal and caulinar, often exposed and aerial or hidden by leaf sheaths, flexuous, to 0.8 mm in diam. **Stems** subterete, slightly compressed, scandent to pendent, freely branching, 10–50 cm long, 0.20–0.25 cm wide across conduplicate sheaths. **Leaves** widely spaced along stem, retrorse-spreading, medium green, thin leathery, 3–11 × 2–3 mm, lanceolate, acute to shortly acuminate; sheaths tightly clasping the stem, to 6 × 3 mm, often marked with darker green spots. **Inflorescences** solitary, 1-flowered, emerging above foliage, the peduncle gently geniculate, 4–12 mm long, provided at the base with a tubular, acute bract, about 3 mm long, slightly emerging from sheath. **Floral bract** double, the outer bract widely ovate-infundibular, subcuspidate, 2.5 × 2.5 mm, the inner bractlet narrowly lanceolate, 1.5–2.0 mm long. **Ovary** ca. 2 mm long, densely long-muricate. **Flower** spreading, strongly scented, with sepals and petals thick-succulent, white to cream-white, the sepals externally tuberculate, the lip yellowish white marked with violet or yellow at the base to almost solid violet, the column white to pale yellow, marked with violet on the margins of wings. **Dorsal sepal** lanceolate-elliptic, acute, abaxially carinate, 5–7 × 2–3 mm. **Lateral sepals** obliquely ovate-elliptic to oblong-lanceolate, acute, abaxially carinate, 5.0–7.0 × 2.5–4.0 mm. **Petals** elliptic-oblong, obtuse, shortly subapiculate, irregularly toothed toward the apex, 4.5–6.0 × 2.0–2.5 mm. **Lip** 3-lobed, sessile, 3.0–5.0 × 2.7–3.3 mm when spread, the hypochile suborbicular-discoid, concave in natural position, 2.5–3.0 mm wide apically, the epichile broadly triangular-subtrapezoidal, obtuse-subtruncate, strongly conduplicate, the lateral lobes not sharply distinct from epichile blade, broadly triangular, rounded-subtruncate, irregularly toothed toward the apex, spreading, 1.0 × 1.3 mm. **Column** continuous with the ovary axis, subterete, 3 mm long, provided with narrowly rectangular, flattened, ciliate wings, the suprarostellar area and the clinandrium strongly reclined, shallow; ligule thickened at the base, broadly triangular, truncate to slightly bifid, glabrous to microscopically pubescent, 0.8 × 1.0 mm. **Anther cap** broadly obovate-subcordate, 2-celled. **Pollinia** 2, transversely elliptic-subcordate, complanate, different in size, superposed, without stipe and definite viscidium. **Fruit** a rounded, muricate capsule.

DISTRIBUTION—The species is known from Guatemala to Panama and the Greater Antilles.

ECOLOGY—In Costa Rica, *D. trichocarpa* is an uncommon epiphyte, usually found in submontane wet forest and cloud forests close to the Continental Divide, at elevations between 1400 and 2000 m. Flowering mostly occurs in July and August, but the species also flowers irregularly during the year.

DISTINGUISHING FEATURES—The subterete stems; the semisucculent, usually strongly retrorse leaves; and the scented flowers with a discoid, concave hypochile easily distinguish *Dichaea trichocarpa* from the closely related *D. squarrosa* and other species in the genus in Costa Rica.

Dichaea trulla Rchb.f., Beitr. Orch. Centr.-Amer. 104. 1886. *Epithecia trulla* Schltr., Orchis 9: 26. 1915. *Dichaeopsis trulla* Schltr. Bot. Centralbl. Beih. 36(2): 519. 1918. Type: Nicaragua. [Zelaya, Bluefields,] Pearley Lagoon auf Palmen, 5.1.1855, *H. R. Wullschlägel s.n.* (holotype: W). *Dichaea powellii* Schltr., Repert. Sp. Nov. Regni Veg. Beih. 17: 90. 1922. Type: Panama. Canal Zone, foothills east of Panama City, near Bohio, sea level, "Flowers sepals et al. petals a yellow greenish. The lip a deep blue," *C. W. Powell 23* (holotype, B: destroyed, copy of Schlechter's drawing of type, AMES; isotype: selected as lectotype by Christenson [1991], AMES 61229). *Dichaea brenesii* Schltr., Repert. Sp. Nov. Regni Veg. Beih. 19: 264. 1922. Type: Costa Rica. San Pedro de San Ramón, 1075 m, XI-1921, *A. M. Brenes 66* (holotype, B, destroyed, copy of Schlechter's drawing of type, AMES; isotype, designed by Barringer [1984] as lectotype, CR 18458). Figure 18 (Voucher: *Castelfranco 136*, JBL-Spirit).

Epiphytic, cespitose **herbs** to over 1 m long. **Roots** basal and caulinar, the caulinar ones completely hidden by leaf sheaths, flexuous, to 0.8 mm in diameter. **Stems** subterete, erect when young, becoming arching-pendent with age, the apex gently upcurved, 15–110 cm long, 0.3–0.5 cm wide across conduplicate sheaths. **Leaves** articulate with the sheaths, widely spaced along stem, spreading, (medium to) dark green, shiny, subcoriaceous, abaxially subcarinate, 5.0–11.0 × 0.4–0.6 cm, narrowly lanceolate-ligulate, acute to acuminate; sheaths tightly clasping the stem, to 2.5 × 1.0 cm, often flushed with purple-brown. **Inflorescences** solitary, 1-flowered, emerging below foliage, the peduncle straight, 22–25 mm long, provided at the base with two imbricating, membranaceous, acute bracts, about 3 mm long. **Floral bract** double, the outer bract ovate-infundibular, subcuspidate, 4 × 4 mm, the inner bractlet narrowly lanceolate, 3.0–3.5 mm long. **Ovary** 2.5 mm long, cylindric-subclavate, glabrous. **Flower** spreading, thick-succulent, microscopically pubescent, the sepals and petals becoming reflexed with age, yellowish green to pale green, the lip dark violet blue on a white background, the column white to pale yellowish green. **Dorsal sepal** oblong to narrowly obovate-elliptic, acute, abaxially carinate, 7–10 × 4–5 mm. **Lateral sepals** obliquely elliptic to elliptic-lanceolate, acute, abaxially carinate, 7–11 × 4–5 mm. **Petals** elliptic-lanceolate, acute to shortly apiculate, slightly conduplicate-concave toward the apex, 1–10 × 3.5–4.5 mm. **Lip** 3-lobed, broadly trulliform, sessile, 8–9 × 6–7 mm when spread, the hypochile narrowly obcuneate, thickened at the base into a transversely elliptic, rounded callus, 5–6 mm wide apically, the epichile semiorbicular-reniform, obtuse to truncate, with an abaxial apicule, deeply conduplicate-concave in natural position, the lateral lobes not sharply distinct, triangular, obtuse to acute, retrorse, 1.0 × 0.7 mm. **Column** continuous with the ovary axis, subterete, ventrally flattened, to 6.5 mm long, provided with linear, flattened, ciliate wings, the clinandrium shallow with shortly bidentate margins; ligule triangular, acute, apically pubescent, gently arching toward the column, 2 × 1 mm. **Anther cap** transversely elliptic, emarginate, 2-celled. **Pollinia** 4, broadly elliptic-suborbicular, complanate, in 2 superposed pairs of different sizes, transversely arranged on a narrow ligulate stipe; viscidium peltate. **Fruit** an elliptic capsule, 2.0 × 1.3 cm.

DISTRIBUTION—The species is distributed from Honduras to Panama, Venezuela and Guyana, Colombia, Ecuador, Peru, and Bolivia.

ECOLOGY—*Dichaea trulla* is a widespread and common epiphyte in tropical and premontane rain to wet forests, where it can be found between 50 and 1300 m. In northern Costa Rica, it is restricted to the Caribbean watershed or occasionally on both the slopes close to the Continental Divide. Along the Talamanca chain, plants of this species have been collected at mid-elevations also in the Pacific watershed. Flowering occurs sporadically throughout the year.

DISTINGUISHING FEATURES—*Dichaea trulla* is the tallest member of the genus in Costa Rica, and its characteristic habit, with long, narrow, and pointed leaves, makes it unmistakable even when it is not in flower. Flower shape and color are remarkably similar throughout the distributional range of the species in Costa Rica, where *D. trulla* has no closely allied species.

Dichaea tuerckheimii Schltr., Orchis 10: 188. 1916, *non* Kraenzl. (1923). *Dichaea guatemalensis* Schltr., Orchis 10: 190, *sphalm*. Type: Guatemala. "Wurde von Baron v. Tuerckheim im Jahre 1912 an Herrn Prof. Dr. Goldschmidt in Essen geschickt und blüte in dessen Sammulung im Juli 1916" (holotype: B, destroyed; lectotype, selected by Pupulin [2007], flower analysis published with the protologue and reproduced in Mansfeld [1931: pl. 80, no. 317]. *Dichaea glabrescens* Kraenzl., Pflanzenr. 4(50): 41. 1923. Type: Costa

Rica. [1867], *A. R. Endrés 118* (holotype: W). *Dichaea wercklei* Schltr., Repert. Sp. Nov. Regni Veg. Beih. 19: 74. 1923. Type: Costa Rica. [San José: Carrillo,] La Palma, fruchtend im Juni 1921, *C. Wercklé 79* (syntype: B, destroyed; lectotype, selected by Pupulin [2007], tracing of Schlechter's drawing of the type, AMES 31573; flower analysis reproduced in Mansfeld, 1931); ebendort, 1400 m, ohne Blüten im März 1908, *A. Brade & C. Brade 1300* (syntype: B, destroyed). Figure 28 (Voucher: *Whitten 2097*, JBL-Spirit).

Epiphytic, prostrate-scandent **herbs**, forming large mats to 60 cm wide. **Roots** filiform, basal and caulinar, to 0.3 mm in diameter, the upper roots mostly hidden by leaf sheaths, sometimes exposed and aerial. **Stem** subterete, slightly compressed, 5–14 cm long, 0.6–1.0 mm wide across conduplicate sheaths, covered by the leaf sheaths, freely branching. **Leaves** numerous, distichous, not articulated, delicately membranous, well spaced along the stem, smooth, spreading, medium green, 3.0–4.0 × 1.5–2.0 mm, ovate to ovate-oblong, acute to subacuminate, the apex shortly aristulate; sheaths 2.5–3.0 × 3.0 mm, clasping, the apical margins slightly inflated, often spotted darker green. **Inflorescence** axillary, 1-flowered, produced above the foliage; the peduncle terete, glabrous, green, suberect to gently geniculate, 7–8 mm long, provided at the base with a papery, imbricating, acute bract, about 1 mm long. **Floral bracts** in pairs, the outer one orbicular, cucullate, acute to apiculate, 2 × 2 mm, the inner one linear, acute, 2.3–3.0 mm long. **Ovary** terete, glabrous, to 1.5 mm long including the pedicel. **Flowers** small, spreading, membranous, glabrous, the sepals and petals cream to pale green, densely blotched with violet purple, the lip white to cream-white, spotted violet, the column white, marked violet along infrastigmatic margins. **Dorsal sepal** ovate-elliptic to lanceolate, acute-subacuminate, 4.0–4.5 × 1.3–1.5 mm. **Lateral sepals** obliquely elliptic-lanceolate, acute-subacuminate, slightly concave, 4.0–4.5 × 1.5–1.8 mm. **Petals** narrowly lanceolate-elliptic, narrower than sepals, shortly acuminate, 3.8–4.0 × 1.0–1.3 mm. **Lip** unguiculate, the claw fleshy, linear-obcuneate, 0.5 mm long, with a central, low ridge decurrent in the blade; the lamina ovate-triangular from a rounded base, subacute, shortly acuminate, concave, 4.0–4.5 × 2.0–2.2 mm, provided at the base with 2 mammillate, rounded calli. **Column** straight, parallel to the ovary axis, terete, 1.8 mm long, the suprarostellar area and the shallow clinandrium strongly reflexed; stigma suborbicular, protruding at the base into a rounded, glabrous ligule. **Anther** dorsal, the anther cap ovate-cordate, membranous, 2-celled. **Pollinia** 4, obpyriform, slightly compressed, on a narrow obtriangualar stipe; viscidium linear-oblong, white. **Fruit** an elliptic, glabrous capsule, 9 × 3 mm.

DISTRIBUTION—The species is known from Guatemala to Colombia.

ECOLOGY—Plants of *D. tuerckheimii* are common epiphytes in deep shade in wet tropical to premontane forests and cloud forests at 100–1300 m elevation. Populations of this species may be found in Costa Rica along the Caribbean drainage of the Guanacaste, Tilarán, and Central Volcanic mountain ranges and on both the watersheds of the Continental Divide along the Talamanca range. Known from Guatemala to Colombia. Flowering occurs mostly from May to August, but sporadic flowering has been observed throughout the year.

DISTINGUISHING FEATURES—The fern-like habit (the smallest in the genus); the scandent-prostrate, freely branching stems; and the persistent, delicately membranous, glabrous leaves easily distinguish *D. tuerckheimii* from any other *Dichaea* species. Flower morphology is also peculiar for the presence of two mammillose basal calli on the lip, the entire lamina, and the straight column with reflexed, dorsal anther.

Dichaea viridula Pupulin, Harvard Pap. Bot. 10(1): 85. 2005. Type: Costa Rica. Cartago: Paraíso, Orosi, Tapantí, Parque Nacional Tapantí, El Mirador, 9°44′13.5″N, 83°46′49.6″W, 1376 m, epífita en sitio sombreado en ramitas jovenes de *Oreomunnea* (Juglandaceae), 24 Aug. 2004, *D. Bogarín 925*, *H. León-Páez & E. Hoppe* (holotype: USJ-Spirit). Figure 27 (Voucher: *Bogarín* 925 (JBL-Spirit) and *Pupulin 4652*, USJ).

Epiphytic, cespitose, pendent **herbs**, to 60 cm long. **Roots** filiform, ca. 1 mm in diameter. **Stem** compressed, covered by the slightly inflated leaf sheaths, rarely branching toward the apex. **Leaves** numerous, distichous, closely spaced along the stem, not articulated, delicately membranous, smooth, deflexed, 7–12 × 3.5–6.5 mm, ovate-lanceolate to oblong, obtusely acute, the apex aristulate, dark green, the margins neatly undulate; sheaths 4–5 mm long, inflated, margins undulate. **Inflorescence** axillary, 1-flowered, produced above the foliage; the peduncle terete, glabrous, green, geniculate, 7–9 mm long. **Floral bract** double, the outer one orbicular, cucullate, acute to apiculate, the inner one linear, acute, shorter than ovary. **Ovary** terete, glabrous, to 3 mm long including the pedicel. **Flower** subglobose, membranous, glabrous, the sepals and petals pale green, the lip and column white. **Dorsal sepal** elliptic-lanceolate, acute-acuminate, cucullate, 6 × 2 mm. **Lateral sepals** obliquely elliptic, concave, 6.0 × 2.5 mm. **Petals** elliptic-lanceolate, narrower than sepals, abruptly acuminate, 3.0 × 1.5 mm, abaxially carinate along the mid-nerve. **Lip** cupped, the hypochile subrhomboid, from a cuneate base, provided with 2 rounded, tumid, lateral lobes and a low, smooth, rounded, ridge-like longitudinal callus; the epichile hastate, 3-lobed, with obtusely falcate, retrorse lateral lobes, the apical lobe triangular-cuspidate, the margins incrassate; 5.5 × 2.0 mm wide across the hypochile, 5.5 mm wide across the spread lateral lobes. **Column** suberect, semiterete, 2.7 mm long, slightly recurved at the triangular apex, dilated on each side of stigma, the margins of clinandrium incurved; stigma suborbicular, the lower margin provided with a subcuneate, upcurved, apically bilobed, puberulent ligule. Anther terminal to subventral, the **anther cap** obovate-reniform, membranous, 2-celled. **Pollinia** 4, triangular-obovate, compressed, on a spatulate stipe; viscidium linear-oblong, white. **Fruit** an elliptic, glabrous capsule, 12 × 5 mm.

DISTRIBUTION—Endemic to Costa Rica.

ECOLOGY—Epiphytic in deep shade in wet premontane forest at 700–1400 m elevation, *D. viridula* is restricted to the Caribbean drainage of Cordillera de Tilarán and Cordillera de Talamanca in central Costa Rica. Flowering has been recorded in May, August, October, and December, and the plants probably flower year-round.

DISTINGUISHING FEATURES—Among Costa Rican species of sect. *Dichaea*, *D. viridula* may be easily recognized by the thin-textured leaves with the margins neatly undulate and leaf venation apparent also in the loose leaf sheaths. Another distinctive feature is the bilobed, barbate, upcurved infrastigmatic ligule, shared in the region only by the distantly related *D. oxyglossa*.

Excluded Taxa

Dichaea diandra Rchb. f., Bot. Zeit. 35: 41. 1877. Type: Costa Rica. *Endrés s.n.* (holotype: to be found in the Reichenbach Herbarium, W, not located; no isotypes known to exist). Endrés's type collection is likely referable to a species of sect. *Dichaea*, the only group that has abaxially verrucose sepals ("*sepalis extus minute verrucosis*"). However, Reichenbach's diagnosis is contradictory. He first assigns the species to a group with muricate fruits ("Echinocarpae"), but later on he describes the ovary as glabrous ("*ovario laeve*"). Naked pollinia, without any stipe or viscidium ("*caudicula glandulaque destitutis*"), are otherwise known in *D. trichocarpa*, but the lip of this species with its characteristic discoid hypochile is hard to define as "*humeratus*." The column of *D. diandra*, with two lateral anthers ("*in mediana oppositis*"), was likely a chimaera, and in the absence of a type specimen or any other material

associated with the original protologue, Reichenbach's diandrous *Dichaea* cannot be assigned with certainty to any of the known taxon.

Dichaea graminoides (Sw.) Lindl., Lindl., Gen. Sp. Orch. Pl. 209. 1833. Bas.: *Epidendrum graminoides* Sw., Prodr. 125. 1788. *Cymbidium graminoides* (Sw.) Sw., Nova Acta Regiae Soc. Sci. Uppsal. 6: 71. 1799. *Isochilus graminoides* (Sw.) Hook., Exot. Fl. 3: t. 196. 1826. *Epithecia graminoides* (Sw.) Schltr., Orchideen: 534. 1914. *Dichaeopsis graminoides* (Sw.) Schltr., Beih. Bot. Centralbl. 36(2): 519. 1918. Type: Jamaica. ''Incolit arbores Regionis temperatae montium Jamaicae australioris,'' *O. Swartz s.n.* (isotypes, BM, UPS, W). Although recorded by Mora-Retana and García (1992) and by Dressler (1993b), no voucher has so far confirmed the presence in Costa Rica of this widely distributed and distinctive species. *Dichaea graminoides* is known from the adjacent regions of Nicaragua and Panama, and its presence in Costa Rica is likely. Its basally biauriculate lip, with a high longitudinal callus, should be diagnostic.

Dichaea muricatoides Hamer & Garay, Orq. El Salv. 1: 148. 1974. Replaced name: *Dichaea tuerckheimii* Kraenzl., Pflanzenr. 4(50): 39. 1923, *non* Schltr. 1916. Type: Guatemala. *H. F. von Türckheim s.n.* (holotype: W). In his recent treatment of Costa Rican Orchidaceae, Dressler (2003) included *D. muricatoides* on the basis of a specimen at CR, which I was unable to locate. However, the description provided by Dressler does not differ from some of the morphs of the variable *D. poicillantha*.

Dichaea neglecta Schltr., Beih. Bot. Centralbl. 36,2: 420. 1918. *Dichaea muricata* var. *neglecta* Kraenzl., Pflanzenr. 4(50): 38. 1923. Syntypes: Mexico. *Schiede 1053* (B, destroyed; drawing of the type, AMES 24900); Valle de Córdoba, Jan. 1866, *Bourgeau 1920* (B, destroyed; isosyntype: AMES); Xalapa, *Olson Seffer s.n.* (B, destroyed); Veracruz, Zacuapam, 900–1000 m, Feb. 1913, *C. A. Purpus 2154*, *pro parte* (B, destroyed). Mora-Retana and García (1992) included the species in their checklist, but they provided no information about any voucher specimens. The only cited voucher of *D. neglecta* from Costa Rica (in Dressler, 2003) is based on a misidentified specimen of *D. oxyglossa*. *Dichaea neglecta* may be recognized by the freely branched stems; the boldly dark-green spotted, unusually wide and strongly flattened leaf sheaths (the stem appearing wide); and the obovate lip with the narrow lateral lobes inserted in the basal half.

Dichaea robusta Schltr., Repert. Sp. Nov. Regni Veg. Beih. 27: 83. 1929. Pupulin (2002) and Dressler (2003) interpreted Costa Rican populations restricted to the lowland and mid-elevation forests of the Pacific slopes as *D. robusta*, a species originally described from Bolivia. The Costa Rican taxon was eventually described as *D. globosa*.

