

Notes on Pachyphyllinae (Vandoideae, Orchidaceae) with a description of a new genus

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Received: 10 October 2013 / Accepted: 21 March 2014 / Published online: 22 April 2014
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Abstract The Neotropical subtribe Pachyphyllinae comprises orchids distributed mainly along the Andes and characterized by the monopodial type of growth. The systematic position of this taxon within Orchidaceae and its generic composition was intensively discussed, but so far no comprehensive morphological study on the group was conducted. In this paper the morphological descriptions of all genera included in Pachyphyllinae are provided and the key to their identification is presented. In addition, the taxonomic position of *Raycadenco* is discussed. The research revealed the existence of two distinctive species which were classified until now within *Pachyphyllum* or *Fernandezia*. Since neither the flower morphology of those two species nor the gynostemium structure fulfils the concept of any known orchid taxon, the new genus is described here under the name *Valdiviesoa*. The two representatives of the new taxon are illustrated and the photographs of the plants are provided. The information about their distribution and ecology are provided. The morphological characters of all Pachyphyllinae representatives are compared.

Keywords Andes · Morphologic inferences · New genus · Neotropics · Taxonomy · *Valdiviesoa*

Introduction

The subtribe Pachyphyllinae comprises small to medium-sized epiphytic, lithophytic or terrestrial orchids with tiny

or small, inconspicuous or quite showy, dull or brightly colored flowers. The unique character of all genera ever included to this group is monopodial growth. Pachyphyllinae is one of the most problematic orchid taxon and its systematic position within Orchidaceae was variously recognized by taxonomists (e.g. Dressler and Dodson 1960; Dressler 1971, 1981; Chase et al. 2003). Pachyphyllinae (originally Pachyphyllae) was proposed first by Pfitzer (1887) based on the large, petaloid clinandrium and fleshy, short leaves observed in *Centropetalum* Lindl., *Nasonia* Lindl. and *Pachyphyllum* Kunth. The author placed the newly created taxon together with Aerideae within Sarcanthinae (originally Sarcanteae). Unfortunately, the nomenclatural problem with this classification system was that over 50 years earlier Lindley applied the generic name *Sarcanthus* twice—in 1824 with *Epidendrum praemorsum* Roxb. as a type species and in 1826 while describing *Sarcanthus rostratus* Lindl. (Lindley 1824, 1826). Hereby, the name Sarcanthinae as an illegitimate was replaced with Aeridinae (Garay 1972).

Schlechter (1915) accepted Pfitzer's Pachyphyllinae, but proposed a different solution, placing Dichaeinae and Pachyphyllinae with "Unterreihe II. Monopodiales", i.e. with Sarcanthinae. While Dressler and Dodson (1960) classified Pachyphyllinae within Epidendreae (Orchidoideae), the first author changed his concept 10 years later (Dressler 1971) elevating the taxon to the tribal rank. Second reconsideration of orchid classification system was presented by Dressler in early 1980s and he proposed to include Pachyphyllinae (as the representative of vandoid orchids) into the tribe Cymbidieae (Dressler 1981). The subtribe was classified within Vandoideae also by Senghas (1995) who, however, considered Pachyphyllinae as members of the tribe Oncidieae. The different approach was proposed by Szlachetko (1995)

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Table 1 Comparative morphology of *Centropetalum*, *Nasonia* and *Fernandezia*

| Character | <i>Centropetalum</i> | <i>Nasonia</i> | <i>Fernandezia</i> |
|-------------------------|---|---|---|
| Pseudobulbs | Absent | Absent | Absent |
| Leaves | Distichous, fleshy | Distichous, fleshy | Distichous, fleshy |
| Inflorescence | Lateral, from the upper part of the plant | Lateral, from the upper part of the plant | Lateral, from the upper part of the plant |
| Lip | Much larger than tepals | Smaller or slightly larger than tepals | Much larger than tepals |
| Lateral sepals | Free | Partially connate or free | Free |
| Gynostemium—column part | Slender, erect, broadly winged | Slender, erect, broadly winged | Slender, erect, broadly winged |
| Column foot | Absent | Absent | Absent |
| Anther | Ventral, incumbent, operculate, dorsiventrally compressed | Ventral, incumbent, operculate, dorsiventrally compressed | Ventral, incumbent, operculate, dorsiventrally compressed |
| Caudiculae | Filiform | Filiform | Filiform |
| Pollinarium | With two tegulae | With single tegula | With two tegulae |
| Clinandrium | Irregularly denticulate | Entire | Irregularly denticulate |

Table 2 Comparative morphology of *Pachyphyllum* and *Orchidotypus*

| Character | <i>Pachyphyllum</i> | <i>Orchidotypus</i> |
|---------------|--|--|
| Leaves | Fleshy, distichous | Fleshy, distichous |
| Inflorescence | Lateral, sparsely branched, 1-5-flowered | Lateral, simple, 1-3-flowered |
| Tepals | Free to the base | Connate forming a prominent tube |
| Lip | Simple to slightly 3-lobed, callus a pair of digitate projections | Petaloid, with claw united to the perianth tube, with a pair of rounded calli on each side below the disk base |
| Gynostemium | Sessile, gently arched, delicate | Sessile, gently arched, delicate |
| Column part | 3 times longer than anther, broadly winged, wings thin, close one to another or even touching each other in front of the gynostemium | Twice as long as anther, broadly winged |
| Column foot | Obscure | Absent |
| Anther | Ventral, incumbent, operculate, slightly dorsiventrally compressed, ellipsoid-obovoid, obscurely 2-chambered | Ventral, incumbent, motile, dorsiventrally compressed, ellipsoid-cordate, obscurely 2-chambered |
| Pollinia | 2, slightly dorsiventrally compressed, obliquely obovoid, rather hard | 2, slightly dorsiventrally compressed, obovoid to clavate, rather hard |
| Caudiculae | Amorphous, sticky | Amorphous, sticky |
| Clinandrium | Well-developed, forming a very high collar hiding completely the anther, entire on margin | Well-developed, forming a very high collar hiding completely the anther, entire or irregularly denticulate on margin |
| Stigma | Elliptic to transversely elliptic, deeply concave | Elliptic, concave |
| Viscidium | Single, very small, elliptic-obovate, thin, lamellate | Single, relatively large, elliptic-obovate, thin, lamellate |
| Rostellum | Very short; remnant very shortly digitate, obscurely bilobed at the apex | Very short; remnant very shortly bilobed at the apex |
| Tegula | Single, oblong, small, thin, lamellate | Single, linear, very small, thin, lamellate |

who based mainly on the gynostemium morphology placed *Pachyphyllinae* in *Dichaeae*, within subfamily *Vandoideae*. The molecular studies (Chase et al. 2003) indicate the close relation between *Pachyphyllinae* and *oncidoid orchids* and its position within *Cymbidieae* (*Epidendroideae sensu lato*).