Galeottia A.Rich.

REFERENCES—L. A. Garay, El complejo *Zygopetalum*. Orquideología 8(1): 15–51. 1973. W. M. Whitten, N. H. Williams, R. L. Dressler, G. Gerlach, & F. Pupulin. Generic relationships of Zygopetalinae (Orchidaceae: Cymbideae): Combined molecular evidence. Lankesteriana 5(2): 87–107. 2005. F. Pupulin. *Galeottia*. Pp. 498–499 *in*: A. M. Pridgeon, P. J. Cribb, M. W. Chase & F. Rasmussen (eds.). Genera Orchidacearum, volume 5. Epidendroideae (Part Two). Oxford University Press.

Galeottia A.Rich., Ann. Sci. Nat., Bot., III, 3: 25. 1845. Type species: *Galeottia grandiflora* A.Rich.

Mendoncella A.D.Hawkes, Orquídea (Rio de Janeiro) 25: 7 (1963), *nom. superfl. illeg.* Type species: *Galeottia grandiflora* A.Rich.

Epiphytic, cespitose, pseudobulbous **herbs**. **Leaves** 2–3, plicate, petiolate, elliptic, acute. **Inflorescences** lateral, a few-flowered raceme, the peduncle terete. **Flowers** spreading, greenish, variously striped with dark purple to brown. **Sepals** subequal, lanceolate, acute, the lateral sepals obliquely inserted on the column foot. **Petals** obliquely lanceolate to subtriangular, acute, inserted on the column foot, subequal to the sepals. **Lip** fleshy, clawed, the lamina 3-lobed, the lateral lobes often fimbriate; callus sub-basal, fleshy, semicircular, provided with several apically acute keels. **Column** arcuate, with a distinct foot, widened toward the apex, provided with broad lateral wings, the clinandrium deeply cucullate, fimbriate; rostellum 3-dentate, the central tooth distinctly longer. **Anther cap** cucullate, subquadrate-subrhombic, compressed, 2-celled. **Pollinia** 4, in 2 pairs of different sizes, linear-oblong to obovoid, on a triangular stipe; viscidium definite.

The genus includes 12 species ranging from southern Mexico to Peru and northern Atlantic Brazil, with the highest diversity on the western slopes of Peruvian and Colombian Andes. The species occur as epiphytes or terrestrial plants in tropical to montane wet forests, at elevations of 150–2500 m, in shady to partially exposed spots. Flowering occurs year-round but mostly during the rainy season, when the immature pseudobulbs have completely developed new leaves. No records about natural pollination of *Galeottia* exist, but the species of the genus are likely pollinated by male euglossine bees.

A synopsis of the genus (as *Mendoncella*) was offered by Garay (1973), who distinguished *Galeottia* from other pseudobulbous Zygopetalinae mainly by the petals decurrent on the column foot and the lateral sepals adnate to the column foot near the apex. He considered *Galeottia* close to *Batemannia*, from which it can be distinguished by the presence of well-developed auricles on the column, a corrugated or flabellate crest at the base of the hypochile, and the lateral sepals basally strongly enrolled-gibbose. Species of *Galeottia* have been described in the genera *Batemannia* Lindl., *Mendoncella*, *Zygopetalum* Hook., and *Zygosepalum* (Rchb.f.) Rchb.f., and many of them were moved back and forth among these genera because of difficulty in assigning sharp generic circumscriptions within the *Zygopetalum* complex on the sole basis of morphological features. As presently circumscribed, the prominent ribbed crest of the lip, the two-winged column, and the distinctly saccate base of the lateral sepals characterize the genus among the taxa of the *Zygopetalum* grade. In the combined analysis of nuclear and plastid DNA data sets carried out by Whitten and collaborators (2005), a strongly supported clade includes *Galeottia*, together with *Batemannia* and *Zygosepalum labiosum*, as the most derived group of the *Zygopetalum* grade. Some species of *Galeottia* (plus *Batemannia lepida*), however, are on a long branch relative to the other members of this clade, likely explained by paralogous *trnL-F* sequences. Inclusion of additional genome regions in the molecular analysis is required for a better understanding of the phylogenetic relationships of these genera.

Galeottia grandiflora A.Rich., Ann. Sci. Nat. Bot. sér. 3, 3: 25. 1845. Type: Mexico. Oaxaca, Cordillera, 1840, *H. Galeotti 5066* (P). *Batemania grandiflora* (A.Rich.) Rchb.f., Bonplandia 4: 323. 1856. *Zygopetalum grandiflorum* (A.Rich.) Hemsl., Biol. Centr.-Amer., Bot. 3: 251. 1884. *Mendoncella*

grandiflora (A.Rich.) Hawkes, Orquidea (Rio de Janeiro) 25: 7. 1963. Figure 46. (Illustration Voucher: *F. Pupulin 3006*).

Epiphytic, cespitose **herbs**, erect, to 30 cm tall, each shoot provided with distinct pseudobulb. **Pseudobulbs** ovoid, 4-angled, smooth, pale green, 4–6 × 2.5–3.5 cm. **Leaves** 2–3, plicate, petiolate, elliptic, acute, to 25 × 10 cm. **Inflorescences** lateral, suberect to pendent, a few-flowered raceme, to 20 cm long, the peduncle terete, provided with 2–3 widely ovate, acute, loose bracts. **Ovary** clavate, to 4 cm long including the pedicel, subtended by a cucullate bract to 3 cm long, **Flowers** spreading, the sepals and petals greenish, longitudinally striped with dark purple to brown, the lip white with red-purple stripes. **Dorsal sepal** lanceolate, acute, slightly concave toward the apex, the margins undulate, 4.0–4.5 × 1.5–1.8 cm. **Lateral sepals** obliquely lanceolate, acute, inserted on the column foot, deeply concave toward the base, the inner basal margin convolute, 4.5–4.8 × 2 cm. **Petals** obliquely lanceolate to subtriangular, acute, inserted on the column foot, 4 × 1.8 cm. **Lip** fleshy, clawed, the lamina 3-lobed, 3.0 × 2.5 cm; the lateral lobes ovate, fimbriate on the apical margin, the midlobe widely ovate to subrhombic, the apical margins irregularly serrulate; callus subbasal, fleshy, semicircular, provided with several keels distally ending in short, acute teeth. **Column** arcuate, with a distinct foot, about 2 cm long, widened toward the apex, provided with broad, lateral, semicircular wings, the clinandrium deeply cucullate, fimbriate; rostellum 3-dentate, the central tooth longer. **Anther cap** cucullate, subquadrate-subrhombic, compressed, 2-celled. **Pollinia** 4, in 2 pairs of different sizes, linear-oblong to obovoid, on a triangular stipe; viscidium peltate.

DISTRIBUTION—The species is distributed from Mexico to Colombia.

ECOLOGY—A widespread but uncommon epiphyte from tropical to premontane wet forests, *G. grandiflora* has been recorded from the Caribbean watershed of northern and central mountain chains and from the Pacific drainage of the Cordillera de Talamanca up to the Osa peninsula. Flowering occurs from February to August, mostly at the beginning of the rainy season.

DISTINGUISHING FEATURES—The large, tetragonous pseudobulbs with plicate, glossy leaves; large flowers with greenish sepals and petals, longitudinally striped with dark purple to brown; and the white lip with red-purple stripes easily distinguish this species among Costa Rican Zygopetalinae.

Huntleya Batem. ex Lindl.

REFERENCES—J. A. Fowlie, Some observations on the genus *Huntleya* and related genera. Orch. Dig. 31(9): 278–281. 1967. J. A. Fowlie, *Huntleya sessiliflora* Lindl., Orch. Dig. 38: 116–119. 1974. J. A. Fowlie, A further contribution to an understanding of the genus *Huntleya*. Orch. Dig. 48(6): 221–225. 1984. R. A. Rolfe, The genus *Huntleya*. Orch. Rev. 8: 2692–2272; 302–303. 1900. W. M. Whitten, N. H. Williams, R. L. Dressler, G. Gerlach, & F. Pupulin, Generic relationships of Zygopetalinae (Orchidaceae: Cymbideae): Combined molecular evidence. Lankesteriana 5(2): 87–107. 2005. F. Pupulin. *Huntleya*. Pp. 502–505 *in*: A. M. Pridgeon, P. J. Cribb, M. W. Chase & F. Rasmussen (eds.). Genera Orchidacearum, volume 5. Epidendroideae (Part Two). Oxford University Press.

Huntleya Bateman ex Lindl., Edwards's Bot. Reg. 23: t. 1991. 1837. Type species: *Huntleya meleagris* Lindl.

Epiphytic, cespitose **herbs**, without pseudobulbs. **Leaves** arranged like a fan, articulated with the basal conduplicate sheaths, linear-lanceolate, acute. **Inflorescence** a 1-flowered erect scape, the peduncle terete. **Flowers** spreading, greenish yellow to brown, variously tessellated or striped. **Sepals** subequal, lanceolate, acute to apiculate, dorsally carinate, the lateral sepals obliquely inserted on the column foot. **Petals** elliptic to subrhombic, acute to subapiculate, inserted on the column foot, subequal to the sepals. **Lip** fleshy, abruptly contracted into a geniculate claw, the lamina sometimes obscurely 3-lobed, articulated with the base of the callus plate; callus sub-basal, fleshy, semicircular, with erect, fimbriate margins. **Column** subterete, arcuate, with a foot, widened toward the apex, provided with lateral wings, the clinandrium deeply cucullate, fimbriate; rostellum 3-dentate, the central tooth usually distinctly longer. **Anther cap** cucullate, subquadrate-subrhombic, compressed, 1- to 2-celled. **Pollinia** 4, in 2 pairs of different sizes, linear-oblong to obovoid, on a linear stipe; viscidium distinct, triangular.

The genus includes some 13 species, ranging from Belize to Brazil, Bolivia, and Trinidad, with a main center of dispersal in the northern Andean regions of Colombia and Ecuador, where seven and six *Huntleya* species have been recorded, respectively. Some of the species are remarkably similar in gross flower morphology and difficult to tell apart on the basis of floral differences, and some of them might not withstand critical examination at specific rank. Species of *Huntleya* are restricted mostly to extremely wet tropical and premontane forests, usually at medium and low elevations (from sea level to 800–1000 m), a few taxa ranging to higher regions up to 2000 m elevation. Plants of *Huntleya* grow mostly as large epiphytes, mainly on trunks and large branches, where the thick rhizome often assumes a creeping habit. The large, scented, long-lasting flowers are usually produced at the beginning of the rainy season, but plants of *Huntleya* may sporadically flower throughout the year. *Huntleya burtii* is pollinated by *Eulaema meriana*, and male euglossine bees in search of fragrance components probably pollinate the other species of the genus. The pollinarium is placed behind the head of the bee.

Many species of *Huntleya* were originally described as members of the genus *Batemannia* Lindl., from which *Huntleya* is distinguished mainly by the absence of pseudobulbs and the shape of the callus, which is long and deeply fimbriate in *Huntleya* versus fleshy, denticulate-ciliate in *Batemannia*. Synoptical views of the genus were offered by Rolfe (1900) and Fowlie (1967, 1984). Recent studies based on comparison of DNA sequences confirm the monophyly of *Huntleya* and show that the genus is only distantly related to *Batemannia*, the latter being sister to *Galeottia* A.Rich. and *Zygosepalum* (Rchb.f.) Rchb.f., as a member of the *Zygopetalum* grade. Molecular phylogenetics place *Huntleya* as the most basal member of the *Huntleya* clade, sister to the anomalous *Dichaea* and *Cryptarrhena*, and consecutively sister to *Chaubardia* Rchb.f. and the other taxa of the *Chondrorhyncha* complex. The large plants lacking pseudobulbs, often with long rhizomes separating the fan-shaped growths, and the large, star-shaped, flat, glossy, and fragrant flowers distinguish the genus among the relatives in the *Huntleya* clade.

Huntleya burtii (Endrés & Rchb.f.) Rolfe, Orch. Rev. 24: 236. 1916. Type: Costa Rica, *Endrés 100* (holotype, W). *Batemannia burtii* Endres & Rchb.f., Gard. Chron. 1099. 1872. Figure 47 (Voucher: *Pupulin 88*, USJ).

Epiphytic, erect, cespitose **herbs**, to 45 cm tall, each shoot provided with 12–16 leaves. **Roots** fleshy, glabrous. **Leaves** sessile, distichous, lanceolate to ligulate, acute, 24.0–45.0 × 3.5–5.0 cm, with strongly marked midvein. **Inflorescences** 1–2, each an erect, solitary flower produced from the axils of the central leaves; peduncle terete, to 5 cm long, with 2 membranaceous, cucullate, acuminate bracts. **Ovary** clavate, to 6–8 cm long including the pedicel, subtended by 2 cucullate bracts to 1.8 cm long, the outer one ovate, acuminate, the inner one linear-lanceolate, acuminate. **Flowers** spreading, fragrant, the sepals and petals tessellated, cinnamon brown, white at the base, the petals basally marked with a large blotch or a fascicle of purple stripes, the lip white turning purple-brown at apex, the callus white

with purple bristles. **Dorsal sepal** lanceolate, acute, concave toward the apex, the margins undulate, 4.2–5.0 × 2 cm. **Lateral sepals** obliquely ovate-lanceolate, acute, the margins undulate, concave toward the apex, 4.4–5.0 × 2.1 cm. **Petals** obliquely rhombic, acute, acuminate, 3.8–4.5 × 2.0 cm. **Lip** with a cuneate, geniculate claw, the lamina obscurely 3-lobed, ovate, acute to acuminate, recurved at apex, 2.8–3.0 × 2.0–3.0 cm, contracted at the base and articulated with the callus plate; callus with an erect, semicircular, fimbriate crest. **Column** erect, semiterete from a narrow base, with a distinct foot, 1.7–2.0 × 1.1 cm at the dilated apex, the clinandrium provided with broad lateral wings, deeply cucullate, fimbriate. **Anther cap** cucullate, flattened, rhombic, 2-celled. **Pollinia** 4, in 2 different pairs, narrowly obpyriform to obovate, on a linear stipe; viscidium triangular.

DISTRIBUTION—The species is known from Guatemala to Panama, perhaps ranging to Colombia.

ECOLOGY—A relatively common, robust epiphyte, the species is restricted mostly to large branches and trunks in shaded positions in tropical and premontane wet forests, at 400–1000 m elevations. Plants of *H. burtii* have been recorded only from the Caribbean watershed of the main mountain chains. Flowering occurs mainly at the end of the dry season, in the months of March–May, with sporadic flowerings also recorded in September and October.

DISTINGUISHING FEATURES—The large plants and the star-shaped, flat, tessellated flowers easily distinguish *H. burtii* among Costa Rican members of the Zygopetalinae.

Kefersteinia Rchb.f.

REFERENCES—H. G. Reichenbach, *Zygopetalum*. Walp. Ann. Bot. Syst. 6: 650–662. 1861. J. A. Fowlie, A revision of the Central American species of *Chondrorhyncha* and *Kefersteinia*, including the description of a new species from Costa Rica. Part II. Orch. Dig. 30: 114–118. 1966. L. A. Garay, El complejo *Chondrorhyncha*. Orquideología 4: 139–152. 1969. F. Pupulin, Contributions to a reassessment of Costa Rican Zygopetalinae (Orchidaceae). The genus *Kefersteinia* Rchb.f., Ann. Naturh. Mus. Wien 32: 134–165. 2001. D. Szlachetko, *Senghasia*, eine neue Gattung der Zygopetaleae. J. Orchideenfreund 10(4): 335. 2003. W. M. Whitten, N. H. Williams, R. L. Dressler, G. Gerlach, & F. Pupulin, Generic relationships of Zygopetalinae (Orchidaceae: Cymbideae): Combined molecular evidence. Lankesteriana 5(2): 87–107. 2005. F. Pupulin. *Kefersteinia*. Pp. 507–510 *in*: A. M. Pridgeon, P. J. Cribb, M. W. Chase & F. Rasmussen (eds.). Genera Orchidacearum, volume 5. Epidendroideae (Part Two). Oxford University Press.

Kefersteinia Rchb.f., Bot. Zeit. (Berlin) 10: 633 (1852). *Zygopetalum* sect. *Kefersteinia* (Rchb.f.) Rchb.f., Walp. Ann. Bot. Syst. 6: 657 (1861). Type species: *Zygopetalum gramineum* Lindl. [= *Kefersteinia graminea* (Lindl.) Rchb.f.].

Syn: *Senghasia* Szlach., J. Orchideenfreund 10: 335 (2003). *Kefersteinia* sect. *Umbonatae* Sengh & G. Gerlach, *in* R. Schlechter, Orchideen, ed. 3, 1/B(27): 1641 (1993). Type species: *Kefersteinia wercklei* Schltr.

Epiphytic, cespitose, small **herbs**, without pseudobulbs. **Leaves** 3–6, arranged like a fan, articulated with the basal conduplicate sheaths, ligulate to oblong, acute to abruptly acuminate, basally decurrent into a conduplicate petiole. **Inflorescences** a 1-flowered scape, suberect to pendulous, the peduncle terete. **Flowers** ringent to spreading, white to greenish yellow to yellow, usually variously spotted and blotched with purple and brown. **Sepals** ovate, oblong or elliptic-lanceolate, acute to apiculate, concave, dorsally carinate, sometimes reflexed at apex, the lateral sepals often slightly falcate or laterally twisted, sometimes with subrevolute margins. **Petals** obliquely elliptic, acute to subapiculate, decurrent on the column foot, rarely deflexed, the margins sometimes subrevolute or slightly denticulate. **Lip** clawed, pandurate to ovate, suborbicular or spathulate, rarely obscurely 3-lobed, acute to obtuse or emarginate, usually concave toward the base with the basal margins erect, the lamina sometimes folding back at the middle; callus basal or subbasal, fleshy, pedicellate or sessile and laminar, mostly bilobed, rarely 2-carinate. **Column** subterete, with a foot, widened toward the apex, sometimes provided with lateral wings, the ventral surface often forming a fleshy plate, basally protruding or not into basal teeth, generally provided with a longitudinal keel that in some cases projects at the rear into a distinct tooth; rostellum 3-dentate, the central tooth usually distinctly longer. **Anther cap** cucullate, subquadrate-subrhombic to triangular-ovate, often slightly compressed, 2- to 4-celled. **Pollinia** 4, in 2 pairs of different sizes, linear-oblong to obovoid, on a linear to ovate or obpyriform stipe, basally rounded or attenuate, sometimes folded along the margins; viscidium hyaline, rhombic to obtriangular-peltate, barely distinguishable from the stipe.

The genus includes about 60 species ranging from southern Mexico to Panama and from Venezuela and Colombia to Surinam and Bolivia in South America. *Kefersteinia* is most diverse along the Andes of Ecuador and Peru (with 19 and 16 species recorded, respectively), and it is particularly well represented also in the mountainous areas of Central America up to Costa Rica, where 11 species have been recorded so far. Species diversity rapidly diminishes toward the north, with a single species known from Guatemala and southern Mexico. Species of *Kefersteinia* occur as small to medium-sized epiphytes in shady habitats, often growing on the trunk and the oldest, mossy branches of trees, frequently found along streams. The habitat of *Kefersteinia* ranges from tropical warm to premontane and submontane temperate, cloud, evergreen, extremely wet forests, at elevations of 100–2500 m, although most of the species are found in premontane forests at mid-elevations (900–1500 m). Independent of the elevation range, all the species are shade-loving plants, which grow with extensive roots deeply embedded in mosses to prevent desiccation. Flowering has been recorded throughout the year, although some of the species seem to flower consistently during the dry season and others during the rainy months. Pollination of *Kefersteinia* is carried out by male euglossine bees of the genera *Euglossa* and *Eulaema* apparently seeking fragrances, a syndrome shared with other members of the Zygopetalinae. However, the prominently toothed ventral surface of the column of *Kefersteinia* plays a critical role in pollination, obliging the bee to twist its body and receive the pollinarium on the basal segment of the antenna. The narrowly lanceolate to linear viscidium quickly curls after removal to adhere to the pollinator's antenna. This pollinarium deposition is unique among euglossine-pollinated orchids.

As circumscribed, the genus *Kefersteinia* includes a large assemblage of species, often with different flower morphology, characterized mostly by the presence of one or more prominent teeth or a distinct infrastigmatic keel on the ventral surface of the column. The relative variability in flower shape renders the genus difficult to define in terms of synapomorphies. Among the characters useful to identify *Kefersteinia* are 1) usually small plants without pseudobulbs, 2) mostly pendent inflorescences, 3) the basal and mostly bilobed callus, and 4) the column provided with a ventral, laminar plate and a central keel, often extending to the rear into a tooth. Two main groups of species may be recognized on the basis of lip and callus morphology: in the mostly Andean group close to *K. graminea* (the type of the genus), the lip blade folds back abruptly at the middle and the callus is sessile, low-laminar, whereas in the species close to *K. wercklei* (mostly Central American in distribution), the lamina of the lip is straight, and the short and high callus is supported by a distinct stipe. Senghas and Gerlach (1993) gave formal recognition to these groups creating sect. *Umbonatae* for the species with

solid, stipitate callus. In 2003, Szlachetko elevated section *Umbonatae* to generic rank with the name of *Senghasia*, distinguishing the new genus from *Kefersteinia* by the presence or absence of a large, umbonate callus at the base of the lip (Szlachetko, 2003). However, it should be noted that both in Central and South America, the distinctiveness between the two groups (at whatever taxonomic rank) is often obscured by the presence of species with highly anomalous flower morphology, precluding the use of sharply defined formal subgroupings. In the molecular analyses by Whitten and collaborators (2005), *Kefersteinia* forms a highly supported, monophyletic group, sister to *Echinorhyncha* Dressler and consecutively sister to *Euryblema* Dressler and *Benzingia* Dodson ex Dodson. Molecular data from the sampled species do not support the distinctiveness of *Senghasia* and show that sections *Kefersteinia* and *Umbonatae* are not monophyletic. Therefore, only one genus, *Kefersteinia*, for this monophyletic and morphologically distinctive group of plants is retained here.

Key to the Species of *Kefersteinia*

1. Callus stipitate 2
   2. Lip distinctly saccate at the base, shorter than the column . . . . . *K. saccata*
   2. Lip concave, not basally saccate, longer than the column 3
      3. Lateral margins of the lip folded toward column 4
         4. Lip entire or slightly subpandurate . . . . . *K. wercklei*
         4. Lip distinctly 3-lobed 5
            5. Apex of lip retuse . . . . . *K. retanae*
            5. Apex of lip acute . . . . . *K. excentrica*
      3. Lateral margins of lip not folded toward column 6
         6. Lip orbicular, folded down at middle . . . . . *K. orbicularis*
         6. Lip obovate, not folded down at middle . . . . . *K. costaricensis*
1. Callus sessile, laminar or carinate 7
   7. Lip much shorter than sepals, straight 8
      8. Lip pandurate; callus cushion-like . . . . . *K. parvilabris*
      8. Lip spathulate; callus of two keels reflexed distally . . . . . *K. endresii*
   7. Lip subequal to the sepals, abruptly bent down at middle 9
      9. Column oblong-elliptic; callus wider distally . . . . . *K. microcharis*
      9. Column with triangular wings at the middle; callus wider proximally 10
         10. Column with a prominent abaxial keel; lip ovate-oblong, entire . . . . . *K. lactea*
         10. Column with an inconspicuous keel; lip rhombic, 3-lobed . . . . . *K. alba*

Kefersteinia alba Schltr., Repert. Spec. Nov. Beih. 19: 228. 1923. Type: Costa Rica. Alajuela: San Pedro de San Ramón, 1075 m, July 1922, *A.M. Brenes 284* (holotype, B, destroyed; lectotype, AMES!, drawings from the holotype). Figure 58 (Vouchers: Atwood [1989] and *A. M. Brenes 284* [drawing of the lectotype]).

Epiphytic, erect, cespitose **herbs** to 12 cm tall, each shoot provided with 5–6 leaves. **Roots** flexuous, glabrous. **Leaves** narrowly elliptic to linear, acute, 6.0–15.0 × 0.7–1.5 cm, the margins of the lamina narrowing toward the base into a conduplicate petiole about 1.5 cm long. **Inflorescences** 1–2, each a patent to erect, solitary flower; peduncle terete, to 2.5 cm long, with membranaceous, triangular-ovate bracts. **Ovary** clavate, to 15 mm long including the pedicel, subtended by 2 cucullate bracts to 4 mm long. **Flowers** spreading, the sepals and petals white, the lip white sparsely spotted with purple at the base, the callus white. **Dorsal sepal** oblong to elliptic-oblong, subacute, apiculate, concave, 12–14 × 4–5 mm. **Lateral sepals** obliquely ovate-lanceolate, acute to apiculate, concave, 13–15 × 5–7 mm. **Petals** obliquely elliptic-oblong, acute to obtuse, apiculate, 12 × 4 mm. **Lip** with a cuneate claw, 3-lobed, widely rhombic to suborbicular when spread, obtuse to shortly emarginate, the distal margins crenulate, 12 × 12 mm, the distal portion reflexed; callus at the base of the lamina, bilobed, lyre-shaped, broadened at the base, the basal margins elevated, about 5 mm long, 3 mm wide. **Column** semiterete from a narrow base, with a foot, 10 × 3.5 mm at the middle, with a pair of narrow, triangular wings just above the middle. **Anther cap** cucullate, ovate, 2-celled. **Pollinia** 4, narrowly obpyriform, on a linear stipe attenuate at the base.

DISTRIBUTION—The species is apparently restricted to Costa Rica.

ECOLOGY—Plants of *K. alba* are epiphytic in premontane and lower montane rain forests, in semishade, at about 300–1000 m elevation. Flowering occurs at least in July.

DISTINGUISHING FEATURES—The winged column without adaxial keel, the rhombic, three-lobed lip, and the lyre-shaped callus are useful diagnostic characters to distinguish *K. alba* from its close relatives, namely, *K. lactea* (Rchb.f.) Schltr. and *K. microcharis* Schltr.

Kefersteinia costaricensis Schltr., Beih. Bot. Centralbl. 36: 413. 1918. Type: Costa Rica: colline vers le Rio Chirripó, 300 m, Jan. 1900, *H. Pittier 16058* (holotype, B; destroyed; lectotype, a drawing from the holotype at AMES!). *Chondrorhyncha costaricensis* (Schltr.) Allen, Ann. Missouri Bot. Gard. 36: 86. 1949. Figure 53 (Voucher: *Dressler & Mora-Retana s.n.*, USJ).

Epiphytic, erect, cespitose **herbs** to about 10 cm tall, each shoot provided with 3–5 leaves. **Roots** flexuous, glabrous. **Leaves** elliptic to elliptic-oblanceolate, acute, 6.0–11.0 × 1.7–2.5 cm, the margins of the lamina narrowing toward the base into a conduplicate petiole about 1 cm long. **Inflorescences** 1–3, each a pendent, solitary flower; peduncle terete, to 4 cm long, with membranaceous, triangular-ovate bracts. **Ovary** clavate, to 17 mm long including the pedicel, subtended by 2 cucullate bracts 3 mm long. **Flowers** spreading, the sepals greenish white to cream, the petals whitish densely spotted with purple, the lip and callus white spotted with purple. **Dorsal sepal** elliptic to elliptic-ovate, acute, carinate, concave, 10–11 × 5–6 mm. **Lateral sepals** obliquely elliptic-lanceolate, slightly subfalcate, acute to apiculate, 11–13 × 6–8 mm. **Petals** obliquely elliptic-oblong, adnate to the column foot, acute, 9–11 × 6–7 mm. **Lip** with a linear claw, obovate when spread, obtuse, apiculate, deeply concave at the base, the distal margins slightly crenulate, 13 × 10–11 mm; callus at the base of the lamina, fleshy, stalked, subreniform, bilobed, 6.0 × 5.0 mm, 2.5 mm high. **Column** with a foot, 10 × 4.5 mm at the

middle, from a narrow base, the ventral surface forming a transversely rectangular plate below stigma, protruding basally in two short teeth, provided with a prominent median keel on the plate projecting at the rear into a triangular tooth. **Anther cap** cucullate, triangular-ovate, 2-celled. **Pollinia** 4, linear-oblong, on an ovate stipe; viscidium peltate.

DISTRIBUTION—*Kefersteinia costaricensis* is known from Nicaragua, Costa Rica, and Panama.

ECOLOGY—This is the most widespread and common *Kefersteinia* species in Costa Rica, where it is usually found on large and shaded branches of tropical rain forests at 20–1600 m elevation. Flowers of *K. costaricensis* are apparently pollinated by male *Euglossa deceptrix* looking for fragrances.

DISTINGUISHING FEATURES—The fleshy lip with flat or only slightly undulate margins and the short tooth formed by the keel under the column well apart from the stigma easily distinguish *K. costaricensis* from other Costa Rican *Kefersteinia* species with a stipitate callus.

Kefersteinia endresii Pupulin, Ann. Naturh. Mus. Wien 32: 134–165. 2001. Type: Costa Rica: without definite locality, *A. Endrés s.n.* (W-R!). Figure 55 (Voucher: *Endrés s.n.*, W).

Epiphytic, erect, cespitose **herbs** to about 12 cm tall, each shoot provided with 3 leaves. **Roots** flexuous, glabrous. **Leaves** oblanceolate to narrowly elliptic, acute to acuminate, 5.4–12.0 × 0.9–1.8 cm, the margins of the lamina narrowing toward the base into a distinct conduplicate petiole to 2.5 cm long. **Inflorescence** a pendent, solitary flower; peduncle terete, to about 3 cm long, with membranaceous, ovate bracts. **Ovary** clavate, to 7 mm long including the pedicel. **Flowers** spreading, the membranous sepals apparently pale greenish white, translucent, petals sparsely spotted with purple, the lip apparently dark, may be purple, callus darker. **Dorsal sepal** elliptic to elliptic-oblong, obtuse, dorsally carinate toward the apex, 8 × 3 mm. **Lateral sepals** narrowly elliptic to lanceolate-elliptic, slightly subfalcate, acute, concave, conduplicate toward the base, 10 × 3 mm. **Petals** obliquely elliptic, acute, 7.5 × 2.5 mm. **Lip** from a short cuneate claw, obpyriform-spathulate, obscurely 3-lobed, obtuse, apiculate, 4 mm long, 3 mm wide; callus extending from the base to about the half of the lamina, two inflated puberulent keels distally abruptly reflexed, abaxially concave toward the apex to form a 4-lobed tip, 1.5 × 1.2 mm. **Column** with a foot, 6.0 × 2.5 mm at the middle, from a narrow base, the ventral surface forming a trapezoidal plate below stigma, the corners basally protruding in two rounded teeth, provided with a distinct median keel on the plate projecting from the stigma to the rear into a high, rounded tooth. **Anther cap** cucullate, subquadrate, compressed, retuse at apex, 2-celled. **Pollinia** 4, obpyriform, on a subquadrate stipe.

DISTRIBUTION—*Kefersteinia endresii* is endemic to Costa Rica.

ECOLOGY—Known only by a single collection made in Costa Rica by A. R. Endrés in the nineteenth century, without definite locality.

DISTINGUISHING FEATURES—The spathulate lip and the keeled, distally abruptly reflexed callus extending to half of the lamina, easily distinguish *K. endresii*, which has apparently no close relatives within the genus.

Kefersteinia excentrica Dressler & Mora-Retana, Orquídea (Méx.) 13: 261. 1993. Type: Costa Rica. Cartago: La Selva, camino a Taus, en la misma ruta al Refugio de Fauna Silvestre Tapantí, 1300–1400 m, 9 Nov. 1984, *R.L. Dressler & D.E. Mora-Retana s.n.* (holotype, USJ). Figure 51 (Voucher: *Pupulin 2424*, USJ).

Epiphytic, erect, cespitose **herbs** to about 15 cm tall, each shoot provided with 4–5 leaves. **Roots** flexuous, glabrous. **Leaves** oblanceolate to narrowly elliptic, acute to acuminate, the margins of the lamina slightly recurved, 8.5–15.0 × 1.1–1.5 cm. **Inflorescences** 1–4, each a pendent, solitary flower; peduncle terete, to 5 cm long, with membranaceous, triangular bracts. **Ovary** clavate, to 17 mm long including the pedicel. **Flowers** not completely spreading, pale green with purple spots and blotches, the petals whitish densely spotted with purple, the lip white spotted with purple especially toward the apex, apex may be solid red. **Dorsal sepal** elliptic or lanceolate-elliptic, acute, carinate, concave, 12–13 × 5–6 mm. **Lateral sepals** elliptic to lanceolate-elliptic, slightly subfalcate, apiculate, 15–17 × 5–6 mm. **Petals** obliquely elliptic, the margins lightly denticulate, acute, 12–14 × 4–5 mm. **Lip** with a cuneate claw, 3-lobed, pandurate, apiculate, 13 × 10 mm; lateral lobes rounded, suberect; midlobe subflabellate, the lamina provided with 5 low, longitudinal keels, the lateral margins dentate; callus bilobed, low, 2 × 4 mm. **Column** elongate, with a foot, 10 × 4 mm at the middle, from a narrow base, the ventral surface forming a subquadrate plate below stigma, the corners basally protruding in two short teeth, provided with a weak median keel on and below the plate projecting at the rear into a low tooth. **Anther cap** cucullate, subquadrate, 2-celled. **Pollinia** 4, linear-oblong, on an obovate stipe; viscidium peltate.

DISTRIBUTION—The species is known from Costa Rica and Panama.

ECOLOGY—Epiphytic in wet premontane forest between 1200 and 1500 m altitude, plants of *K. excentrica* usually grow on mossy tree trunks in rather shady sites. Flowering occurs from December to March.

DISTINGUISHING FEATURES—The most distinctive character of *K. excentrica* is the off-center position of the lip, which rotates along its longitudinal axis.

Kefersteinia lactea (Rchb.f.) Schltr., Repert. Sp. Nov. Regni Veg. Beih. 19: 228. 1923. Syntypes: Costa Rica [?]. Chiriquí, without locality data, cultivated by *Linden s.n.* [lectotype, selected by Pupulin (2001), W-R!]; Costa Rica. Without locality data, *A.R. Endrés 334* (W-R!); Costa Rica [?]. Chiriquí, without locality data, *Wallis s.n.*; without locality data, cultivated by Veitch 201 (W-R!). *Zygopetalum lacteum* Rchb.f., Gard. Chron. 1290. 1872. *Kefersteinia lactea* (Rchb. f.) B.D. Jacks., Index Kew. 2: 4. 1895, *nom. illeg. Chondrorhyncha lactea* (Rchb.f.) L.O. Williams, Caldasia 5: 194. 1942. *Senghasia lactea* (Rchb. f.) Szlach. & Romowicz, Richardiana 6(4): 182. 2006. Figure 57 (Voucher: *Pupulin* 2431, USJ).

Epiphytic, erect, cespitose **herbs** to 12 cm tall, each shoot provided with 3–4 leaves and 1–2 acute, triangular bracts at the base. **Roots** flexuous, glabrous. **Leaves** articulate with the conduplicate basal sheaths, narrowly elliptic, abruptly acute, 4.0–11.0 × 1.2–1.5 cm, the margins of the lamina narrowing toward the base into a conduplicate petiole to 2 cm long. **Inflorescences** 1–2, each a patent to pendulous, solitary flower; peduncle terete, to 2.3 cm long, with membranaceous, ovate, acute bracts. **Ovary** subclavate, to 12 mm long including the pedicel, subtended by 2 cucullate, ovate, acute bracts to 3.5 mm long. **Flowers** spreading, the sepals and petals white, the lip white sparsely spotted with purple at the base, the callus white spotted purple. **Dorsal sepal** linear-elliptic to elliptic, obtuse, apiculate, 10 × 4.5 mm. **Lateral sepals** lanceolate to elliptic, subacute, concave toward the apex, 12 × 4 mm. **Petals** obliquely widely elliptic to oblanceolate, subacute, apiculate, slightly concave toward the apex, 11 × 5 mm. **Lip** widely ovate from a cuneate base, emarginate, the distal margins crenulate, 12 × 12 mm wide, the distal portion reflexed; callus at the base of the lamina, bilobed, ovate, broadened at the base, the basal margins elevated, 3.5 × 2.5 mm. **Column** elongate, semiterete from a narrow base, with a foot, 9.0 × 4.2 mm at the middle, with a pair of narrow, triangular wings just above the middle, the ventral surface provided with a distinct, semicircular, median longitudinal keel extending from the stigma to about the middle of column. **Anther cap** cucullate, ovoid, 2-celled. **Pollinia** 4, narrowly obpyriform, on an obtriangular stipe attenuate at the base.

DISTRIBUTION—The species is known only from Costa Rica and Panama.

ECOLOGY—*Kefersteinia lactea* is a widespread but not common epiphyte of the premontane and lower montane rain forests from both Atlantic and Pacific drainage in central and southern Costa Rica, at 700–1200 m elevation, which usually

grows in shaded and wet spots. Flowering occurs from February to August.

DISTINGUISHING FEATURES—Among white-flowered Costa Rican *Kefersteinia* species, *K. lactea* may be recognized by the ventral keel and the triangular wings at the middle of column, the ovate or lyre-shaped callus wider toward the base, and the entire lip.

Kefersteinia microcharis Schltr., Repert. Sp. Nov. Beih. 19: 300. 1923. Type: Costa Rica. Umgebung von San Ramon, im Jahre 1921, *G. Acosta s.n.* (B, destroyed; lectotype, drawings from the holotype, AMES!). *Chondrorhyncha microcharis* (Schltr.) L.O. Williams, *Ceiba* 5: 194. 1956. Figure 56 (Voucher: *Pupulin 252*, USJ).

Epiphytic, erect, cespitose **herbs** to 13 cm tall, each shoot provided with 3–5 leaves and 1–2 acute, triangular bracts at the base. **Roots** flexuous, glabrous. **Leaves** articulate with the conduplicate basal sheaths provided with scarious margins, ligulate to oblanceolate, abruptly acute, 5.0–13.0 × 1.5–2.1 cm, the margins of the lamina decurrent toward the base into a conduplicate petiole to about 1 cm long. **Inflorescences** 1–2, each a patent to pendulous, solitary flower; peduncle terete, to 3.2 cm long, with membranaceous, ovate, apiculate bracts. **Ovary** clavate, to 15 mm long including the pedicel, subtended by 2 cucullate, ovate, acute bracts to 5 mm long. **Flowers** spreading, the sepals and petals white, the lip white sparsely spotted with purple at the base, the callus white spotted purple. **Dorsal sepal** elliptic to widely lanceolate, obtuse, concave, 13 × 6 mm. **Lateral sepals** lanceolate to elliptic, obtuse, concave, 13 × 7 mm. **Petals** obliquely widely elliptic, subacute to obtuse, slightly concave toward the apex, 13.0 × 7.2 mm. **Lip** with a cuneate claw, widely ovate when spread, emarginate, shortly apiculate, the distal margins strongly crenulate, 14.0 × 15.8 mm, the distal portion reflexed; callus at the base of the lamina, bilobed, obovate, broadened at apex, the basal margins elevated, about 4.0 × 3.3 mm. **Column** elongate, semiterete, oblong from a narrow base, with a foot, 9.0 × 3.5 mm at the middle, the ventral surface provided with a distinct, rounded, median longitudinal keel extending from the stigma to the apex of the column foot. **Anther cap** cucullate, subrhombic, 2-celled. **Pollinia** 4, obovoid, on a linear stipe rounded at the base.

DISTRIBUTION—*Kefersteinia microcharis* is known only from Costa Rica.

ECOLOGY—Plants of *K. microcharis* grow epiphytically in premontane and lower montane wet forests on the Atlantic drainage of Cordillera de Tilarán and Cordillera Central, at 700–800 m elevation, usually in shady conditions. Flowering occurs from April to June.

DISTINGUISHING FEATURES—*Kefersteinia microcharis* has a subreniform, widely ovate lip and a rhombic callus; the semiterete column has no lateral wings but is notable for the prominent abaxial keel.

Kefersteinia orbicularis Pupulin, Lindleyana 15: 21. 2000. Type: Costa Rica. San José: Dota, crest of Cerro Nara, 1100 m, epiphytic in disturbed primary forest, 15 Jan. 1999, *F. Pupulin, D. Castelfranco & L. Spadari 1170* (USJ!). Figure 52 (Voucher: *Pupulin 1170*, USJ).

Epiphytic, erect, cespitose **herbs** to about 10 cm tall, each shoot provided with 2–3 leaves and 2–4 basal cataphylls, foliaceous or not. **Roots** flexuous, glabrous. **Leaves** obovate-elliptic, acute to obscurely retuse, the margins of the lamina slightly undulate, to 6.0 × 1.1–1.4 cm, narrowing at the base into a conduplicate petiole. **Inflorescences** 1–5, each a pendent, solitary flower; peduncle terete, to 4 cm long, with 1–2 infundibular bracts. **Floral bracts** infundibular, ovate, acute, 4.5 × 3.5 mm. **Ovary** clavate, 8 mm long including the pedicel. **Flowers** large for the genus, the perianth spreading, white to pale greenish white, translucent, the petals with sparse purple spots at the base, the lip white spotted with dark purple along the midrib and toward the base, the callus white to yellow. **Dorsal sepal** elliptic-lanceolate, apiculate, reflexed at apex, 13.0 × 3–3.5 mm. **Lateral sepals** narrowly elliptic to linear-elliptic, slightly falcate, laterally twisted, acute, concave, 17 × 3 mm. **Petals** obliquely elliptic-lanceolate, acute, 12 × 4 mm. **Lip** with a cuneate claw, entire, orbicular to widely obovate, retuse, concave at the base, 13 × 11 mm, the lamina folding back at the middle, the lateral margins crisped; callus sub-basal, obreniform, peltate, bilobed, 1.4 × 4.0 mm, 2.5 mm high. **Column** elongate, with a foot, 10 × 5 mm at the middle, from a narrow base, the ventral surface forming a transversely elliptic plate, basally protruding in two velutine teeth, provided with a median keel projecting into an elongate tooth, apically velutine. **Anther cap** cucullate, obovate, 4-celled. **Pollinia** 4, narrowly obpyriform, on a linear, folded stipe; viscidium hyaline, rhombic.