As mentioned before also the generic delimitation within *Pachyphyllinae* was a topic of discussion between

taxonomists. Schlechter (1915) recognized *Pachyphyllum*, *Nasonia* and *Centropetalum* as the members of the subtribe and he considered *Orchidotypus* Kraenzl. synonymous with *Pachyphyllum*. Except Senghas (1995) and Szlachetko and Mytnik-Ejsmont (2009), the broad concept of the latter genus was accepted by the subsequent researchers. Dressler and Dodson (1960) included species of *Fernandezia* in *Centropetalum*, but the first author accepted *Fernandezia*



Fig. 1 Gynostemium structure of **A** *Fernandezia ionanthera* (a Gynostemium, side view. b Gynostemium, bottom view. c Gynostemium, front view. d Gynostemium, front view, wings partially removed. e Rostellum remnant. f Anther, back view. g Pollinarium. h Pollinia, various views (L.H–N 3985, AAU). **B** *Pachyphyllum pastii* (a Gynostemium, side view. b Gynostemium, bottom view. c Gynostemium,

bottom view, wings spread. d Anther, back view. e Rostellum remnant. f Tegula and viscidium, various views. g Pollinia, various views (L.H–N 6486, AAU). **C** *Orchidotypus bryophytus* (a Gynostemium, bottom view. b Gynostemium, side view. c Pollinia, various views (Heidelberg BG O-636360, HEID). Reproduced from Szlachetko and Mytnik-Ejsmont (2009)

as a correct name for those plants in 1981. The most recent molecular studies on oncioid orchids (Chase and Whitten 2011; Neubig et al. 2012) resulted in synonymization of *Pachyphyllum* under *Fernandezia*. Chase and Whitten (2011) included in this genus also monotypic *Raycadenco* which was not considered as member of Pachyphyllinae ever before.

In this paper the results of the morphological studies on Pachyphyllinae combined with molecular outcomes already published are presented.

Materials and methods

Dried herbarium specimens as well as flowers preserved in liquid of species considered as members of Pachyphyllinae in any previous research were examined. Herbaria acronyms are cited in these papers according to *Index Herbariorum* (Thiers, continuously updated).

The plant material was studied in or borrowed from the following herbaria AMES, B, BM, COL, HBG, HEID, K, P, W. The specimens were examined according to the

standard procedures. Each studied specimen was photographed and the data from the label were taken. The shape of the leaf blade and form of the leaf base were studied first. The perianth segments as well as the form of ovary and floral bracts were studied under a stereoscopic microscope. The floral elements, including the gynostemium, their shape, structure and surface were examined after softened flowers in the boiling water. Comparison of the studied material with the designated type specimens and protologues assured the correctness of identifications. A total of about 300 herbarium sheets and specimens preserved in alcohol were revised. Field studies have been conducted during expeditions to Colombia, Ecuador and Peru in the years 2005–2012.

Results

The analysis of the morphology of three recently combined genera, *Fernandezia*, *Pachyphyllum* and *Raycadenco* indicated the generic distinctiveness of each of them. Two genera, *Centropetalum* Lindl. and *Nasonia* Lindl., recognized in several previous studies (Pfitzer 1887; Schlechter 1915; Dressler and Dodson 1960; Schweinfurth 1961) were found to be synonymous with *Fernandezia* (Table 1). The first genus was described by Lindley (1838) based on i.a. its lip larger than free sepals while the second one was found different by the same author (Lindley 1844) in its smaller lip and partially connate lateral sepals. However, in 1846 he added a new species to *Nasonia*, *N. sanguinea* which was not in accordance with the previously provided floral characters of the genus, but as its nominal species, *N. punctata*, it was characterized by the presence of a single tegula. In 1923 Kraenzlin transferred known *Nasonia* species to *Centropetalum* and the latter was synonymized with *Fernandezia* by Garay and Dunsterville (1972).

The comparison of the three genera is presented in Table 1. Species of *Centropetalum* and *Fernandezia* are undistinguishable in their morphological characters; thus we agree that the former should be treated as a synonym with *Fernandezia*. The observed morphological differences are not sufficient to consider *Nasonia* and *Fernandezia* as separated genera either, however, the dissimilarities should be emphasized by the division of the latter genus into two subgenera as proposed by Garay and Dunsterville (1972).

The morphological characters of *Pachyphyllum* and *Orchidotypus*, which are usually considered as synonymous (e.g. Schlechter 1915; Schweinfurth 1961; Dressler 2003; Christenson 2008), were studied and their comparison is presented in Table 2. Based on the numerous differences observed both in perianth segments form as well as in the gynostemium structure (Fig. 1), we believe that those taxa should be treated separately, as proposed by Senghas (1995).