DISTRIBUTION—*Kefersteinia orbicularis* is known from Costa Rica and western Panama.

ECOLOGY—Epiphytic in premontane wet forest and cloud forest in southern and Central Pacific Costa Rica, plants of *K. orbicularis* grow on mossy branches in the understory of disturbed primary vegetation, at 400–1100 m elevation. Flowering occurs from February to May.

DISTINGUISHING FEATURES—*Kefersteinia orbicularis* closely resembles *K. costaricensis*, but the larger size of its flowers, the crisped margins of the lip, the different-shaped callus and column, and the peculiar arrangement of the lateral sepals easily distinguish the two species.

Kefersteinia parvilabris Schltr., Repert. Sp. Nov. Beih. 19: 52. 1923. Type: Costa Rica. San Jerónimo, Jan. 1922, *C. Wercklé 116* (B, destroyed; lectotype, AMES!). *Chondrorhyncha parvilabris* (Schltr.) L.O. Wms., Ceiba 5: 195. 1956. *Kefersteinia deflexipetala* Fowlie, Orch. Dig. 30: 117 (1966). Type: Costa Rica. Cartago: Cedral de Orosi, 1400 m, *Horich H64CR13* (LA). Figure 54 (Voucher: *Pupulin s.n.*, USJ).

Epiphytic, erect, cespitose **herbs** to about 12 cm tall, each shoot provided with 4–6 leaves, and 2–5 acute, triangular bracts at the base. **Roots** flexuous, glabrous. **Leaves** cuneate-oblong, subacuminate, undulate along the margins, to 12.0 × 2.3–3.1 cm, narrowing at the base into a conduplicate petiole 1.5 cm long. **Inflorescences** 1–2, each a prostrate to pendent, solitary flower from the axils of the larger basal bracts; peduncle terete, slender to subfiliform, to 5 cm long, with 2–3 imbricating, cucullate, oblong, acute bracts. **Floral bracts** double, the outer one cucullate, orbicular, apiculate, membranaceous, to 6 × 5 mm, the inner one cuneate-oblong, acute, shorter, and narrower. **Ovary** subclavate, terete, to 11 mm long including the pedicel. **Flowers** with the perianth patent, greenish yellow densely striped and spotted with purplish black, the petals darker than sepals, the lip with black claw and the lamina whitish suffused with lilac, densely spotted with purplish black, the callus white. **Dorsal sepal** lanceolate, acute, the apex incurved, the margins subrevolute, 13.5 × 6.0 mm. **Lateral sepals** narrowly lanceolate, acute to subobtuse, concave toward the base, the margins subrevolute, 15.0 × 4.8 mm. **Petals** obliquely ovate-lanceolate, acuminate, the margins subrevolute, deflexed toward the column, 13.5 × 5.0 mm. **Lip** from a cuneate claw, oblong-rhombic, subpandurate, apiculate, with 2–4 low longitudinal keels, slightly concave toward the base, the apex reflexed, 11.5 × 7.0 mm, provided at the base with two triangular auricles; callus basal, fleshy, transversely oblong, sometimes 3–gibbous, obscurely tomentose. **Column** semiterete, convex at apex, with a foot, 12 × 5 mm at the middle, from a cuneate base, the ventral surface provided with a low median, longitudinal keel, basally protruding into a velutine tooth. **Anther cap** cucullate, subquadrate, compressed, retuse at apex, 2-celled. **Pollinia** 4, obpyriform, on a subquadrate, rounded stipe.

DISTRIBUTION—The species ranges from Costa Rica to Colombia.

ECOLOGY—Plants of *K. parvilabris* are epiphytic in premontane and lower montane wet forests along the Caribbean watershed of Cordillera de Tilarán, Cordillera Central, and Cordillera de Talamanca, in shady conditions at 600–1400 m elevation. Flowering occurs from January to June.

DISTINGUISHING FEATURES—The yellow flowers densely blotched with purplish red and the deflexed petals easily

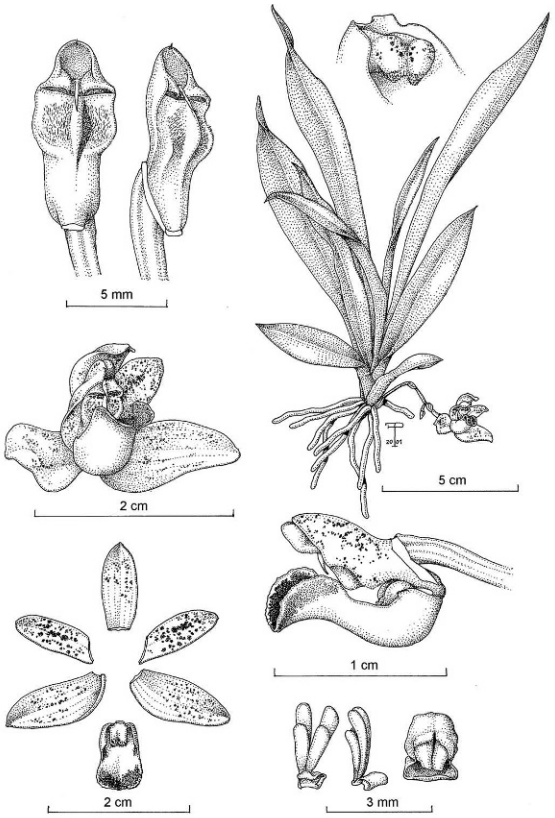

Figure 49.

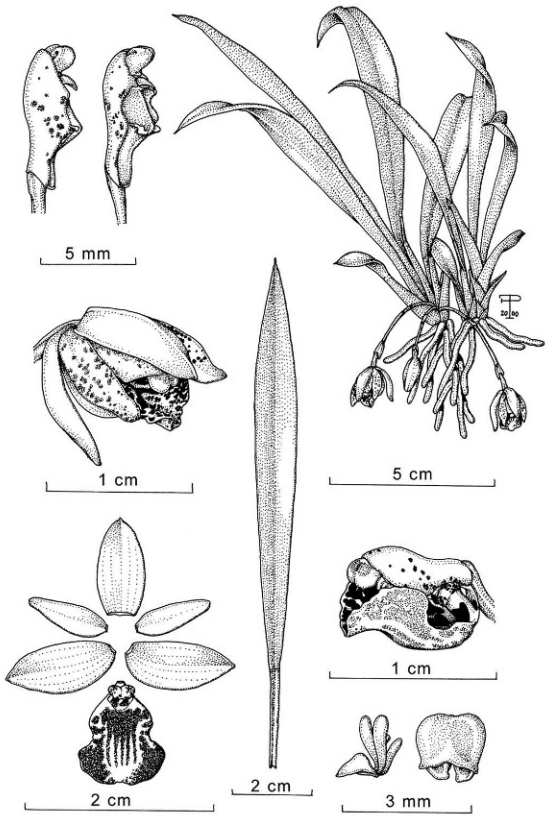

Figure 50.

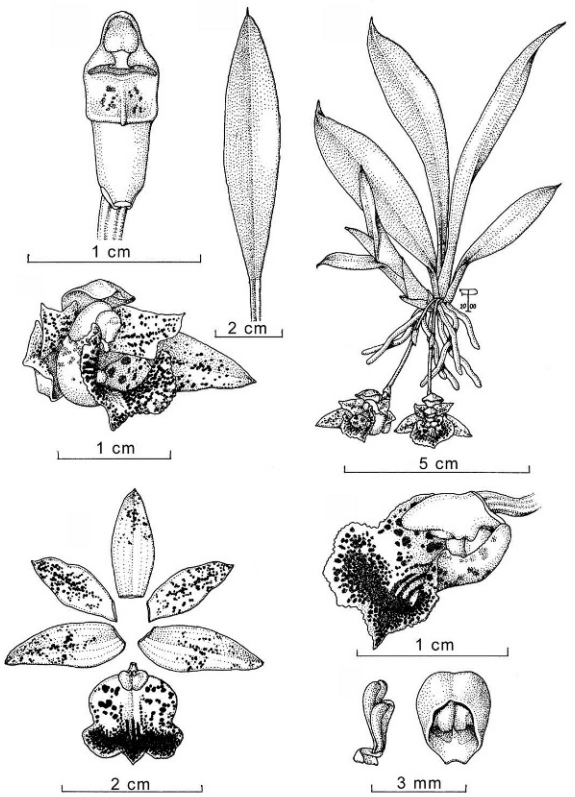

Figure 51.

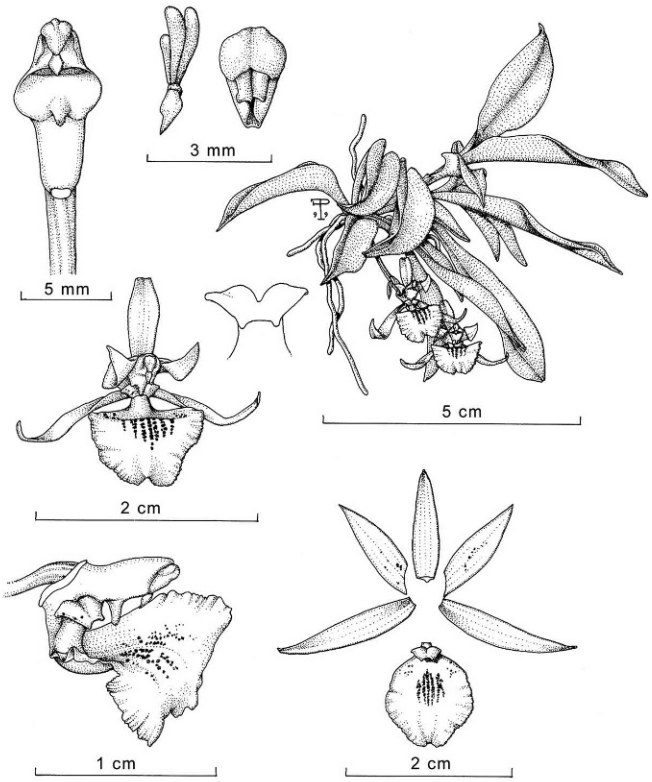

Figure 52.

FIG. 49. *Kefersteinia wercklei*. FIG. 50. *Kefersteinia retanae*. FIG. 51. *Kefersteinia excentrica*. FIG. 52. *Kefersteinia orbicularis*.

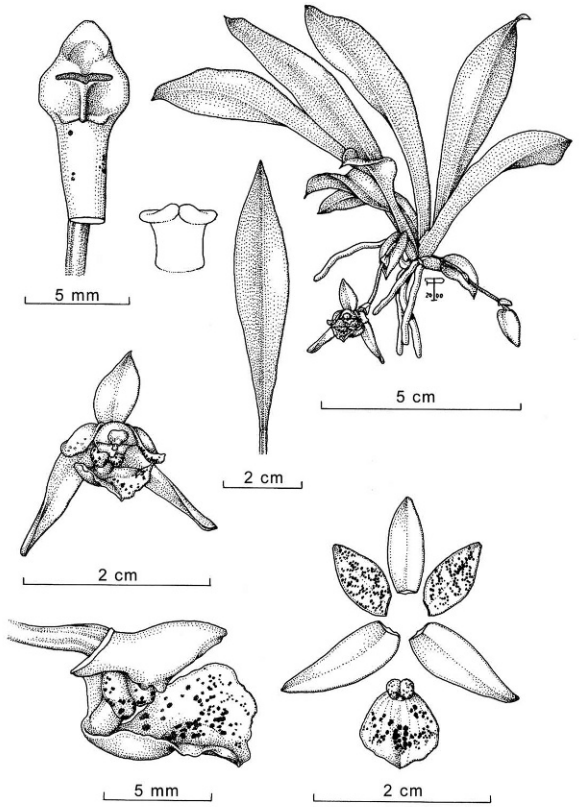

Figure 53.

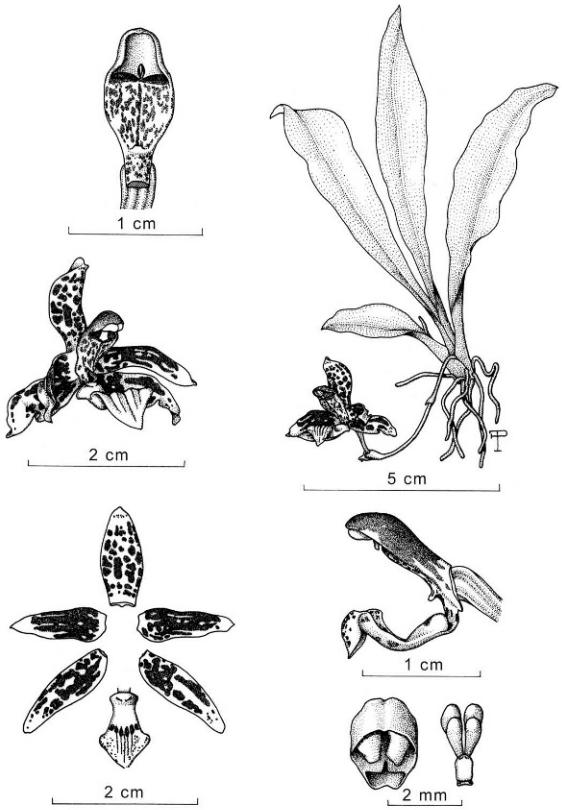

Figure 54.

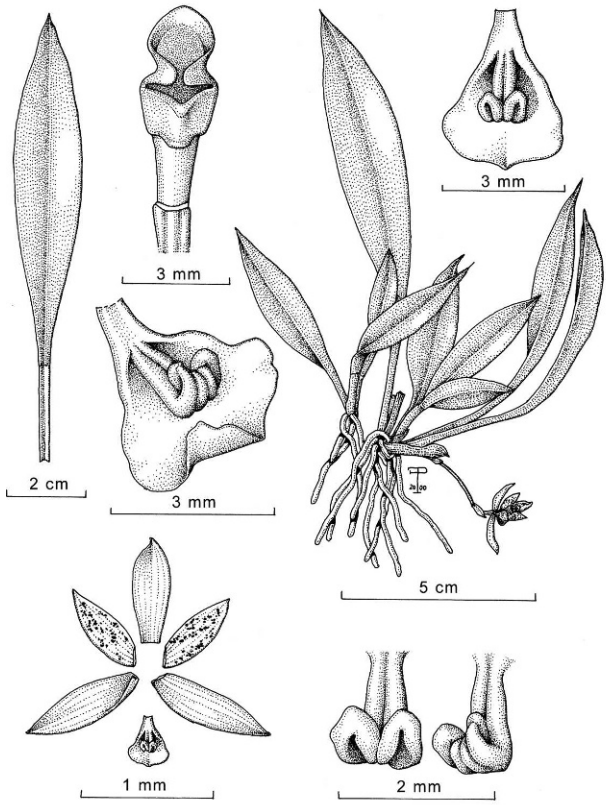

Figure 55.

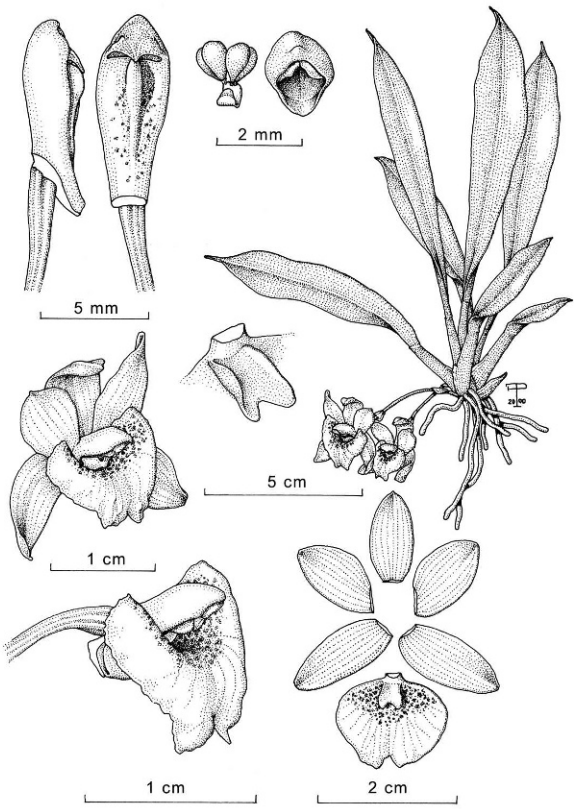

Figure 56.

FIG. 53. *Kefersteinia costaricensis*. FIG. 54. *Kefersteinia parvilabris*. FIG. 55. *Kefersteinia endresii*. FIG. 56. *Kefersteinia microcharis*.

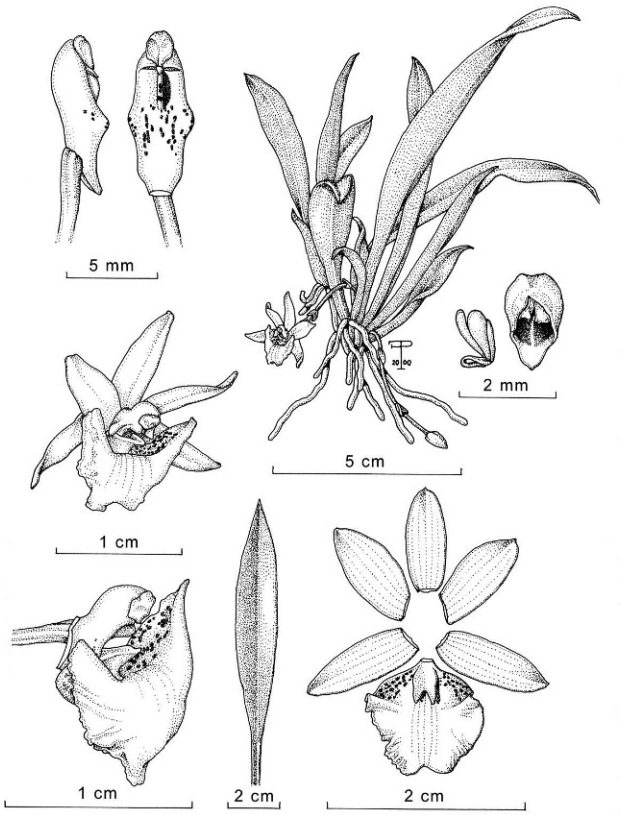

Figure 57.

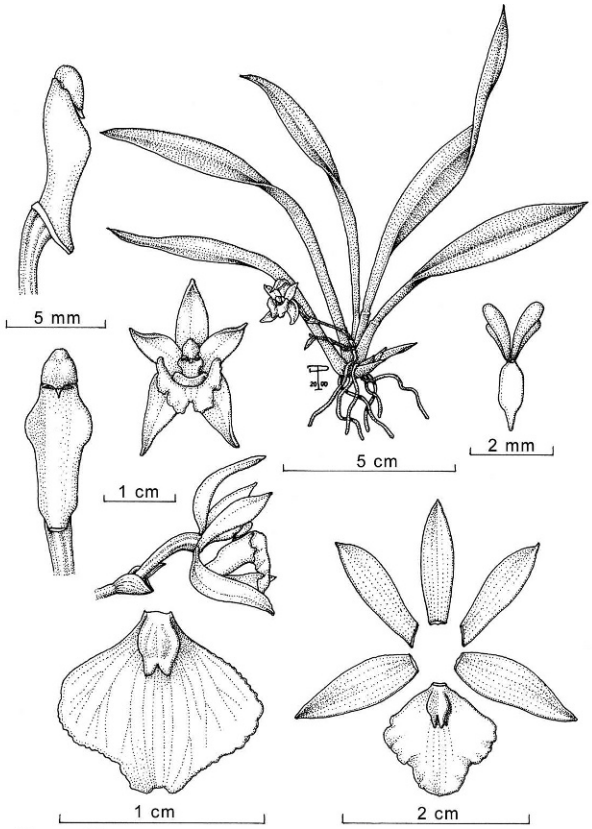

Figure 58.

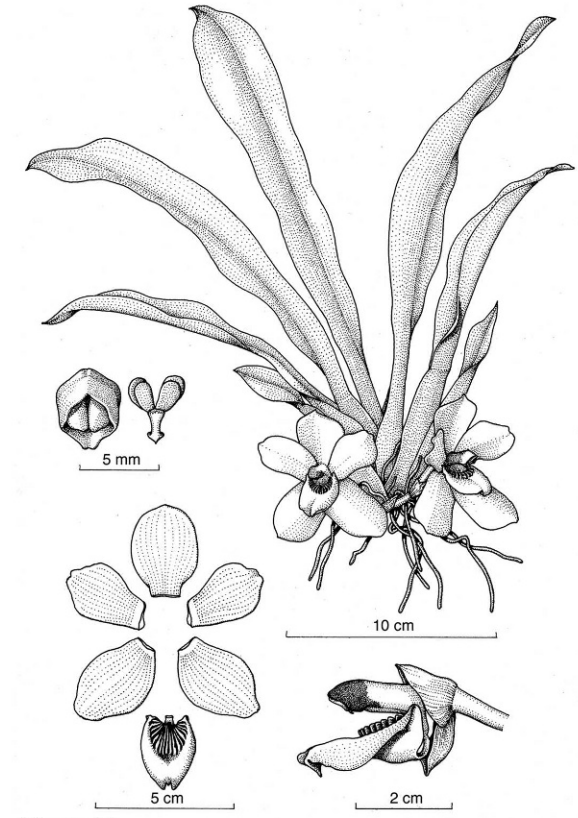

Figure 59.

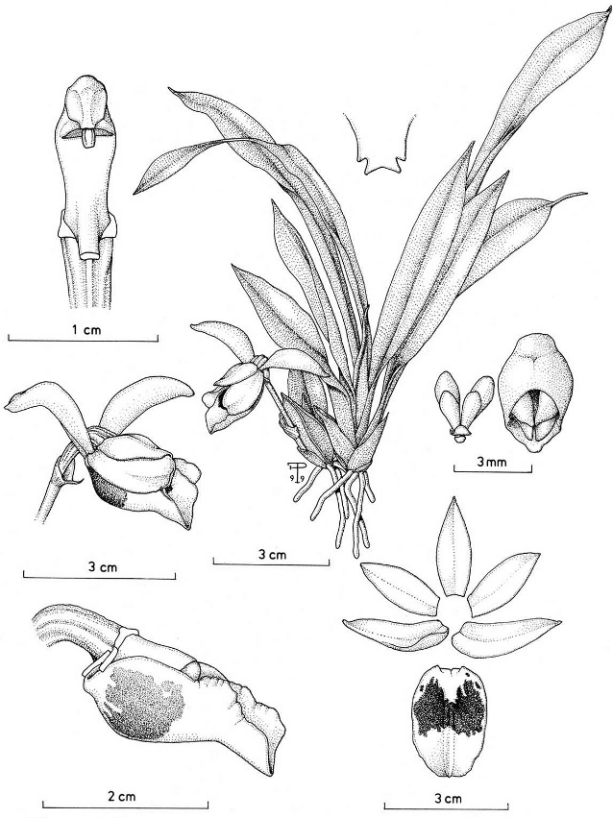

Figure 60.

FIG. 57. *Kefersteinia lactea*. FIG. 58. *Kefersteinia alba*. FIG. 59. *Pescatoria cerina*. FIG. 60. *Stenotyla lankesteriana*.

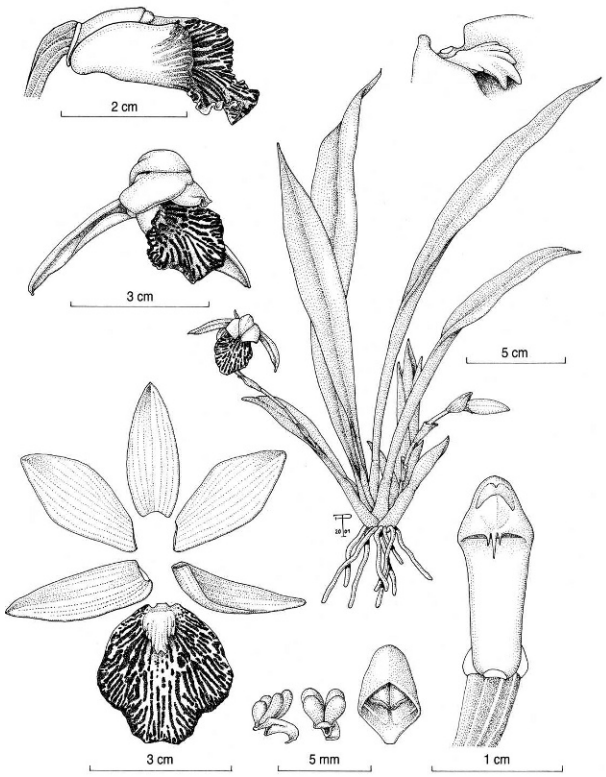

Figure 61.

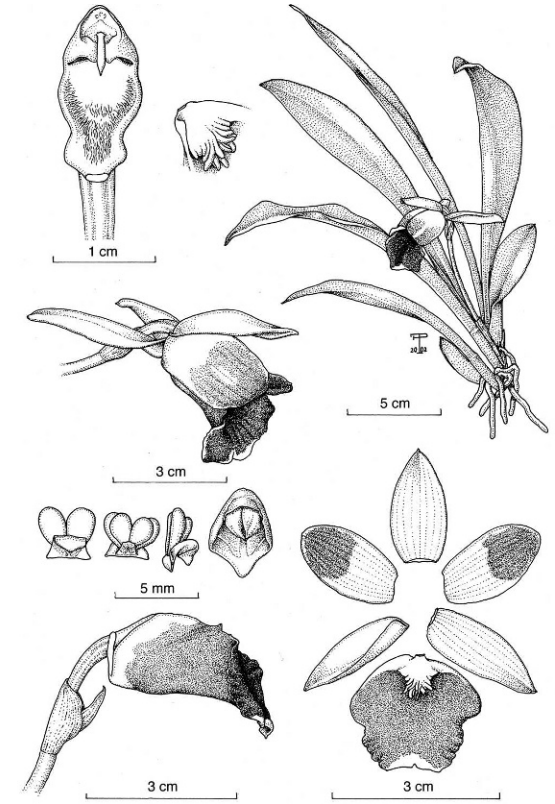

Figure 62.

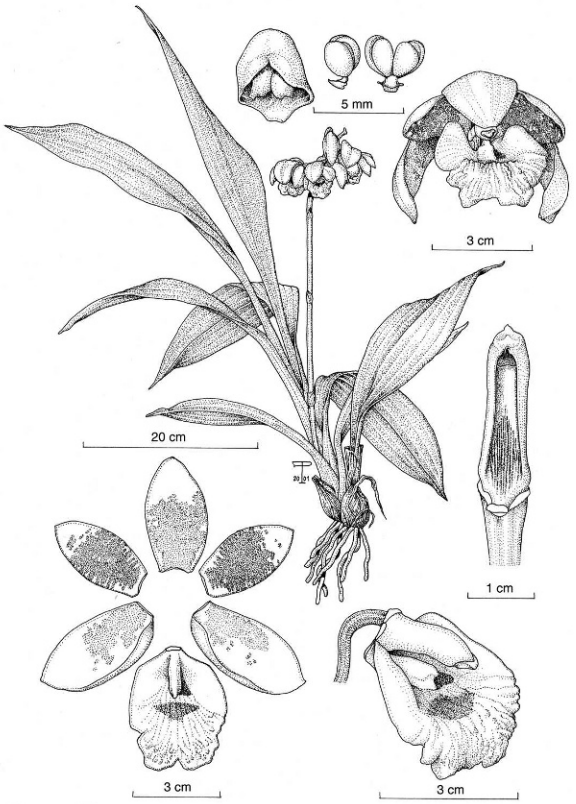

Figure 63.

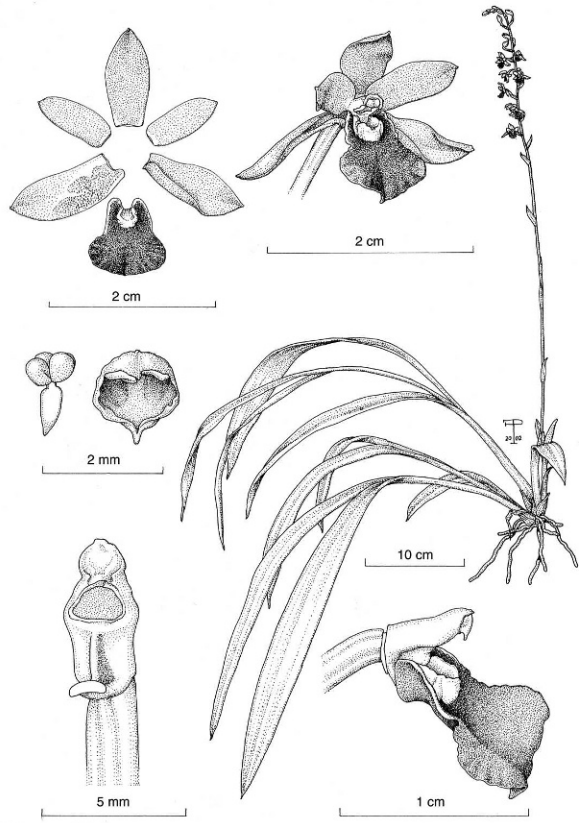

Figure 64.

FIG. 61. *Stenotyla picta*. FIG. 62. *Warczewiczella discolor*. FIG. 63. *Warrea costaricensis*. FIG. 64. *Warreopsis parviflora*.

distinguish *K. parvilabris* from the other Costa Rican species of the genus.

Kefersteinia retanae G.Gerlach, Brenesia 52: 75. 1999 [2000]. Type: Costa Rica. San José: Pérez Zeledón, Peña Blanca, 600 m, flowered in cultivation at Munich Botanical Garden, Jun. 1992, prepared in the same date, *G. Gerlach s.n.* (USJ!). Figure 50 (Voucher: *Pupulin 708*, USJ).

Epiphytic, erect, cespitose **herbs** to about 10 cm tall, each shoot provided with 2–3 leaves and 3–5 basal cataphylls, foliaceous or not. **Roots** flexuous, glabrous. **Leaves** linear to narrowly oblanceolate, acute, minutely apiculate, to 13(17) × 1.1–1.4 cm, narrowing at the base into a conduplicate petiole 2 cm long. **Inflorescences** many, each a pendent, solitary flower; peduncle terete, to 4 cm long, with 2–3 conic-infundibular, membranous bracts. **Floral bracts** peltate, obtuse, 4.0 × 3.5 mm. **Ovary** subclavate, winged, 7 mm long including the pedicel. **Flowers** small for the genus, the perianth not spreading out completely, greenish yellow, translucent, the petals with sparse purple spots , the lip white spotted and blotched with dark purple along veins and margins, the callus pale yellow spotted purple. **Dorsal sepal** elliptic, apiculate, concave, 10.0 × 4–5 mm. **Lateral sepals** elliptic to elliptic-lanceolate, falcate, acute, concave, 12 × 3 mm. **Petals** obliquely elliptic-lanceolate, acute, 12 × 4–5 mm. **Lip** with a cuneate claw, obovate-pandurate, retuse, concave, 11 × 9 mm, the margins upcurved; callus sub-basal, peltate-obreniform, bilobed, 2 × 3 mm, about 3 mm high. **Column** elongate, with a foot, 7 × 5 mm at the middle, from a narrow base, the ventral surface forming a transversely elliptic plate, basally protruding into a transversal keel, the margins obscurely lacerate, provided with a median longitudinal keel projecting into an obtuse tooth. **Anther cap** cucullate, subquadrate, compressed, rounded at apex, 4-celled. **Pollinia** 4, linear-oblong to narrowly obpyriform, on a folded stipe; viscidium hyaline, obtriangular.

DISTRIBUTION—The species is known only from Costa Rica.

ECOLOGY—*Kefersteinia retanae* is a rare epiphyte in premontane wet forest of Cordillera de Talamanca in southern Costa Rica, at 500–600 m elevation. Flowering occurs from May to November.

DISTINGUISHING FEATURES—The ringent, yellowish flowers heavily spotted with purple and the obovate-pandurate lip with retuse apex and the upcurved margins easily distinguish *K. retanae* from its close relatives, namely, *K. wercklei* and *K. excentrica*. *Kefersteinia retanae* is the most floriferous species of the genus in Costa Rica, and a single growth may bear up to 20 flowers.

Kefersteinia saccata Pupulin, Willdenowia 38: 2. 2008. Type: Preserved from a plant in flower cultivated by A. Alfaro H. and originally collected in Jan. 2006 by Alberto Rodríguez in Costa Rica, Alajuela, San Carlos, Río Cuarto, La Española, 4 km N of Santa Rita, 10°26′34″N, 84°11′73″W, 200 m, 23 Apr. 2007, *Pupulin 6549* (CR-Spirit). Figure 48 (Voucher: *Pupulin 6549*, CR-Spirit).

Epiphytic, erect, cespitose **herbs** to about 12 cm tall. **Roots** terete, 3–4 mm in diameter. **Stem** abbreviated, enclosed by 4–5 imbricating sheaths provided with hyaline, scarious margins, the upper ones foliaceous, to 3 cm long. **Leaves** elliptic, acute, 6.0–10.0 × 2.5–3.2 cm, narrowing at the base into a conduplicate petiole 0.7–2.0 cm long. **Inflorescence** arched to pendent, a solitary flower; peduncle terete, to 3.5 cm long, with 1–2 triangular-infundibular, acute, membranous to scarious bracts. **Floral bract** double, the outer one broadly ovate, acute, 5–6 × 4 mm, the subopposite internal bractlet narrowly lanceolate-ligulate, 5.0 × 1.5 mm. **Ovary** subclavate, distinctly winged, 9 mm long including the pedicel. **Flowers** small for the genus, the dorsal sepal and the petals ringent, greenish cream, translucent, the petals with sparse, minute purple spots, the lip white with purple spots arranged in a few radiating lines, the callus pale yellow. **Dorsal sepal** narrowly elliptic, acute, strongly concave, abaxially subcarinate, 9.0 × 3.5 mm. **Lateral sepals** lanceolate-elliptic, acute, minutely apiculate, concave, inrolled-folded toward the base, 10.5 × 4.5 mm. **Petals** obliquely elliptic, acute, 10.0 × 4.5 mm. **Lip** with a cuneate claw, ovate-subtrapezoidal, acute, deeply concave-cymbiform, 9 × 8 mm, the margins irregularly crenate, the apex upcurved; callus sub-basal, obreniform, bilobed, 1.6 mm long, 3 mm wide, about 2.5 mm high. **Column** semiterete from a narrow base, 6.5 mm long excluding the foot, 3.5 mm wide at the middle, the foot 2.5 mm long, the ventral surface forming a transversely elliptic-subrectangular plate, the lateral margins infolded, provided with a median, longitudinal, infrastigmatic keel projecting at the rear into a high, obtuse tooth. **Anther cap** cucullate, ovate, flattened, 3-dentate at apex, 2-celled. **Pollinia** 4, in 2 pairs of different sizes, linear-oblong, on a cross-shaped, folded stipe; viscidium hyaline, rounded.

DISTRIBUTION—Known only from Costa Rica.

ECOLOGY—*Kefersteinia saccata* is an apparently rare epiphyte from the tropical wet forests of the San Carlos plain, in northern Costa Rica, at about 200 m elevation. Flowering occurs at least in May, at the beginning of the rainy season in Costa Rica.

DISTINGUISHING FEATURES—The porrect petals flanking the column up to the apex; the saccate, ovate-subrhombic lip shorter than the column, acute and recurved at apex; and the obreniform basal callus distinguish *K. saccata* from its relatives, namely, *K. retanae* and *K. wercklei* Schltr. *Kefersteinia saccata* is the smallest species of the genus in Mesoamerica.

Kefersteinia wercklei Schltr., Repert. Sp. Nov. Beih. 19: 53. 1923. Type: Costa Rica. Alajuela: San Ramón, La Palma, Jun. 1921, *C. Wercklé 120* (B, destroyed; lectotype, AMES!). *Zygopetalum umbonatum* Rchb.f., Ms. at W-R. Figure 49 (Voucher: *Pupulin 3039*, USJ).

Epiphytic, erect, cespitose **herbs** to about 15 cm tall, each shoot provided with 3–4 leaves and 2–3 acute, triangular bracts at the base. **Roots** flexuous, glabrous. **Leaves** cuneate-ligulate to lanceolate, acuminate, to 13.0 × 0.8 cm, narrowing at the base into a conduplicate petiole 1.5 cm long. **Inflorescences** 1–2, each a pendent to suberect, solitary flower; peduncle terete, to 3 cm long, with 1–2 cucullate, oblong, acute bracts. **Floral bracts** cucullate, obtuse, membranaceous, to 5 × 4 mm. **Ovary** subclavate, terete, 8 mm long including the pedicel. **Flowers** not spreading out completely, greenish white to cream, the petals sometimes with sparse red spots, the lip white with sparse rose blotches toward the base, sometimes spotted red toward the edges, the callus white. **Dorsal sepal** oblong-lanceolate, apiculate, concave, 12 × 4.2 mm. **Lateral sepals** elliptic to elliptic-lanceolate, acute to obtuse, concave, 14.5 × 5.3 mm. **Petals** obliquely elliptic to elliptic-lanceolate, acute, 11 × 3.5 mm. **Lip** with a cuneate claw, ovate-oblong, subpandurate, obtuse, subapiculate, concave toward the base, curved sigmoidally, 9.5 × 5.5 mm, the basal margins erect, the apical margins subcrenulate; callus basal, fleshy, clitelliform, truncate, bilobed and obscurely puberulent at apex, sulcate along the middle, the groove dividing before reaching the apical notch, about 2.5 × 2.0 mm. **Column** subterete, with a foot, 8.0 × 3.7 mm at the middle, from a narrow base, the ventral surface forming a subquadrate plate, basally protruding into two widely rounded keels, the margins puberulent, provided with a low median, longitudinal keel. **Anther cap** cucullate, subquadrate, compressed, rounded at apex, 2-celled. **Pollinia** 4, linear-oblong, on a long, oblanceolate, acute stipe.

DISTRIBUTION—The species is known only from Costa Rica.

ECOLOGY—Plants of *K. wercklei* are epiphytic in premontane wet forest of the Caribbean drainage of Cordillera de Tilarán in northern Costa Rica at 600–650 m elevation. Flowering occurs from June to November.

DISTINGUISHING FEATURES—The ringent, whitish flowers, sometimes flushed with purple toward the apex of lip, and the prominent callus distinguish *K. wercklei* from its relatives.

Pescatoria Rchb.f.*

REFERENCES—C. H. Dodson, *Pescatorea* Rchb.f. *In*: C. H. Dodson, Native Ecuadorian Orchids 3: 734–735. Dodson Trust, Sarasota. 2003. C. H. Dodson & G. P. Frymire, Preliminary studies in the genus *Stanhopea*. Ann. Missouri Bot. Gard. 48: 137–172. 1961. J. A. Fowlie, A key and annotated checklist to the genus *Pescatorea*. Orch. Dig. 32(3): 86–91. 1968. J. A. Fowlie, A key and annotated checklist to the genus *Bollea*. Orch. Dig. 33(3): 100–103. 1969. W. M. Whitten, N. H. Williams, R. L. Dressler, G. Gerlach, & F. Pupulin, Generic relationships of Zygopetalinae (Orchidaceae: Cymbideae): Combined molecular evidence. Lankesteriana 5(2): 87–107. 2005. F. Pupulin. *Pescatoria*. Pp. 521–524 *in*: A. M. Pridgeon, P. J. Cribb, M. W. Chase & F. Rasmussen (eds.). Genera Orchidacearum, volume 5. Epidendroideae (Part Two). Oxford University Press.

Pescatoria Rchb.f., Bot. Zeitung (Berlin) 10: 667. 1852. Type species: *Huntleya cerina* Lindl. & Paxton [= *Pescatoria cerina* (Lindl. & Paxton) Rchb.f.].

Syn.: *Bollea* Rchb.f., Bot. Zeitung (Berlin) 10: 667 (1852). Type species: *Huntleya violacea* Lindl. = *Bollea violacea* (Lindl.) Rchb.f.