Discussion

As mentioned before, Chase and Whitten (2011) transferred all *Pachyphyllum*, *Orchidotypus* and *Raycadenco* species to *Fernandezia* based on the molecular studies; however, the outcomes from the genetic research are difficult to evaluate. The phylogenetic tree presented by Chase (2009) includes just two *Fernandezia* s.str. species, one representative of *Pachyphyllum* s.str. and *Raycadenco*. The latter is sister to the pair *Fernandezia*–*Pachyphyllum*, which are sisters to each other. On the other hand, the tree provided by Neubig et al. (2012; Fig. 2) contains 17 taxa of Pachyphyllinae (sensu Chase and Whitten 2011), seven of which remains unidentified on the species level. Also here, *Raycadenco* is sister to all other Pachyphyllinae taxa. According to Neubig et al. (2012), *Fernandezia* and

Fig. 2 Fragment of single maximum likelihood tree resulting from analysis of the combined five-region data (Neubig et al. 2012)

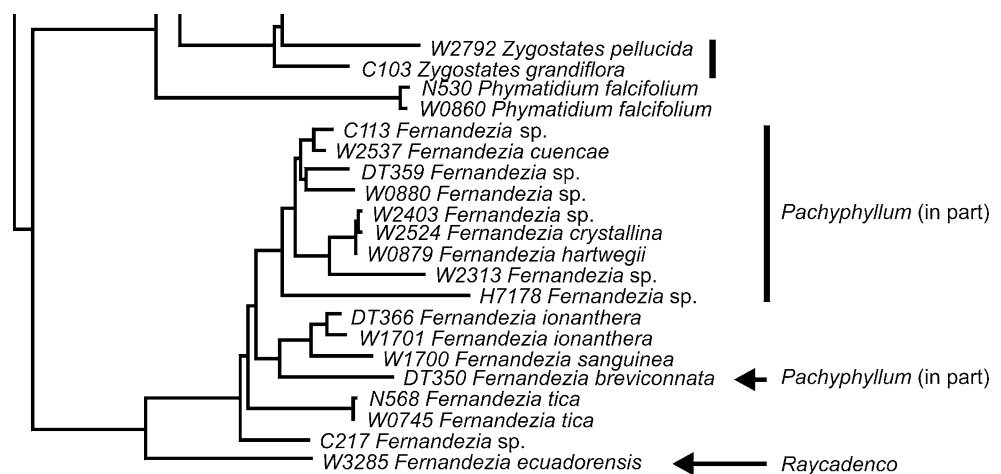


Fig. 3 *Fernandezia brevicornata*. **a** Dissected perianth (redrawn from Schlechter 1929). **b** Plant (photo: Senghas, SOF)

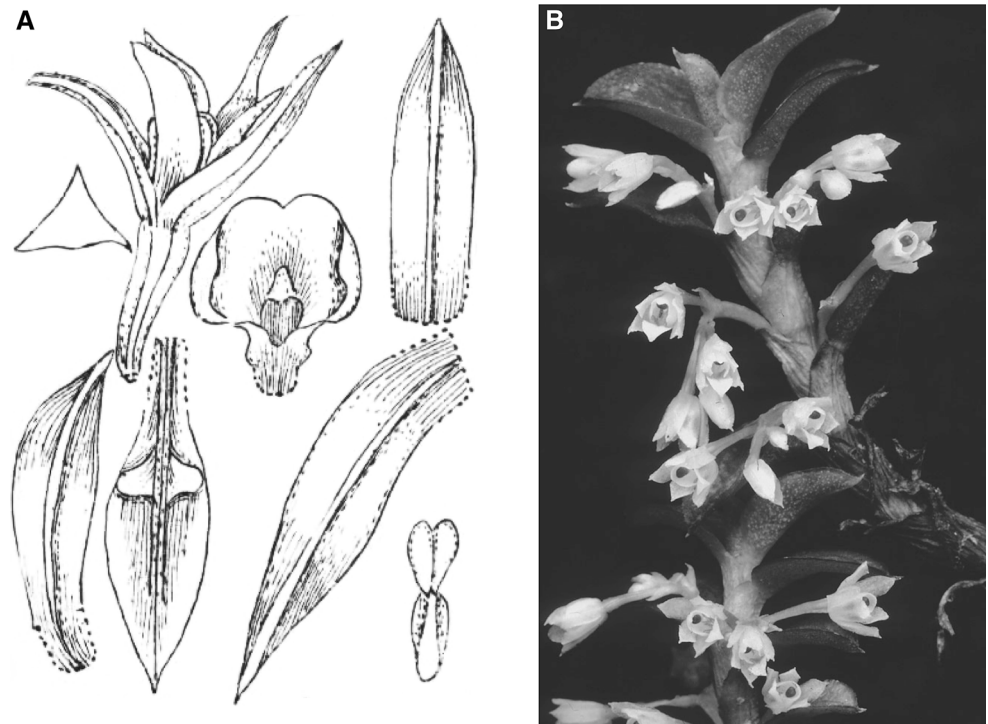
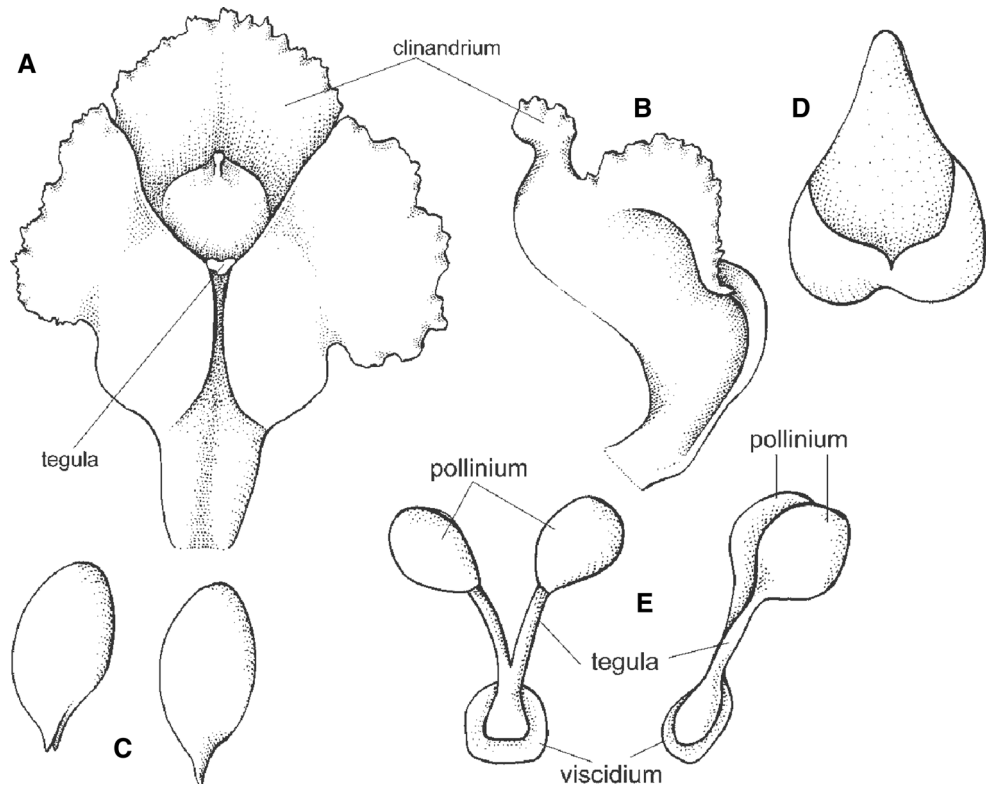