Epiphytic, often large, cespitose **herbs** without pseudobulbs. **Roots** terete, thick, produced from the rhizome. **Stem** enclosed by 7–12 imbricating, mostly foliaceous sheaths. **Leaves** conduplicate, articulate, membranaceous to thinly coriaceous, erect to erect-spreading, narrowly ligulate to oblanceolate, obtuse to acute or acuminate, abaxially carinate, sometimes lightly veined, contracted at the base into an indistinct, conduplicate petiole, grass green to dark green. **Inflorescence** 1 or more per shoot, lateral, single-flowered, produced from the axils of the lower, non-foliaceous sheaths; the peduncle terete, arcuate or pendulous, provided with 1–3 conduplicate, slightly loose, papery bracts; floral bract double, conduplicate, papery, shorter than ovary, the external one loose, widely ovate, acute, the subopposite internal bractlet narrowly lanceolate to ligulate. **Flowers** resupinate, large, fleshy, the sepals and petals white to creamy yellow, greenish cream or pink to solid purple-violet, mostly flushed with lavender toward the apex, rarely striped with lavender or purple in the basal half, the lip white to pink or yellow, the midlobe often flushed lavender or purple apically, rarely solid violet, the callus yellow (rarely white) to dark purple, the ribs of the callus usually purple. **Dorsal sepal** free, erect to bent over the column, elliptic to ovate-oblong to broadly obovate, obtuse to acute, mostly concave toward the apex. **Lateral sepals** basally adnate to the column foot, forming a short and often distinct mentum, elliptic-lanceolate to widely ovate-oblong or obovate, obtuse to shortly acute, concave toward the apex, the margins sometimes undulate to wavy and the inner margins slightly inrolled at the base. **Petals** broadly elliptic to obovate, obtuse to subacute, often with undulate and sometimes revolute margins. **Lip** fleshy, contracted at the base into a claw, articulate or solidly adnate to the column foot, entire or obscurely 3-lobed, ovate to obovate or sagittate, acute to retuse, usually convex and reflexed at apex, sometimes provided with warty asperities or bristles, the lateral margins recurved; the hypochile cupped, sometimes provided with lateral lobes resting against the base of the column, with a large, erect, semicircular, fleshy, plurisulcate callus, deeply grooved longitudinally into numerous, rounded ridges. **Column** arcuate, semiterete to navicular, dilated at apex, sometimes provided with broad, swollen lobes, provided with a distinct foot and a transverse, narrow stigma. **Anther cap** cucullate, broadly ovate-subquadrate to transversely elliptic, flattened, 2-celled. **Pollinia** 4, in 2 superposed pairs of different sizes, on a rectangular stipe and a flattened, cordiform, hyaline viscidium.

Pescatoria is a Neotropical genus of some 22 species and two named natural hybrids, ranging from Costa Rica to Brazil and Peru, centered in northwestern South America. The genus exhibits the highest diversity along the Andes of Colombia and Ecuador. Species diversity rapidly diminishes toward the southern end of the Andes and in eastern South America as well as toward the north, with a single species recorded for Costa Rica. Most of the species of *Pescatoria* are native to extremely wet, premontane cloud forests at medium elevations (around 800–1500 m), with only a few taxa ranging to the warmer forests of the basal, tropical belt at 200–500 m elevation. Plants of *Pescatoria* grow as large epiphytes of mature vegetation, where they are restricted mostly to the trunks and large branches of their hosts. The large and long-lasting flowers are produced mostly during the rainy season, but species of *Pescatoria* sporadically flower throughout the year. Male euglossine bees pollinate species of *Pescatoria*, and Dodson and Frymire (1961) recorded the pollination of *P. wallisii* by *Eulaema polychroma*. The bees scrub at the base of the lip, and the pollinarium becomes attached under the back of the thorax (Dodson, 2003).

Reichenbach originally described *Pescatoria* and *Bollea* in the same publication, distinguishing the latter mainly on the basis of the broad lateral lobes of the column that protrude over the enlarged, semicircular callus. The two genera have been traditionally regarded as sister taxa, which differ primarily in the relative width of the column, and their close relationship was supported by the presence of putative "intergeneric" natural hybrids (*Pescatobollea*). Keys and annotated checklists of *Pescatoria* and *Bollea* have been given by Fowlie (1968, 1969a), who informally divided *Pescatoria* into three groups on the basis of characteristics of lip vestiture. In the phylogenetic analysis by Whitten and coworkers (2005) based on DNA sequences, the sampled species of *Pescatoria* and *Bollea* are intercalated on short branches, forming a well-supported clade, sister to *Warczewiczella* Rchb.f. and to the clade including *Chaubardiella* Garay, *Ixyophora* Dressler, and *Aetheorhyncha* Dressler.

Pescatoria cerina (Lindl. & Paxton) Rchb.f., Bot. Zeitung (Berlin) 10: 667. 1852. Type: Panama. Veragua, Chiriqui Volcano, 8000 ft, *Warscewicz s.n.* (K). *Huntleya cerina* Lindl. & Paxton, Paxton's Fl. Gard. 3: 62. 1852. *Zygopetalum cerinum* (Lindl. & Paxton) Rchb.f. in W.G.Walpers, Ann. Bot. Syst. 6: 651. 1863. *Pescatoria costaricensis* Schltr., Repert. Spec. Nov. Regni Veg. Beih. 19: 139. 1923. Type: Costa Rica: Ohne nähere Standortsangabe, im Mai 1910, *A. Brade & C. Brade 1196* (B, destroyed). Figure 59 (Voucher: *Pupulin s.n.*, not preserved).

Epiphytic, cespitose **herbs** without pseudobulbs. **Roots** terete, produced from the rhizome. **Stem** enclosed by 7–9 imbricating, mostly foliaceous sheaths. **Leaves** conduplicate-subplicate, articulate, membranaceous to thinly coriaceous, erect to arching, elliptic to oblanceolate, acute to shortly acuminate, abaxially carinate, grass green to dark green, 15–55 × 3–5 cm, contracted at the base into a conduplicate petiole to 2 cm long. **Inflorescences** 1 or more per shoot,

*In creating the genus to accommodate Lindley's *Huntleya cerina*, Reichenbach originally published the name with the spelling *Pescatoria*, dedicating it to the "praenobilissimo Pescatore [Jean-Pierre Pescatore, Luxembourg 1793—Celle Saint-Cloud 1855], Orchidearum cultori celeberrimo" (Reichenbach, 1852). According to Article 60.1 of the ICBN, "the original spelling of a name or epithet is to be retained, except for the correction of typographical or orthographical errors." Article 60.7 expressly states that when "changes in spelling by authors who adopt personal, geographic, or vernacular names in nomenclature are intentional latinizations, they are to be preserved." Even though in subsequent publications Reichenbach adopted the spelling *Pescatorea*, he correctly quoted the surname of Pescatore when the name was validly published, and we should assume that the original spelling was an intentional latinization.

lateral, single-flowered, produced from the axils of the lower sheaths, 4.5–10.0 cm long; the peduncle suberect to arcuate-pendulous, provided with 1–2 conduplicate, slightly loose, papery bracts; floral bract double, conduplicate, papery, shorter than ovary, the external one loose, widely ovate, subacute, 15 × 18 mm, the subopposite internal bract smaller, ovate, acute, 15 × 8 mm. **Flowers** resupinate, large, spreading, fleshy, the sepals and petals white to creamy yellow, the lip yellow, the callus yellow with dark purple ribs, the column cream, blotched purple at the base. **Dorsal sepal** free, erect to slightly bent over the column, clawed, ovate-oblong to suborbicular, obtuse, mostly concave toward the apex, 3.0–3.2 × 2.0–2.7 cm. **Lateral sepals** basally adnate to the column foot, forming a mentum, widely elliptic to obovate, obtuse to subrounded, concave toward the apex, the margins slightly revolute, 3.0–3.5 × 2.2–2.8 cm. **Petals** obovate, obtuse to retuse, the margins slightly revolute, 2.7–3.0 × 1.8–2.3 cm. **Lip** fleshy, contracted at the base into a claw, articulate to the column foot, entire, sagittate-ovate, acute, apically reflexed, 2.0–2.5 × 1.8–2.2 cm; hypochile cupped, the lateral lobes resting against the base of the column, with a large, erect, semicircular-lunate, fleshy, plurisulcate callus, deeply grooved longitudinally into numerous, low, rounded ridges. **Column** semiterete, dilated at apex, 1.8–2.3 cm long, provided with a distinct foot about 1 cm long; the stigma narrow, transverse. **Anther cap** cucullate, broadly ovate-subquadrate, flattened, 2-celled. **Pollinia** 4, in 2 superposed pairs of different sizes, on a triangular, sigmoid stipe and a flattened, cordiform-ovate, hyaline viscidium.

DISTRIBUTION—The species is known from Costa Rica and Panama.

ECOLOGY—Epiphytic in premontane to lower montane wet forests at 600–1600 m elevation, populations of *P. cerina* are restricted in Costa Rica to the Caribbean drainage along the northern and central Cordilleras but have been recorded from both watersheds in the Talamanca mountain range. Flowering occurs from March to December, with a flowering peak in October–November, toward the end of the rainy season.

DISTINGUISHING FEATURES—The large, spreading, fleshy, creamy flowers with a many-ridged, semilunar callus striped with dark purple make *P. cerina* unmistakable.

Stenotyla Dressler

REFERENCES—R. L. Dressler, Precursor to a revision of the *Chondrorhyncha* complex. Orquideología 21: 233–247. 2000. J. A. Fowlie, A revision of the Central American species of *Chondrorhyncha* and *Kefersteinia*, including the description of a new species from Costa Rica. Part I. Introduction and the genus *Chondrorhyncha*. Orch. Dig. 30: 79–82. 1966. L. A. Garay, El complejo *Chondrorhyncha*. Orquideologiá 4: 139–152. 1969. W. M. Whitten, N. H. Williams, R. L. Dressler, G. Gerlach, & F. Pupulin, Generic relationships of Zygopetalinae (Orchidaceae: Cymbideae): Combined molecular evidence. Lankesteriana 5(2): 87–107. 2005. F. Pupulin, The genus *Stenotyla*, and a new species. Orch. Rev. 117: 158–165. 2009. F. Pupulin. *Stenotyla*. Pp. 529–531 *in*: A. M. Pridgeon, P. J. Cribb, M. W. Chase & F. Rasmussen (eds.). Genera Orchidacearum, volume 5. Epidendroideae (Part Two). Oxford University Press.

Stenotyla Dressler, Lankesteriana 5: 96. 2005. Type species: *Chondrorhyncha lendyana* Rchb.f. [= *Stenotyla lendyana* (Rchb.f.) Dressler]

Epiphytic, cespitose **herbs** with ruderal pseudobulbs. **Roots** terete, produced from the rhizome. **Pseudobulb** ovate-elliptic, laterally complanate, aphyllous or apically provided with a scale-like leaf, enclosed by 6–8 imbricating sheaths, the upper ones foliaceous. **Leaves** conduplicate, articulate, membranaceous, narrowly elliptic to obovate, acute to acuminate, abaxially carinate, narrowed at the base into a conduplicate petiole, pale to medium green. **Inflorescences** lateral, 1–2 per shoot, single-flowered, produced from the axil of the lower sheaths; the peduncle terete, patent to erect, provided with 2–3 narrow, conduplicate, membranaceous bracts; floral bract double, conduplicate, shorter than ovary, the external one broadly ovate, obtuse to subacute, amplectant, the subopposite internal bractlet narrowly ligulate. **Flowers** resupinate, the sepals and petals white to yellowish cream, the lip white to cream, blotched at the base with yellow or purple red, or striped with chestnut brown or dark purple, the callus white or yellow. **Dorsal sepal** free, lanceolate-elliptic to elliptic, acute to subacuminate, distinctly porrect. **Lateral sepals** lanceolate-elliptic to elliptic, acute, sometimes distinctly falcate, spreading to reflex, sometimes becoming suberect, strongly inrolled-folded toward the base. **Petals** lanceolate-elliptic to narrowly obovate, acute to obtuse-rounded, usually gently revolute at apex. **Lip** articulate with the **column** foot, entire to obscurely 3-lobed, elliptic to obovate, rarely cymbiform, the base shortly cordate to form a short chin, the apex truncate to emarginate-retuse, slightly deflexed, the distal margins undulate, the proximal margins erect, flanking the column; callus laminar, in the proximal third of the blade, apically 2- to 4-toothed, sometimes provided with indistinct, low lateral keels. Column straight, with a distinct foot, slightly dilated at apex, the ventral surface flat, the stigma transverse, narrow. **Anther cap** cucullate, elliptic-obovate to narrowly ovate, slightly flattened, 2-celled. **Pollinia** 4, in 2 pairs of different sizes, on a obtriangular-elliptic stipe scarcely distinct from the ventral, ligulate, apically truncate, hyaline viscidium.

Stenotyla is a Neotropical genus of five species ranging from southern Mexico to western Panama. The species of *Stenotyla* occur as epiphytes of shady places in premontane to submontane, evergreen, wet and cloud forests at elevations of 1100–2100 m. Flowering occurs mostly from May to October, roughly corresponding to the rainy season, but once the new shoot matures, the flowers may be produced at any moment of the year. The pollinator of *Stenotyla* is unknown, but the shape of the pollinarium, with its stipe and viscidium that curl immediately after removal (pers. obs.), indicates that the species of this group are pollinated by euglossine bees in a way similar to *Kefersteinia* or *Chaubardiella*.

The five named species referable to *Stenotyla* were previously assigned to *Chondroryhncha* Lindl. and *Warczewiczella* Rchb.f., but they do not fit either group well. Vegetatively, *Stenotyla* resembles *Chondroryhncha*, but all the species of the genus are provided with distinct pseudobulbs completely hidden by the leaf-sheaths, and they may be distinguished among other Zygopetalinae of the *Huntleya* clade by the narrow, laminar, basal, toothed callus; the chin at the base of the lip; and the column without wings. Phylogenetic analyses based on DNA sequences (Whitten et al., 2005) unequivocally placed *Stenotyla* species into a definite clade with strong bootstrap support, sister to *Cochleanthes* Raf. and consecutively sister to the true species of the genus *Chondrorhyncha*.

Key to the Species of *Stenotyla*

1. The lip cymbiform, white with a large purple blotch at the base; the callus flat, smooth . . . . . *Stenotyla lankesteriana*

1a. The lip spreading at apex, cream, finely striped with purple (sometimes reticulated); the callus raised, minutely sulcate . . . . . *Stenotyla picta*

Stenotyla lankesteriana (Pupulin) Dressler, Lankesteriana 5: 96. 2005. Type: Costa Rica. Without definite locality; a confiscated plant flowered in cultivation at Jardín Botánico Lankester at Paraíso de Cartago, 1400 m, 19 May 1999, *F. Pupulin 1467* (USJ!). *Chondrorhyncha lankesteriana* Pupulin, Lindleyana 15: 21. 2000. Figure 60 (Voucher: *Pupulin 1467*, USJ).

Epiphytic, erect, cespitose **herbs**, to 30 cm tall. **Roots** flexuous, glabrous. **Pseudobulb** ovoid, complanate, completely hidden by the leaf-sheaths, apically provided with a rudimentary leaf and enclosed by 5–9 distichous sheaths, the upper ones foliaceous. **Leaves** membranaceous, oblanceolate to linear-lanceolate, acute, with undulate margins, 7.0–13.0 × 1.0–1.2 cm, contracted at the base into a conduplicate petiole to 2.8 cm long. **Inflorescences** 1–2, each erect, single-flowered, lateral, produced from the base of the stem and arising from the axil of basal cataphylls; peduncle terete, to 8 cm long, provided with an infundibular, ovate, acute bract 7 mm long. **Floral bract** conspicuous, infundibular, acute to acuminate, 7 mm long. **Ovary** clavate, arcuate, provided with low, undulate wings, 1.2 cm long including the pedicel. **Flowers** spreading, white, the lip blotched adaxially with dark purple at the base, this slightly visible without. **Dorsal sepal** narrowly elliptic to lanceolate, acute, concave, dorsally carinate, 2.4 × 0.8 cm. **Lateral sepals** linear-elliptic, subfalcate, acute, connate with the base of the column foot, strongly concave, subgeniculate at the middle, the basal margins convolute, apically strongly divergent, 2.6 × 0.8 cm. **Petals** elliptic-lanceolate, acute to obscurely apiculate, with revolute apex, 2.2 × 0.9 cm. **Lip** entire, tubular, elliptic when spread, truncate, apiculate, obscurely cordate at the base, the apical margins slightly undulate-crisped, the basal lobes erect, clasping the column, 2.7 × 1.8 cm; the disk provided at the base with a low, deltoid, truncate, laminar callus, 4-toothed at apex. **Column** straight, semiterete, widening toward the stigma, with a foot, 1.2 cm long. **Anther cap** cucullate, obovate-complanate, 2-celled. **Pollinia** 4, narrowly obovate, in 2 pairs of different sizes, on an obdeltoid stipe scarcely distinct from the shield-shaped, hyaline viscidium.

DISTRIBUTION—The species is known from Costa Rica and the Caribbean slopes in western Panama.

ECOLOGY—Plants of *S. lankesteriana* are found as rare epiphytes in premontane rain forests, at about 1000 m elevation. Flowering occurs in January–May.

DISTINGUISHING FEATURES—*Stenotyla lankesteriana* is closely related to *S. estrellensis* and *S. lendyana*, with which it shares a similar low, laminar callus. However, the tubular lip of *S. lankesteriana*, not spreading at apex and provided with a large, red purple blotch at the base, and the 4-toothed callus are useful features to distinguish the species.

Stenotyla picta (Rchb.f.) Dressler, Lankesteriana 5: 96. 2005. *Warczewiczella picta* Rchb. f., Gard. Chron., n.s., 20: 8. 1883. *Zygopetalum pictum* Rchb. f., Gard. Chron., n.s., 20: 8. 1883. *Chondrorhyncha picta* (Rchb. f.) Senghas, Orchidee (Hamburg) 41(3): 94. 1990. Syntypes: Costa Rica. *A.R. Endrés s.n.* (W-R); R. *Pfau s.n.* (W-R). *Chondrorhyncha estrellensis* Ames, Sched. Orch. 4: 54–56. 1923. Type: Costa Rica. Estrella de Cartago, 10 Jan. 1923, *C.H. Lankester & A. Sancho 396* (holotype, AMES). *Warczewiczella caloglossa* Schltr., Repert. Spec. Nov. Regni Veg. 12: 216. 1913. *Chondrorhyncha caloglossa* (Schltr.) P.H. Allen, Ann. Missouri Bot. Gard. 36(1): 85. 1949. Syntypes: Panama. Chiriquí: feuchte Wälder von Cuesta de las Palmas an der Südseite von Cerro de la Horqueta, 1700–2100 m, Mar. 1911, *H. Pittier* (*B.S.P.C.Z. 3214*) (B, destroyed); Panama. Mar 1911, *W.R. Maxon* (*B.S.P.C.Z. 5510*) (B, destroyed; lectotype, selected here, drawings of a syntype, AMES 26811). Figure 61 (Voucher: *Pupulin 3027*, USJ).

Epiphytic, erect, cespitose **herbs**, to 30 cm tall. **Roots** flexuous, glabrous. **Pseudobulb** ovoid, complanate, hidden by the leaf-sheaths, provided at apex with a rudimentary leaf and enclosed by 5–9 distichous sheaths, the upper ones foliaceous. **Leaves** membranaceous, oblanceolate to linear-lanceolate, attenuate, obscurely ribbed abaxially, 15.0–30.0 × 1.0–2.5 cm, contracted at the base into a conduplicate petiole ca. 2 cm long. **Inflorescences** 1–2, each erect, single-flowered, lateral, produced from the base of the stem and arising from the axil of basal cataphylls; peduncle terete, 7–10 cm long, provided with an ovate, acute, infundibular bract, 6–8 mm long. **Floral bract** double, the external one lanceolate, acute, 8–10 × 5–6 mm, the internal bractlet narrowly lanceolate, acuminate, 13–16 × 3–4 mm. **Ovary** clavate, arcuate, winged, 2 cm long including the pedicel. **Flowers** not completely spreading, cream to pale yellow, the lip pale yellow, finely striped with dark purple up to the apex, the stripes sometimes reticulate, the callus yellow. **Dorsal sepal** lanceolate, acute, concave, dorsally subcarinate, 2.3–2.6 × 0.7–0.9 cm. **Lateral sepals** lanceolate, subfalcate, acute-attenuate, connate with the base of the column foot, strongly concave, the margins convolute at the inflexed base, 2.6–2.8 × 0.8–0.9 cm. **Petals** obliquely elliptic, acute, with revolute apex, 2.7–2.8 × 1–1.3 cm. **Lip** trilobate (sometimes obscurely), broadly ovate when spread, obtuse-truncate, obscurely cordate at the base, 2.5–3.0 × 2.8–3.1 cm; the basal lobes erect to flank the column, the margins of the midlobe undulate; the disk provided at the base with a raised, deltoid, minutely sulcate callus, 4- to 6-toothed at apex, sometimes with smaller lateral teeth. **Column** straight, semiterete, widening toward the stigma, with a foot, 1.4 cm long. **Anther cap** cucullate, obovate-complanate, 2-celled. **Pollinia** 4, obovate, in 2 pairs of different sizes, on an obdeltoid stipe scarcely distinct from the shield-shaped, hyaline viscidium.

DISTRIBUTION—The species is distributed from Costa Rica to western Panama.

ECOLOGY—Epiphytic in premontane and lower montane wet and cloud forests at 1400–2100 m elevation, plants of *S. picta* are found mostly in shaded trunks and large branches covered with mosses. In Costa Rica, it has been recorded from the Caribbean drainage of the northern volcanic and central mountain ranges and from both watersheds along the slopes of the Cordillera de Talamanca. Flowering occurs mostly during the dry season, from December through April, but the species also flowers sporadically throughout the year.

DISTINGUISHING FEATURES—The erect inflorescences, the cream flowers with the lip finely striped with purple, and the raised, sulcate callus are useful features to distinguish *S. picta* from other members of the Zygopetalinae in Costa Rica. The morphology of the flower of *Warczewiczella caloglossa*, as represented in the copy of Schlechter's drawing of a syntype (now at AMES), leaves no doubts about the identity of this taxon and its synonymy with the earlier *W. picta*. The drawing at AMES is selected as the species' lectotype in spite of the fact that it mixed the name and the numbers of both collectors under "Pittier N° 5510," not cited in the protologue.

Warczewiczella Rchb.f.

REFERENCES—R. L. Dressler, Precursor to a revision of the *Chondrorhyncha* complex. Orquideología 21: 233–247. 2000. J. A. Fowlie, An annotated check list of the genus *Warscewiczella*. Orch. Dig. 33: 7224–7231. 1969. R. E. Schultes & L. A. Garay, On the validity of the generic name *Cochleanthes* Raf. Bot. Mus. Leafl. Harvard Univ. 18: 321–327. 1954. W. M. Whitten, N. H. Williams, R. L. Dressler, G. Gerlach, & F. Pupulin, Generic relationships of Zygopetalinae (Orchidaceae: Cymbideae): Combined molecular evidence. Lankesteriana 5(2): 87–107. 2005. F. Pupulin. *Warczewiczella*. Pp. 531–534 *in*: A. M. Pridgeon, P. J. Cribb, M. W. Chase & F. Rasmussen (eds.). Genera Orchidacearum, volume 5. Epidendroideae (Part Two). Oxford University Press.

Warczewiczella Rchb.f., Bot. Zeit. 10: 636. 1852. Type species: *Warrea discolor* Lindl. [= *Warczewiczella discolor* (Lindl.) Rchb.f.]

Epiphytic, cespitose **herbs** without pseudobulbs. **Roots** terete, flexuous, produced from the rhizome. **Stem** completely enclosed by 4–7 imbricating sheaths, the upper ones foliaceous. **Leaves** conduplicate, articulate, membranaceous, lanceolate to elliptic or oblanceolate, acute to acuminate, abaxially carinate, narrowed at the base into a conduplicate petiole, medium to dark green. **Inflorescence** lateral, 1–2 per shoot, single-flowered, produced from the axil of the lower

sheaths; the peduncle terete, erect to pendent, provided with 1–2 basal, tubular-infundibular, membranaceous to papery bracts; floral bract double, conduplicate, shorter than or equaling the ovary, the external one lanceolate to broadly ovate, obtuse to acute, amplectant, the subopposite internal bractlet narrowly ligulate. **Flowers** resupinate, mostly scented, the sepals white to yellowish cream or pale green, rarely suffused with pale violet, the petals white to yellowish cream or pale green, sometimes flushed violet or with a violet blotch toward the apex, the lip white to cream, blotched at the base with purple or yellow or striped with red to purple-violet or bluish-violet, sometimes purple or violet toward the edge or flushed purple along the midvein, the callus white or yellow variously spotted or veined with purple. **Dorsal sepal** free, lanceolate-elliptic to elliptic or ovate, acute to subacuminate, mostly arched-reflexed. **Lateral sepals** lanceolate-elliptic to elliptic or ovate, acute, mostly abruptly reflexed, rarely spreading, strongly inrolled-folded toward the base. **Petals** lanceolate to broadly elliptic, acute to obtuse-rounded, usually gently revolute at apex. **Lip** articulate with the column foot, unguiculate, entire to 3-lobed, ovate to broadly elliptic, the base rounded to cordate, the apex rounded to retuse or emarginate, gently deflexed, the distal margins undulate, the lateral lobes and the proximal margins erect, enfolding the column; disc with a semicircular, thick, multiseriate callus, composed by many distinct, radiating keels, sometimes of variable length, free at apex and laterally. **Column** straight or gently arched, with a foot, slightly dilated in the central portion or toward the apex, provided with rounded stigmatic wings, the ventral surface flat, sometimes sparsely covered with very hairs, the stigma transverse, narrow. **Anther cap** cucullate, elliptic-obovate, flattened, 2-celled. **Pollinia** 4, in 2 pairs of different sizes, on a wide, shield-shaped, ligulate to obovate-elliptic or obpeltate stipe, indistinct from the ventral, hyaline viscidium.

Warczewiczella is a tropical American genus of ten species ranging from Honduras to southern Brazil, Bolivia and Peru, with the highest diversity along the Amazonian slopes of Colombian Andes. A single species is known from Costa Rica. The species of *Warczewiczella* occur as epiphytes or rarely terrestrial herbs in open to dark shade, mostly on large branches covered with dense layers of mosses, in tropical to submontane wet forests and cloud forests. The elevational range of the genus spans from near sea level to over 2500 m, but most of the species grow in temperate regions of mid-elevation (700–1300 m). Flowering mostly occurs during the rainy season; however, flowers are also sporadically produced following the development of new shoots. In most species of *Warczewiczella* the lateral sepals are swept back and revolute to form a false spur, and the lip has a notch on either side of its base, allowing the entrance to the tubular base of the sepals. These false nectaries, which mimic the floral arrangement of species of lianas in the Bignoniaceae, deceive euglossine bees pollinators in search of nectar (Ackerman, 1983).

The original generic description of *Warczewiczella* by Reichenbach clearly stated the characteristic shape of the callus that distinguish it from the closely related taxa in the *Chondrorhyncha* complex. Although Schultes and Garay (1954) lumped the species of *Warczewiczella* with *Cochleanthes* Raf., Fowlie (1969b) was emphatic in maintaining the two genera apart on the basis of the different callus and column morphology. Combined molecular data (Whitten et al., 2005) strongly supported the separation of *Warczewiczella* from *Cochleanthes*, affirming Fowlie's view. In the combined molecular analysis, *Warczewiczella* forms a well-supported clade (with the exception of *W. wailesiana*), sister to *Pescatoria* Rchb.f, *Chaubardiella* Garay, *Ixyophora* Dressler, and *Aetheorhyncha* Dressler and only distantly related to the clade containing *Cochleanthes* and *Stenotyla* Dressler. Morphologically, the genus is characterized by relatively large plants and flowers, with the base of the lip enfolding the column and a basal callus, free apically and laterally, composed of many ridges.

Warczewiczella discolor (Lindl.) Rchb.f., Bot. Zeit. 10: 636. 1852. Type: Costa Rica, *Warszewicz* (holotype, K). *Warrea discolor* Lindl., J. Hort. Soc. Lond. 4: 265. 1849. *Zygopetalum discolor* (Lindl.) Rchb.f., Walp. Ann. Bot. Syst. 6: 655, 1861. *Chondrorhyncha discolor* (Lindl.) Allen, Ann. Missouri Bot. Gard. 36: 87. 1949. *Cochleanthes discolor* (Lindl.) Schultes & Garay, Bot. Mus. Leafl. Harvard Univ. 18: 324. 1954. Figure 62 (Voucher: *Pupulin 5993*, JBL-Spirit).

Epiphytic, cespitose **herbs**, without pseudobulbs. **Roots** terete, flexuous. **Stem** completely enclosed by 4–7 imbricating sheaths, the upper ones foliaceous. **Leaves** conduplicate, articulate, membranaceous, elliptic or oblanceolate, acute to acuminate, abaxially carinate, 15.0–35.0 × 2.0–3.5 cm, narrowed at the base into a conduplicate petiole, medium green. **Inflorescences** lateral, 1–2 per shoot, single-flowered, produced from the axil of the lower sheaths, 12–15 cm long; the peduncle terete, erect to patent, provided with 1–2 basal, tubular-infundibular, papery bracts; floral bract double, conduplicate, papery, the external one broadly ovate, obtuse to acute, amplectant, 1.5 × 1.2 cm, the internal bractlet narrowly lanceolate, 1.5 × 0.7 cm. **Flowers** resupinate, not completely spreading, the sepals pale green, the petals yellowish cream or pale green, with a large violet blotch toward the apex, the lip violet-blue, often with white apex, the callus yellow. **Dorsal sepal** free, lanceolate-elliptic, acute, shortly apiculate, concave, bent over the column, 2.5–4.0 × 1.2–1.5 cm. **Lateral sepals** lanceolate-elliptic, acute, reflexed, strongly inrolled-folded toward the base, 2.5–4.0 × 1.0–1.3 cm. **Petals** elliptic, obtuse-rounded, gently revolute at apex, 2.6–4.0 × 1.5–1.9 cm. **Lip** articulate with the column foot, unguiculate, 3-lobed, broadly ovate when flattened, 3.0–4.0 × 3.2–4.2 cm, the apex retuse, the lateral lobes triangular-ovate, erect, enfolding the column, the midlobe transversely ovate, deflexed, the distal margins slightly undulate; disc with a radiate, multiseriate, digitate callus, the free apex of the radiating keels projecting into teeth of variable length. **Column** gently arched, 14–15 mm long, with a distinct foot, dilated in the central portion, provided with rounded stigmatic wings, the ventral surface flat, basally puberulent, the stigma transverse, narrow. **Anther cap** cucullate, obovate, flattened, 2-celled. **Pollinia** 4, in 2 pairs of different sizes, on a wide, transversely trapezoidal stipe, indistinct from the large, shield-shaped, hyaline viscidium.

DISTRIBUTION—The species is known from Costa Rica and Panama.

ECOLOGY—*Warczewiczella discolor* is a common epiphyte on large branch and trunks, in partial shade, in premontane and lower montane moist forest on both the watersheds of the Tilarán, Central, and Talamanca mountain ranges, at 700–2000 m elevation. Flowering occurs during the dry season, from December to May, with a flowering peak in April.

DISTINGUISHING FEATURES—The violet-blue lip that encircles the column and the yellow, multidigitate callus easily distinguish *W. discolor* from other Costa Rican Zygopetalinae.

Warrea Rchb.f.

REFERENCES—K. Senghas and G. Gerlach, Tribus: Maxillarieae. 60. Subtribus: Zygopetalinae. Pp. 1674–1727 *in* R. Schlechter, Die Orchideen, 3, Aufl., Bd. 1. Paul Parey, Berlin. 1993. D. Szlachetko, Systema Orchidalium. Frag. Flor. Geobot. Suppl. 3: 1–152. 1995. F. Pupulin, Zygopetalinae poco conocidas. El género *Warrea* Lindl. Epidendrum 24: 3–7. 2004. W. M. Whitten, N. H. Williams, R. L. Dressler, G. Gerlach, & F. Pupulin, Generic relationships of Zygopetalinae (Orchidaceae: Cymbideae): Combined molecular evidence. Lankesteriana 5(2): 87–107. 2005. F. Pupulin. *Warrea*. Pp. 534–536 *in*: A. M. Pridgeon, P. J. Cribb, M. W. Chase & F. Rasmussen (eds.). Genera Orchidacearum, volume 5. Epidendroideae (Part Two). Oxford University Press.

Warrea Lindl., Edwards's Bot. Reg. 29: Misc. 14. 1843. Type species: *Warrea tricolor* Lindl. [= *W. warreana* (Lodd. ex Lindl.) C.Schweinf.]

Terrestrial, rarely epiphytic, cespitose, pseudobulbous **herbs**. **Roots** terete, produced along the rhizome at the base of the pseudobulbs. **Pseudobulbs** homoblastic, fusiform-cylindric to elliptic-ovoid, usually cryptic among the bases of the foliaceous sheaths, 3–4-leaved, the oldest ones exposed and covered with papery, lacerate, veined sheaths. **Leaves** plicate, articulate, membranaceous, linear-lanceolate to elliptic, acute to acuminate, narrowed at the base into a distinct, conduplicate petiole. **Inflorescence** lateral, a few- to many-flowered (4–14) raceme emerging from the axils of the lower sheaths from the immature, developing pseudobulb; the peduncle terete, erect, provided with 3–6 widely ovate-triangular, acute, scarious, conduplicate, clasping bracts; floral bracts triangular-lanceolate, acute, conduplicate, membranaceous-scarious, shorter than ovary. **Flowers** resupinate, usually facing down, subglobose, with the sepals white to pale orange-yellow on the inner surface, sometimes faintly blotched with rose toward the base, abaxially cream to orange, flushed purple; the petals white to yellowish cream, often flecked with rose or pale purple; the lip white to yellow, with a large, orange to purple basal blotch, or the blotch restricted to the disc, or flushed rose-purple and striped with purple at the apex; the callus white to yellow, apically purple or solid purple. **Dorsal sepal** free, elliptic, acute, concave, usually reclinate over the column. **Lateral sepals** widely elliptic, obtuse, sometimes minutely apiculate, abaxially carinate, concave, the inner margin replicate-folded toward the base, forming a chin with the column foot. **Petals** elliptic to lanceolate-elliptic, widely subacute to acute, porrect, incurved. **Lip** articulate with the column foot, widely elliptic-suborbicular, sometimes obscurely 3-lobed, deeply cup-shaped in natural position, the base cuneate and contracted into an indistinct claw, the apex rounded-truncate, usually emarginate, the basal lobes erect, clasping the column, the distal lobe often reflexed, with strongly revolute, undulate-crisped margins; disc with a central, high, tuberculate, fleshy keel, extending from the base to near the half of lip. **Column** semiterete, curved, with a foot and inconspicuous stigmatic wings; the stigma transversely elliptic-rounded. **Anther cap** cucullate, obovate, flattened, 2-celled. **Pollinia** 4, in 2 subequal pairs, on a trapezoidal or narrowly triangular stipe, and a distinct, lanceolate-elliptic to triangular, hyaline viscidium.

Warrea is a genus of four to five species native from Mexico to Venezuela, Brazil and Argentina, and Peru. Species occur as terrestrials (rarely as epiphytes) in decaying leaf substrata, mostly in the shaded understory of dense, wet forests and occasionally on drier slopes and more exposed conditions. Records of *Warrea* distribution indicate that plants are restricted mostly to premontane forests, occasionally ranging to the tropical belt of moist to wet forests at (100)600–1500 m elevation. In South America, flowering mostly occurs from February to July, whereas plants from the Mesoamerican region produce their flowers in September–October. Species of this genus are presumed to be pollinated by male euglossine bees searching for fragrances. A single species is known from Costa Rica.

When Lindley described *Warrea* in 1843, he briefly characterized the genus by the subglobose flowers, the entire lip provided with fleshy keels, and the pollinarium with four pollinia in two pairs, a linear stipe, and a triangular viscidium. Because of the broad original circumscription, species currently assigned to such diverse genera as *Koellensteinia* Rchb.f., *Warreella* Schltr. and *Warczewiczella* Rchb.f. were subsequently described as members of *Warrea*. As presently understood, the genus can be easily characterized by the large plants with homoblastic pseudobulbs surrounded by the bases of membranaceous, plicate leaves; the lateral, erect inflorescences; the large, subglobose and usually pendent flowers; and the massive, basal callus of the lip. Szlachetko (1995) selected *Warrea* as type of his new subtribe Warreinae, created to group those taxa with homoblastic pseudobulbs, plicate leaves, and distinctly auriculate column, including *Otostylis*, *Warreella*, and *Warreopsis*. In the phylogenetic analyses carried out by Whitten and collaborators (2005), *Warrea* formed a well-supported clade together with *Warreopsis* Garay. This clade is the most basal in the Zygopetalum grade, sister to all other taxa and consecutively sister to the *Koellensteinia*/*Otostylis*/*Paradisanthus* clade and the *Aganisia* clade.

Warrea costaricensis Schltr., Repert. Sp. Nov. 16: 446. 1920. Type: Costa Rica. Forêts de La Palma, 1500 m, *Brade 16327* (holotype, B, destroyed; isotype, CR; tracings of Schlechter's drawings of type, AMES). Figure 63. (Voucher: *Pupulin 2952*, USJ).

Terrestrial, rarely epiphytic, cespitose, pseudobulbous **herbs**, to 80 cm tall. **Roots** terete, ca. 3 mm in diameter. **Pseudobulbs** homoblastic, fusiform-cylindric to narrowly ovoid, 11.0–17.0 × 1.8–2.3 cm, the newest ones cryptic among the bases of the foliaceous sheaths, apically monophyllous, the oldest ones exposed and covered with papery, lacerate, veined sheaths. **Leaf** plicate, membranaceous, elliptic from a narrow, conduplicate petiole to 7 cm long, acute to acuminate, 35–70 × 7–11 cm. **Inflorescence** lateral, a few-flowered raceme from the immature, developing pseudobulb, to 70 cm long; the peduncle terete, erect, with 3–4 ovate-triangular, clasping to slightly loose bracts. **Floral bracts** triangular-lanceolate, membranaceous, to 2 cm long. **Flowers** resupinate, subglobose, facing down, with the sepals pale orange-yellow on the inner surface, abaxially orange-red, flushed purple; the petals yellowish cream, flecked with pale purple; the lip white, with a purple blotch in the middle, the callus white. **Dorsal sepal** elliptic, obtuse to acute, reclinate over the column, 27–34 × 12–16 mm. **Lateral sepals** widely elliptic-ovate, obtuse, minutely apiculate, 28–35 × 13–17 mm, the inner margin replicate-folded toward the base, forming a chin with the column foot. **Petals** lanceolate-elliptic, subacute, porrect-incurved, 25–32 × 12–13 mm. **Lip** broadly elliptic-ovate to suborbicular, entire to obscurely 3-lobed, the base cuneate and contracted into an indistinct claw, the apex rounded to emarginate, 25–35 × 23–33 mm, the basal margins erect, clasping the column, the distal lobe subverrucose, reflexed, with revolute, undulate-crisped margins; disc with a central, high, tuberculate, fleshy callus, extending from the base to near the half of lip. **Column** semiterete, curved, with a distinct foot, 23–30 mm long, and inconspicuous stigmatic wings; the stigma transversely elliptic-rounded. **Anther cap** cucullate, obovate, flattened, 2-celled. **Pollinia** 4, in 2 subequal pairs, on a trapezoidal stipe and a lanceolate, hyaline viscidium.

DISTRIBUTION—The species is distributed from Guatemala to Panama.

ECOLOGY—A mostly terrestrial plant, *W. costaricensis* is rarely found in open soils and shaded places, in tropical and premontane wet forest from both the watersheds of the Continental Divide, at 100–1100 m elevation. Flowering occurs mostly at the beginning of the dry season, in December and January, but plants have been recorded in flower most of the year.

DISTINGUISHING FEATURES—The tall plants with erect, few-flowered inflorescences, and the flowers facing down, with red-purple sepals (orange adaxially) and a broad, white lip blotched with purple at the middle easily distinguish *W. costaricensis* in Costa Rica.

Warreopsis Rchb.f.

REFERENCES—L. A. Garay, El complejo *Zygopetalum*. Orquideología 8(1): 15–51. 1973. K. Senghas and G. Gerlach, Tribus: Maxillarieae. 60. Subtribus: Zygopetalinae. Pp. 1674–1727 *in* R. Schlechter, Die Orchideen, 3, Aufl., Bd. 1. Paul Parey, Berlin. 1993. D. Szlachetko, Systema Orchidalium. Phrag. Flor. Geobot. Suppl. 3: 1–152. 1995. W. M. Whitten, N. H. Williams, R. L. Dressler, G. Gerlach, & F. Pupulin, Generic relationships of Zygopetalinae (Orchidaceae: Cymbideae): Combined molecular evidence. Lankesteriana 5(2): 87–107. 2005. F. Pupulin. *Warreopsis*. Pp. 538–541 *in*: A. M. Pridgeon, P. J. Cribb, M. W. Chase & F. Rasmussen (eds.). Genera Orchidacearum, volume 5. Epidendroideae (Part Two). Oxford University Press.

Warreopsis Garay, Orquideologiá 8: 51. 1973. Type species: *Zygopetalum pardinum* Rchb.f. [=*Warreopsis pardina* (Rchb.f.) Garay]

Terrestrial (rarely epiphytic), cespitose to repent, pseudobulbous **herbs**. **Roots** terete, produced along the rhizome at the base of the pseudobulbs. **Pseudobulbs** homoblastic, ellipsoid to subcylindric, cryptic among the bases of the sheaths, becoming increasingly foliaceous toward the apex, 3–5 leaved at the nodes, 1-leaved apically. **Leaves** articulate, membranaceous, abaxially distinctly plicate, lanceolate to narrowly elliptic, acuminate, narrowed at the base into a conduplicate petiole. **Inflorescence** lateral, a successively few- to many-flowered (with 3–8 flowers simultaneously opened), lax raceme emerging from the axils of the lower sheaths of the mature shoot; the peduncle terete, erect, subequal to longer than the leaves, provided with 4–5 lanceolate-elliptic, acute, clasping to loose bracts; floral bracts narrowly triangular-lanceolate, acute, membranaceous, subequal to the ovary. **Flowers** resupinate, spreading, the sepals and petals yellow to bronze-purple, sometimes spotted with purple-red or dorsally flushed with pink toward the apex, the lip white to pinkish white, turning pale red to yellow with age, or solid violet, the callus and the column white. **Dorsal sepal** free, oblong to ovate-elliptic, acute to acuminate, usually apiculate. **Lateral sepals** oblong to elliptic, acute to minutely apiculate, abaxially carinate, concave, the inner margin strongly replicate-folded toward the base. **Petals** obovate-oblong to elliptic-obovate, obtuse-rounded, minutely apiculate. **Lip** clawed, obovate to spathulate-oblong, sometimes obscurely 3-lobed, the base cordate, the apex rounded to truncate or emarginate, the basal margins suberect to erect, the distal lobe spreading, sometimes with undulate margins; disc with a ligulate to horseshoe-shaped, glabrous to verrucose callus. **Column** semiterete, straight, with or without a foot, slightly dilated in the central portion, provided with a prominent, longitudinal keel on the ventral surface; stigma transversely elliptic. **Anther cap** cucullate, obovate to subreniform, flattened, 2-celled. **Pollinia** 4, in 2 pairs subequal in size, on a ligulate-lanceolate, hyaline viscidium and a scarcely distinct stipe.