Fig. 4 Gynostemium structure of *Raycadenco ecuadorensis*. **a** Gynostemium, bottom view, anther removed. **b** Gynostemium, side view. **c** Pollinia. **d** Anther. **e** Pollinarium (*a-c* Heidelberg BG O-838, HIED; *d-e* redrawn from Dodson 1989)



Pachyphyllum are distinguished on the basis of flower size and color. *Pachyphyllum* (including *Orchidotypus*) has tiny, white or yellow flowers and its pollinators are unknown, whereas *Fernandezia* s.str. has larger flowers that are bright red or orange and are hummingbird pollinated. In our opinion this differentiation is an obvious simplification, what we tried to demonstrate above. The measurements of the perianth segments of these genera overlap frequently and there is no demarcation line in this respect. The flowers of *F. brevicornata* are white or whitish, rather small (Fig. 3).

All *Pachyphyllum*, *Orchidotypus* and *Fernandezia*, as well as *Raycadenco* are small, monopodial plants (up to 30 cm tall), with lateral, 1- or few-flowered inflorescences. Unlike in former genera, the tegula of *Raycadenco* is Y-shaped (vs filiform to oblong) and its lip is 4-lobed (vs entire) with a complicated callus, similar to *Oncidium* and allied taxa.

Chase and Whitten (2011) stated that *Raycadenco* exhibits the suite of traits associated with oil-collecting

bees' pollination. According to the authors, the floral structure of *Pachyphyllum*, *Fernandezia* and *Raycadenco*, "outside of the gross modifications for different pollinators, is otherwise similar; they all have a pair of column wings and/or a dorsal hood", what is in conflict with our observations. Chase and Whitten (2011) postulated that *Raycadenco* could be maintained as a separate genus due to its sister position to the rest of the clade, but given that its habit and floral morphology agree with that of *Fernandezia/Pachyphyllum* in technical detail, the authors decided to include it in *Fernandezia*, and thereby, decrease the redundancy/increase information content of the classification. Again, we cannot accept this "technical" solution, as all of these four genera differ clearly one from another in the floral characters and their only common, but not unique feature is a monopodial type of growth. The amalgamation of all the taxa in question under common name *Fernandezia* surely does not improve the information content of the classification, but increase the chaos.

Fig. 5 Gynostemium structure of *Lockhartia chocoensis*. *a* Gynostemium, bottom view. *b* Gynostemium, side view. *c* Rostellum remnant, front view. *d* Anther, back view. *e* Pollinia, various views. *f* Tegula and viscidium, view from above (Heidelberg BG O-65080, HEID)

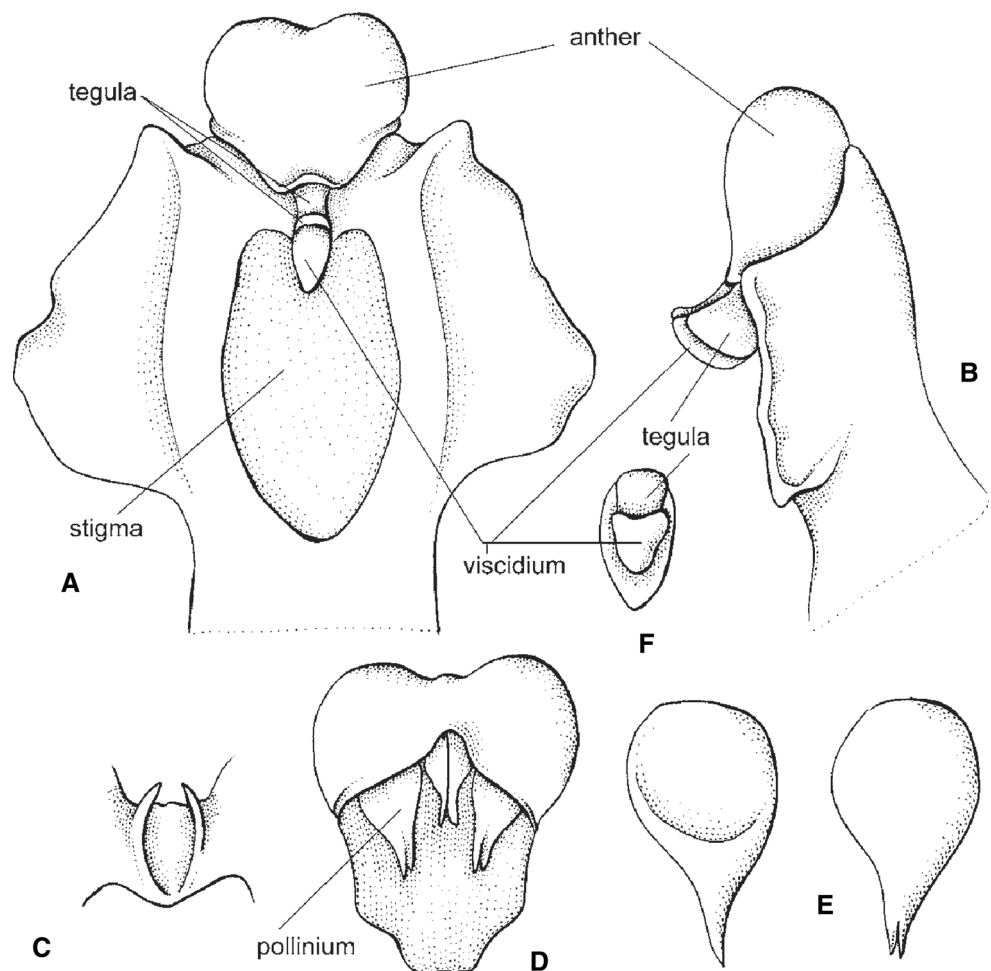


Table 3 Comparative morphology of *Plectrophora*, *Valdiviesoa*, *Fernandezia* and *Pachyphyllum*

| | <i>Plectrophora</i> | <i>Valdiviesoa</i> | <i>Fernandezia</i> | <i>Pachyphyllum</i> |
|--------------------------|--|---|--|--|
| Growth type | Sympodial | Monopodial | Monopodial | Monopodial |
| Flowers | Medium-sized, campanulate, spurred | Inconspicuous, slightly asymmetric, not spurred | Showy, spreading to campanulate, not spurred | Inconspicuous, campanulate, not spurred |
| Flower color | Greenish-white, lip with pale yellow-orange nectar guides | Semitransparent, white | Red to yellow, orange, or purple, rarely greenish-white | Green to whitish or yellowish |
| Tepals | Sepals forming a tube | Sepals and petals similar, not forming a tube | Sepals and petals similar, not forming a tube | Sepals and petals similar, petals often adnate to the sepals forming part of the cup of the tube |
| Lip | Forming a spur at the base within the sepaline spur, entire, often with sides embracing the gynostemium | Not spurred, entire, with obscure callus below the middle, basally asymmetrical, shallowly saccate. | Usually entire, often flabellate, Sometimes the base parallel with the column and the apex somewhat reflexed, callus vary between species, but usually lamellate | Usually entire, sometimes Somewhat 3-lobate, usually with a pair of tuberculate Callii |
| Gynostemium—column part | ca. 3 Times longer than anther, fused basally with lip, with two prominent, elongate-rhomboid wings near stigma, wings erect, thick, irregularly and shallowly lobed | Broadly winged; wings basally connate with the lip margins forming spacious sac | As long as anther, broadly winged, wings thin, close one to another or even touching each other in front of gynostemium | ca. 3 Times longer than anther, broadly winged, wings thin, close one to another or even touching each other in front of Gynostemium |
| Gynostemium—column foot | Obscure | Absent | Absent | Obscure |
| Gynostemium—clinandrium. | Apical clinandrium narrow | Apical clinandrium obscure, narrow | Apical clinandrium well-developed, forming a very high collar hiding completely anther, entire or irregularly denticulate (on margin) | Apical clinandrium well-developed, forming a very high collar hiding completely anther, entire on margin |
| Gynostemium—anther | Apical, incumbent, rather stiffly joined with column apex, ellipsoid, 2-chambered. Filament elongate | Thin-walled, motile, not operculate, anther partitions reduced. Filament digitate, erect | Ventral, incumbent, operculate, dorsiventrally compressed, ellipsoid, 2-chambered | Ventral, incumbent, operculate, slightly dorsiventrally compressed, ellipsoid-obovoid, obscurely 2-chambered |
| Gynostemium—pollinia | 2, dorsiventrally compressed, oblong ellipsoid, Deeply and unequally cleft at apex, hard. Connective narrow, thin. | 2, suborbicular-obovoid, hard, split at the apex. | 2, slightly dorsiventrally compressed, obovoid, Hard. Connective narrow, thin. | 2, slightly dorsiventrally compressed, obliquely Obovoid, rather hard. Connective narrow, thin. |
| Gynostemium—stigma | Large, transversely elliptic to elliptic-cordate, deeply concave | Cordate-obovate in general outline, concave, covered by sticky matter | Small, elliptic, concave, partially hidden by rostellum | Elliptic to transversely elliptic, deeply concave |
| Gynostemium—caudiculae | Sticky, amorphous | Sticky, amorphous | Filiform, longer than pollinia, sometimes amorphous, sticky | Sticky, amorphous |
| Gynostemium—rostellum | Dome-like, rounded at apex | Digitate, curved over stigmatic surface | Ligulate, pendent, built of several cell layers | Very short, triangular, rather fleshy, blunt |
| Gynostemium—viscidium | Single, very small, elliptic, thick | Triangular-ovate, lamellar, thin | Single, relatively large, elliptic to obovate, thin, lamellate | Single, very small, elliptic-obovate, thin, lamellate |
| Gynostemium—tegula | Single, oblong linear, thin, lamellate | Filiform, sticky | Single, linear, elliptic to obovate, thin, lamellate, built of cells with inner walls thickened and outer walls thin | Single, oblong, small, thin, lamellate |