A Neotropical genus of four species, *Warreopsis* ranges from Costa Rica to northern Venezuela and Ecuador. The species occur mostly as terrestrial herbs in well-drained, open soils, in evergreen, wet cloud forests at 1500–2200 m elevation, under intermediate to moderately cool temperatures. The pollinator of *Warreopsis* is unknown, but the species of this genus are presumed to be pollinated by fragrance-collecting bees. Flowering has been recorded most of the year. A single species is recorded from Costa Rica.

The generic concepts used to circumscribe the genera of Zygopetalinae with many-noded pseudobulbs were traditionally labile. With the exception of the recently described *W. purpurea* P.Ortiz, the other species of the genus *Warreopsis* were originally published as members of the polymorphic *Zygopetalum* Hook. and even as species of the genus *Ototstylis* Schltr. In his introduction to the *Zygopetalum* alliance, Garay (1973) assigned *Warreopsis* to the *Warrea* complex on the basis of its homoblastic pseudobulbs, placing the new genus close to *Warrea* Lindl. and *Warreella* Schltr., from which it can be distinguished by the clawed lip and the footless column. A similar view was adopted by Senghas and Gerlach in their key to the genera of Zygopetalinae (1993) and by Szlachetko (1995), who created subtribe Warreinae for the taxa with homoblastic pseudobulbs, plicate leaves, and distinctly auriculate column. In the phylogenetic analyses of Zygopetalinae by Whitten and coworkers (2005), based on combined molecular evidence, *Warreopsis* is on a long and highly supported clade together with *Warrea*, basal to all the rest of the *Zygopetalum* grade. As presently understood, the genus may be recognized among Zygopetalinae by the presence of narrowly ellipsoid-subcylindric, homoblastic pseudobulbs, enclosed by the bases of the leaves, the narrow and plicate leaves, the erect, small-flowered inflorescence, the lateral sepals with the basal margins deeply inrolled, the distinctly clawed lip, and the column without a foot, with a prominent ventral keel.

Warreopsis parviflora (L.O.Williams) Garay, Orquideología 8(1): 51. 1973. Type: Panama. Chiriquí: terrestrial, flowers purple, lip violet, column white, vicinity of Bajo Chorro, 1900 m, 20–22 Jul. 1940, *Woodson & Schery 605* (holotype, AMES; isotype, MO). *Zygopetalum parviflorum* L.O. Williams, Ann. Missouri Bot. Gard. 28(4): 424. 1941. Figure 64 (Voucher: *Pupulin 3580*, JBL-Spirit).

Terrestrial (rarely epiphytic), cespitose to repent, pseudobulbous **herbs**, to 80 cm tall. **Roots** terete, produced along the rhizome at the base of the pseudobulbs. **Pseudobulbs** homoblastic, narrowly ellipsoid to subcylindric, 3.0–9.0 × 1.2–1.5 cm, cryptic among the bases of the sheaths, becoming increasingly foliaceous toward the apex, 1–5 leaved at the nodes, 1-leaved apically. **Leaves** articulate, membranaceous, abaxially distinctly plicate, lanceolate to narrowly elliptic, acuminate, 30–70 × 3–7 cm, narrowed at the base into a conduplicate petiole ca. 2 cm long. **Inflorescence** lateral, a successively many-flowered (with 3–8 flowers simultaneously opened), lax raceme emerging from the axils of the lower sheaths of the mature shoot, 60–100 cm long; the peduncle terete, erect, subequal to longer than the leaves, with 4–5 broadly lanceolate-elliptic, acute, loose bracts; floral bracts triangular-lanceolate, acute, membranaceous, 7–9 × 1.5–2 mm. **Flowers** resupinate, spreading, the sepals and petals bronze-purple, the lip solid violet, the callus and the column white. **Dorsal sepal** free, elliptic-oblong, acute, minutely apiculate, 8–10 × 4–5 mm. **Lateral sepals** oblong, acute, minutely apiculate, abaxially carinate, concave, the inner margin strongly replicate-folded toward the base, 10–14 × 5–7 mm. **Petals** elliptic-obovate, obtuse, minutely apiculate, 9–10 × 3–4 cm. **Lip** clawed, obovate-spathulate, obscurely 3-lobed, slightly pandurate in natural position, 7–9 × 6–8 mm, the base cordate, the apex broadly obtuse-round, the basal margins suberect, the distal lobe spreading, with slightly undulate margins; disc with a high, horseshoe-shaped callus, irregularly crenulate along the upper margin. **Column** semiterete, straight, with a foot, 5 mm long, dilated in the central portion, with a prominent, longitudinal keel on the ventral surface; stigma transversely elliptic. **Anther cap** cucullate, suborbicular, flattened, 2-celled. **Pollinia** 4, in 2 pairs subequal in size, on a subquadrate stipe and a ligulate-lanceolate, hyaline viscidium.

DISTRIBUTION—*Warreopsis parviflora* is known from Costa Rica and western Panama.

ECOLOGY—A rather uncommon terrestrial (rarely found as epiphyte) in open soils and partial shade, *W. parviflora* inhabits lower montane wet and cloud forest on the Caribbean watersheds of the Tilarán and Central volcanic mountain ranges, at 1600–2000 m elevation. Flowering occurs mostly during the dry season, from February to April.

DISTINGUISHING FEATURES—The plants with erect, many-flowered inflorescence, and the flowers with bronze-purple sepals and petals and violet lip, as well as the column provided with a prominent abaxial keel are useful features to distinguish *W. parviflora* among other Zygopetalinae in Costa Rica.

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Literature Cited

ACKERMAN, J. D. 1983. Euglossine bee pollination of the orchid *Cochleanthes lipscombiae*: a food source mimic. Amer. J. Bot., **70:** 830–834.

———. 1995. An orchid flora of Puerto Rico and the Virgin Islands. Memoirs of the New York Botanical Garden, **73:** 1–203.

BRUMMITT, R. K. 2007. Report of the Committee for Vascular Plants. (1707). To reject *Cymbidium muricatum* Sw. (Orchidaceae). Taxon, **56**(4): 1290.

CAMERON, K. M., M. W. CHASE, W. M. WHITTEN, P. J. KORES, D. C. JARRELL, V. A. ALBERT, T. YUKAWA, H. G. HILLS, AND D. H. GOLDMAN. 1999. A phylogenetic analysis of the Orchidaceae: Evidence from *rbcL* nucleotide sequences. American Journal of Botany, **86:** 208–224.

CHASE, M. W., J. V. FREUDENSTEIN, K. M. CAMERON, AND R. L. BARRETT. 2003. DNA data and Orchidaceae systematics: A new phylogenetic classification, pp. 69–89. *In* Dixon, K. W., S. P. Kell, R. L. Barrett, and P. J. Cribb, eds., Orchid Conservation. Natural History Publications, Kota Kinabalu, Sabah.

CHRISTENSON, E. A. 1993. Mesoamerican orchid studies V: A synopsis of *Cryptarrhena* R. Br. Lindleyana, **8**(3): 163–165.

———. 2006. Deux genres hybrids naturels chez les Zygopetalinae. Richardiana, **6**(3): 136–138.

COGNIAUX, A. 1906. Orchidaceae III, *Dichaea*, pp. 484–504. *In* Martius, C. F. P., ed., Flora Brasiliensis. 1906.

DODSON, C. H. 1989. *Benzingia hirtzii*. Icones Plantarum Tropicarum Ser. 2, **5:** pl. 406.

———. 1990. *Chaubardiella* Garay, p. 36. *In* Escobar, R., ed., Native Colombian Orchids, **1,** Editorial Colina, Medellín.

———. 2003. *Pescatorea* Rchb.f., pp. 734–735. *In* Dodson, C. H., Native Ecuadorian Orchids, **3,** Dodson Trust, Sarasota.

DODSON, C. H., AND R. ESCOBAR. 1993a. *Ackermania* Dodson & Escobar, p. 36. *In* Dodson, C. H., and R. Escobar, Native Ecuadorian Orchids, **1.**

———. 1993b. *Benzingia* Dodson & Chase, p. 60. *In* Dodson, C. H., and R. Escobar, Native Ecuadorian Orchids, **1.**

DODSON, C. H., AND G. P. FRYMIRE. 1961. Preliminary studies in the genus *Stanhopea*. Annals of the Missouri Botanical Garden, **48:** 137–172.

DODSON, C. H., AND C. LUER. 2005. Orchidaceae. Genera *Aa-Cyrtidiorchis*, pp. 1–345. *In* Harling, G., and L. Andersson, eds., Flora of Ecuador, **76.**

DODSON, C. H., AND G. A. ROMERO. 1995. Revalidation of the genus *Benzingia* (Zygopetalinae: Orchidaceae). Lindleyana, **10**(2): 74. 1995.

DRESSLER, R. L. 1968. Observations on orchids and euglossine bees in Panama and Costa Rica. Revista de Biología Tropical, **15**(1): 143–183.

———. 1980. Orquídeas huérfanas II. *Cryptarrhena*—Una nueva tribu, Cryptarrheneae. Orquídea (Mexico), **7:** 283–288.

———. 1981. The Orchids: Natural History and Classification. Harvard University Press, Cambridge, Massachusetts.

———. 1983. Die Gattung *Chondrorhyncha* in Panama mit zwei neun Arten: *Chondrorhyncha crassa* und *Chondrorhyncha eburnea*. Orchidee (Hamburg), **34**(6): 220–226.

———. 1993a. Phylogeny and Classification of the Orchid Family. Dioscorides Press, Portland, Oregon.

———. 1993b. Field guide to the orchids of Costa Rica and Panama. Ithaca and London, Cornell University Press.

———. 2000. Precursor to a revision of the *Chondrorhyncha* complex. Orquideología, **21:** 233–247.

———. 2001. Sobre el género *Chondroscaphe*, con dos especies nuevas de América Central, *Chondroscaphe atrilinguis* y *C. laevis*. Orquideología, **22**(1): 12–22.

———. 2002. New species and combinations in Costa Rican orchids. Lankesteriana, **2:** 25–29.

———. 2003. Orchidaceae. *In* Hammel, B. E., M. H. Grayum, C. Herrera & N. Zamora (eds.). Manual de Plantas de Costa Rica, vol. 3. Monogr. Syst. Bot. Missouri Bot. Gard., **93:** 1–595.

DRESSLER, R. L., AND C. H. DODSON. 1960. Classification and phylogeny in the Orchidaceae. Annals of the Missouri Botanical Garden, **47:** 25–68.

FOLSOM, J. B. 1987. A systematic monograph of *Dichaea* section *Dichaea* (Orchidaceae). Thesis. University of Texas, Austin.

FOWLIE, J. A. 1961. Ecology notes: *Cochleanthes flabelliformis*. American Orchid Society Bulletin, **30:** 797–799.

———. 1966a. A revision of the Central American species of *Chondrorhyncha* and *Kefersteinia*, including the description of a new species from Costa Rica. Orchid Digest, **30:** 79–82.

———. 1966b. A revision of the Central American species of *Chondrorhyncha* and *Kefersteinia*, including the description of a new species from Costa Rica. Part II. Orchid Digest, **30:** 114–118.

———. 1967. Some observations on the genus *Huntleya* and related genera. Orchid Digest, **31**(9): 278–281.

———. 1968. A key and annotated checklist to the genus *Pescatorea*. Orchid Digest, **32**(3): 86–91.

———. 1969a. A key and annotated checklist to the genus *Bollea*. Orchid Digest, **33**(3): 100–103.

———. 1969b. An annotated checklist of the genus *Warscewiczella*. Orchid Digest, **33:** 224–231.

———. 1974. *Huntleya sessiliflora* Lindl., Orch. Dig., **38:** 116–119.

———. 1984. A further contribution to an understanding of the genus *Huntleya*. Orchid Digest, **48**(6): 221–225.

GARAY, L. A. 1961. Orquídeas Colombianas nuevas o críticas. Decena III. Orquideología, **4:** 153–161.

———. 1969. El complejo *Chondrorhyncha*. Orquideología, **4:** 139–152.

———. 1973. El complejo *Zygopetalum.* Orquideología, **8:** 15–51.

KRÄNZLIN, F. W. L. 1923. *Dichaea*, pp. 33–64. *In* Engler, A., Das Pflanzenreich, **4**(50).

KUNTZE, C. E. O. 1903. Revision of *Dichaea*, p. 171. *In* von Post, T. E., ed., Lexicon Generum Phaneroganarum. Deutsche verlag-Anstalt, Stuttgart.

MANSFELD, R. 1931. Blütenanalysen neuer Orchideen von R. Schlechter. II. Mittelamerikanischer Orchideen. Repert. Sp. Nov. Regni Veg. Beih., **49**(2): pl. 77, fig. 308.

MORA, D. E., AND J. T. ATWOOD. 1992. *Chaubardiella*. Icon. Pl. Tropic., **14:** sub pl. 1410–1411.

MORA-RETANA, D. E., AND J. B. GARCÍA. 1992. Lista actualizada de las orquídeas de Costa Rica (Orchidaceae). Brenesia, **37:** 79–124.

NEUBIG, K. M. 2005. Molecular systematics of the genus *Dichaea* (Zygopetalinae: Orchidaceae). Thesis, University of Florida, Gainesville.

NEUBIG, K. M., N. H. WILLIAMS, AND W. M. WHITTEN. 2005. Molecular systematics of the genus *Dichaea* (Zygopetalinae: Orchidaceae), p. 38. *In* First Scientific Conference on Andean Orchids, Gualaceo, Ecuagenera & Universidad A. Pérez Guerrero. Conference abstracts.

NEUBIG, K. M., N. H. WILLIAMS, W. M. WHITTEN, AND F. PUPULIN. 2009. Molecular phylogenetics and the evolution of fruit and leaf morphology of *Dichaea* (Orchidaceae: Zygopetalinae). Annals of Botany, **104:** 457–467.

NEUDECKER, T. 1994. ×*Ackersteinia dodsonii*, un nuevo híbrido intergenérico en la Subtribu Huntleyinae. Orquideología, **19**(2): 25–28.

PFITZER, E. H. H. 1887. Entwurf einer Natürlichen Anordnung der Orchideen. Carl Winter's Universitätsbuchhandlung, Heidelberg.

———. 1888. Monandrae-Dichaeinae, pp. 206–207. *In* Engler & Prantl, Die Naturlichen Pflanzenfamilien, **2**(6).

PUPULIN, F. 2001. Contributions to a reassessment of Costa Rican Zygopetalinae: The genus *Kefersteinia* Rchb.f. Annalen des Naturhistorisches Museums Wien, **103B:** 525–555.

———. 2002. Catálogo revisado y anotado de las Orchidaceae de Costa Rica. Lankesteriana, **2**(2): 1–88.

———. 2003. Die Orchideen flora Mittelamerika—Ergänzungen (Teil 1). Additamenta ad orchideologiam mesoamericanam, 1. Orchidee (Hamburg), **54:** 467–477.

———. 2004. Zygopetalinae poco conocidas. El género *Warrea* Lindl. Epidendrum, **24:** 3–7.

———. 2005a. *Chaubardiella* Garay, pp. 96–97. *In* Pupulin, F., ed., Vanishing Beauty—Native Costa Rican Orchids 1. Editorial de La Universidad de Costa Rica, San José.

———. 2005b. *Cochleanthes* Raf., pp. 132–133. *In* Pupulin, F., ed., Vanishing Beauty—Native Costa Rican Orchids 1. Editorial de la Universidad de Costa Rica, San José.

———. 2005c. *Cryptarrhena* R.Br., pp. 164–165. *In* Pupulin, F., ed., Vanishing Beauty—Native Costa Rican Orchids 1. Editorial de la Universidad de Costa Rica, San José.

———. 2005d. *Chondrorhyncha* Lindl, pp. 100–109. *In* Pupulin, F., ed., Vanishing Beauty—Native Costa Rican Orchids 1. Editorial de la Universidad de Costa Rica, San José.

———. 2005e. *Dichaea* Lindl., pp. 204–227. *In* Pupulin, F., ed., Vanishing Beauty—Native Costa Rican Orchids 1. Editorial de la Universidad de Costa Rica, San José.

———. 2006a. Genera Zygopetalinarum, 1—The genus *Daiotyla* Dressler. Orchid Review, **114:** 144–149.

———. 2006b. Genera Zygopetalinarum, 2—The genus *Cochleanthes*. Orchid Review, **114:** 202–210.

———. 2007a. Contributions toward a reassessment of Costa Rican Zygopetalinae (Orchidaceae). 3. A systematic revision of *Dichaea* in Costa Rica. Harvard Papers in Botany, **12**(1): 15–153.

———. 2007b. ×*Bensteinia ramonensis*, a new natural hybrid in the Zygopetalinae (Orchidaceae). Selbyana, **28**(2): 112–116.

———. 2009. The genus *Stenotyla*, and a new species. Orchid Review, **117:** 158–165.

———. 2009b. Subtribe Zygopetalinae. *In* Pridgeon, A. M., P. J. Cribb, M. W. Chase, and F. N. Rasmussen, eds., Genera Orchidacearum, Volume 5. Epidendroideae (Part Two). Oxford University Press: 456–546.

PUPULIN, F., R. L. DRESSLER, AND H. MEDINA. 2009. A revision of the white-flowered species of *Chondroscaphe* (Orchidaceae: Zygopetalinae). Orchid Digest, **72**(1): 32–51.

REICHENBACH, H. G. 1852. Gartenorchideen. Bot. Zeit. (Berlin) **10**(39): 665–678.

———. 1861. *Zygopetalum*. Walpers Annales Botanices Systematicae, **6:** 650–662.

ROLFE, R. A. 1900. The genus *Huntleya*. Orchid Review, **8:** 2692–272; 302–303.

ROMERO, G. A., AND G. CARNEVALI. 1993. Reappraisal of subtribe Vargasiellinae (Maxillarieae, Orchidaceae). Novon, **3:** 79.

ROUBIK, D. W., AND P. E. HANSON. 2004. Orchid Bees of Tropical America: Biology and Field Guide. Instituto Nacional de Biodiversidad, Santo Domingo de Heredia, Costa Rica.

SCHLECHTER, R. 1914. Die Orchideen-Gruppe Dichaeinae Pfitzers. Orchis, **8:** 96–101.

———. 1915. Die Orchideen, ihre Bechreibung, Kultur und Züchtung. Paul Parey, Berlin.

———. 1916. Das System der Orchidaceen. Notizblatt des Botanischen Gartens und Museum zu Berlin-Dahlem, **9:** 563–591.

SCHULTES, R. E., AND L. A. GARAY. 1954. On the validity of the generic name *Cochleanthes* Raf. Botanical Museum Leaflets, Harvard University, **18:** 321–327.

SENGHAS, K. 1996. Dichaeinae. *In* Schlechter, R., ed. Die Orchideen. Berlin, Blacwell Wissenschafts-Verlag:1853–1861.

SENGHAS, K., AND G. GERLACH. 1992–1993. Subtribus Huntleyinae, pp. 1620–1674. *In* Die Orchideen, 3rd ed., **1/B.**

———. 1993a. Subtribus Zygopetalinae, pp. 1674–1727. *In* Die Orchideen, 3rd ed., **1/B.**

———. 1993b. *Chondroscaphe* (Dressl.) Sengh. & Gerl., pp. 1655–1658. *In* Orchideen, 3rd ed., **1/B**(27).

SZLACHETKO, D. L. 1995. Systema Orchidalium. Fragmenta Floristica et Geobotanica Polonica, **3:** 1–152.

———. 2003. *Senghasia*, eine neue Gattung der Zygopetaleae. Journal für den Orchideenfreund, **10**(4): 335.

WHITTEN, W. M., N. H. WILLIAMS, R. L. DRESSLER, G. GERLACH, AND F. PUPULIN. 2005. Generic relationships of Zygopetalinae (Orchidaceae: Cymbidieae): Combined molecular evidence. Lankesteriana, **5**(2): 87–107.

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