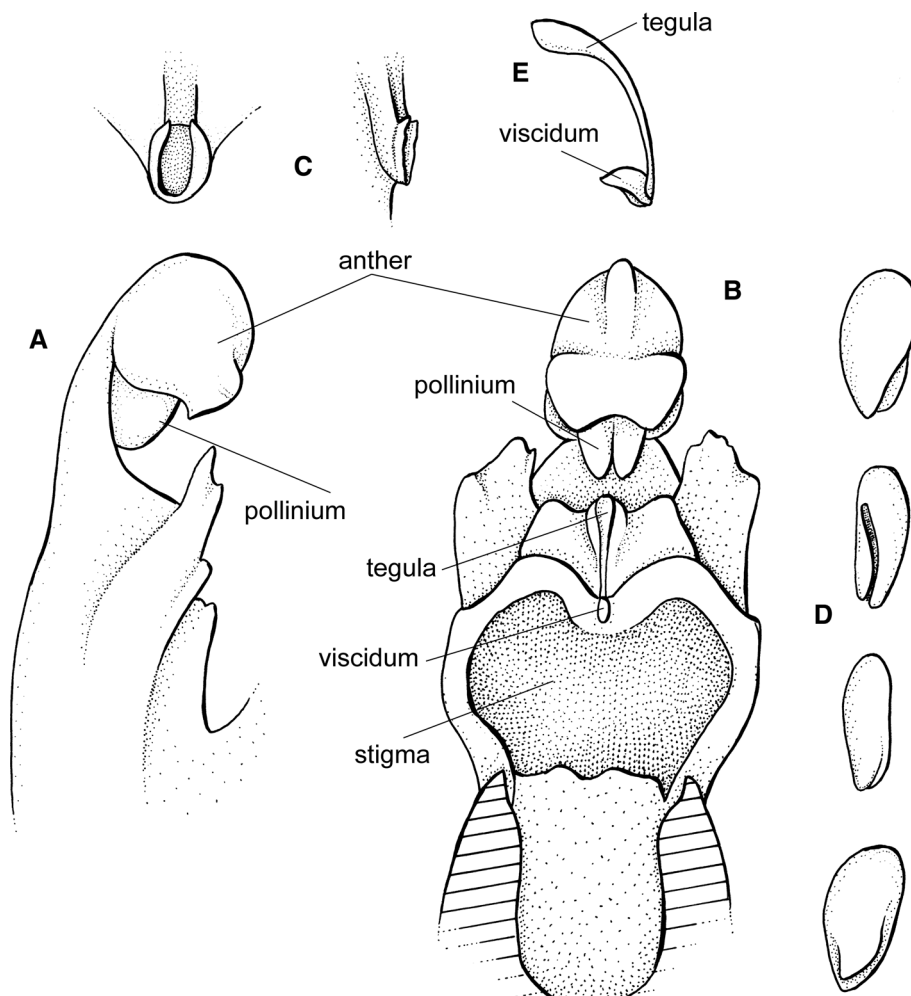
The monopodial type of growth, the *Oncidium*-like flowers, the crenate, prominent clinandrium and basally bifid pollinia prompted Senghas (1995) to establish the separate, monotypic subtribe Raycadencoinae (Fig. 4). The gynostemium of *Raycadenco*, which is slightly sigmoid, slender, delicate, with the wing-like clinandrium, the short rostellum, the small, oval viscidium and the bifid tegula, corresponds well in its structure to *Lockhartia* (Fig. 5), but surely not to Pachyphyllinae. The general flower morphology, i.a. free tepals, 3-lobed lip with bifid apical lobe and complicated, lobulate, glandular callus could also suggest the close relation between *Lockhartia* and *Raycadenco*. These similarities are probably an effect of independent adaptation to similar pollination systems, as they are in serious conflict with results of molecular outcomes (Neubig et al. 2012) and obvious differences in the structure of vegetative parts between *Raycadenco* and *Lockhartia*. In the latter genus leaves are iridiform and

stem is sympodial, in contrast to monopodial *Raycadenco* with dorsiventrally flattened leaves. Hereby, we postulate to maintain a status of separate monogeneric subtribe for Raycadencoinae.

As a conclusion to this discussion, we propose to reject most of the nomenclatural changes proposed by Chase and Whitten (2011) as premature. Until more materials of *Pachyphyllum*, *Fernandezia* and related genera are available to study, we postulate to maintain traditional concept of the above-mentioned genera, despite that *Fernandezia* remains a paraphyletic taxon.

The results of the molecular studies of Pachyphyllinae are inconclusive. With his approach only one transfer proposed by Chase and Whitten (2011), *F. brevicornata*, should be accepted. This species originally described by Schlechter (1921) as member of *Pachyphyllum* really belongs to *Fernandezia*. It is the only species of the genus with white flowers, otherwise similar to other *Fernandezia* representatives.

Fig. 6 Gynostemium structure of *Plectrophora iridifolia*. a Gynostemium, side view. b Gynostemium, bottom view. c Rostellum remnant, various views. d Pollinia, various views. e Tegula and viscidium (ter Steege & al. 36, U)



Taxonomic treatment

During the examination of materials deposited in the National Colombian Herbarium, two distinctive species resembling *Pachyphyllum* in its habit were found. While in the vegetative structure this taxon resembles other Pachyphyllinae representatives, the gynostemium morphology reminds that of *Plectrophora* H. Focke (Table 3; Fig. 6). Since neither the flower morphology of the species nor the gynostemium structure fulfils the concept of any known orchid genus, it is described here as new under the name *Valdiviesoa*.

Subtribe Pachyphyllinae Pfitz., Entw. Nat. Anord. Orchid.: 107. 1887.

Plants monopodial. Inflorescence single- to several-flowered. Clinandrium very tall, hiding anther and rostellum or obscure. Tegula single to double, joined basally, usually narrow and long. Viscidium usually elliptic and small to oblong or triangular-ovate. Pollinia 2, dorsiventrally flattened.

A subtribe of four, mainly Andean genera.

Key to the genera of Pachyphyllinae

1. Flowers relatively large, callus in form of two lamellae running along the lip...*Fernandezia*

1* Flowers inconspicuous, callus not as above, if any...2

2. Apical clinandrium relatively obscure, lip callus missing...*Valdiviesoa*

2* Apical clinandrium well-developed, forming a very high collar hiding completely the anther, callus in form of two digitate or round projections in the lip centre...3

3. Sepals partially connate forming a prominent tube...*Orchidotypus*

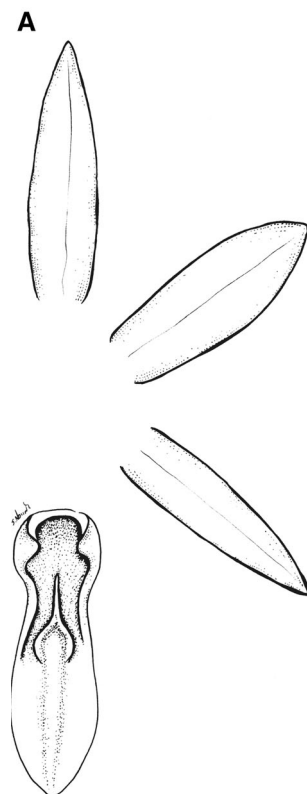
3* Sepals free to the base...*Pachyphyllum*

Fernandezia Ruiz & Pav., Fl. Peruv. Prodr.: 123. t. 27. 1794.—GENERITYPE: *Fernandezia subbiflora* Ruiz & Pav.

syn. *Centropetalum* Lindl. 1839.

Plants up to 20 cm long. Stems concealed by the leaf sheaths. Leaves conduplicate, distichous, articulate. Inflorescence single-flowered or a fascicle of few, showy, red to yellow, orange, or purple flowers, very rarely white. Perianth parts free. Sepals usually smaller than petals, all tepals subsimilar. Lip similar to tepals, rarely flabellate. Gynostemium slender, erect, rather delicate, prominently stalked. Column part as long as the anther, broadly winged, wings thin, close one to another or even touching each other in front of the stigma. Column foot absent. Anther ventral,

Fig. 7 **A** *Fernandezia lanceolata*—dissected perianth (redrawn from Dunsterville and Garay 1979). **B** *Fernandezia ionanthera* (photo: A. Zöllig)



incumbent, operculate, dorsiventrally compressed, ellipsoid, 2-chambered. Connective narrow, thin. Pollinia 2, slightly dorsiventrally compressed, obovoid, hard. Caudiculae filiform, longer than pollinia, sometimes amorphous, sticky. Apical clinandrium well-developed, forming a very high collar hiding completely the anther, entire or irregularly denticulate on margin. Stigma small, elliptic, concave, partially hidden by rostellum. Rostellum ligulate, pendent, built of several cell layers. Viscidium single, relatively large, elliptic to obovate, thin, lamellate, built of two layers of cells: the inner one very stiff and thin, formed of cells with thickened walls, the outer one thicker formed of thin-walled cells. Tegula single, linear, elliptic to obovate, thin, lamellate, built of cells with inner walls thickened and outer walls thin. Rostellum remnant ligulate, canaliculate on the upper surface, very shortly bilobed at the apex (Figs. 1, 7).

The genus embraces about 11 species distributed from Peru to Costa Rica. *Fernandezia* species grow in wet Andean forest or open paramo vegetation. Their occurrence was reported from the altitudes of 2,100–3,300 m.

The two subgenera of *Fernandezia* may be distinguished as follows:

Pollinarium with two separated tegulae...subgen. *Fernandezia*

Pollinarium with a single tegula...subgen. *Nasonia*
Pachyphyllum Kunth in Humb., Bonpl. & Kunth, Nov. Gen. Sp. Pl. 338: t.77. 1816.—GENERITYPE: *Pachyphyllum distichum* Kunth.

Terrestrial or epiphytic plants. Pseudobulbs absent. Stems erect, creeping or pendulous, concealed by leaf sheaths. Leaves 8–30, conduplicate, fleshy, articulate, sometimes deciduous. Inflorescences 1–50, lateral, sparsely branched, usually few-flowered. Flowers resupinate,

Fig. 8 **A** *Pachyphyllum dalstroemii*—dissected perianth (redrawn from Dodson 1997). **B** *Pachyphyllum crystallinum* (photo: M. Kolanowska)

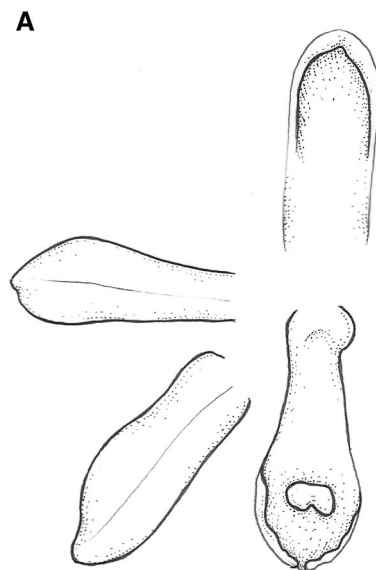


Fig. 9 **A** *Orchidotypus hispidulus*—dissected perianth (redrawn from Mora-Retana and Atwood 1992). **B** *Orchidotypus hispidulus* (photo: S. Vieira)

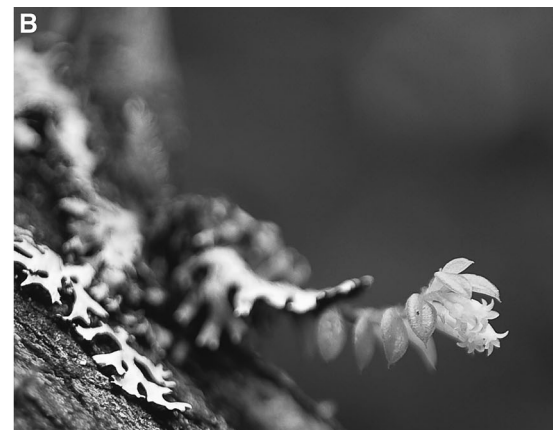
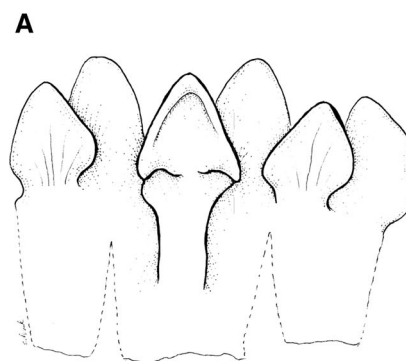
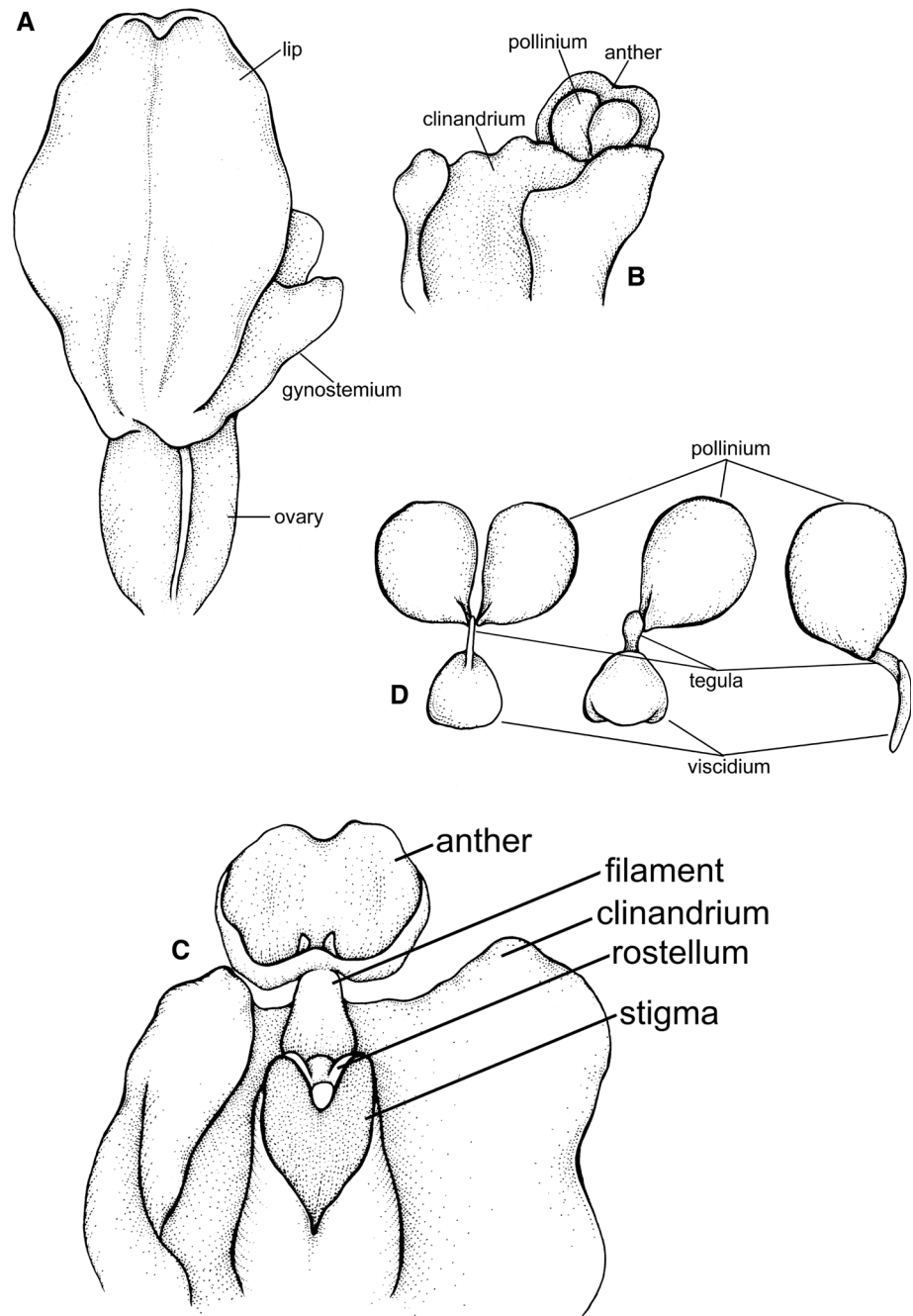


Fig. 10 Gynostemium structure of *Valdiviesoa*. **A–C** gynostemium, bottom view; **D** pollinarium, various views



inconspicuous, green to whitish or yellowish. Floral bracts shorter than pedicel. Ovary glabrous. Tepals free, subsimilar. Lip simple to obscurely 3-lobed, callus a pair of digitate projections. Gynostemium sessile, rather short, gently arched, delicate. Column part ca. 3 times longer than anther, broadly winged, wings thin, close one to another or even touching each other in front of the receptive surface. Column foot obscure. Anther ventral, incumbent, operculate, slightly dorsiventrally compressed, ellipsoid-obovoid, obscurely 2-chambered. Pollinia 2,

slightly dorsiventrally compressed, obliquely obovoid, rather hard. Caudiculae amorphous, sticky. Apical clinandrium well-developed, forming a very high collar hiding completely the anther, entire on margin. Stigma elliptic to transversely elliptic, deeply concave. Rostellum very short, triangular, rather fleshy, blunt. Viscidium single, very small, elliptic-obovate, thin, lamellate. Tegula single, oblong, small, thin, lamellate. Rostellum remnant very shortly digitate, obscurely bilobed at the apex (Figs. 1, 8).



Fig. 11 Distribution of *Valdiviesoa debedoutii* (white circles) and *V. tortuosa* (gray circles)

The genus embraces about 40 species described so far distributed from Bolivia and Peru to Costa Rica. *Pachyphyllum* species grow in wet montane forest or open páramo vegetation. They occur at high elevation of about 2,800–4,000 m.

Orchidotypus Kraenzl., Bot. Jahrb. Syst. 37: 383. 1906.—GENERITYPE: *Orchidotypus muscoides* Kraenzl.

Small or tiny, pendent epiphytes or terrestrials. Stems weak, branching only at the base, concealed by the leaf sheaths. Leaves fleshy, distichous, ciliate-dentate on margins, blades falcate-lanceolate to elliptic, acute, diminishing in size apically, often twisted basally. Inflorescence axillary, 1-3-flowered, shorter than the leaves. Flowers minute. Perianth parts connate into prominent tube. Lip similar to the petals, with claw united to the perianth tube, and a pair of rounded calli

on each side below the disk base. Gynostemium sessile, short, bent back or gently arched, delicate. Column part ca. twice as long as anther, broadly winged, wings thin, rather close to each other in front of the gynostemium. Column foot absent. Anther ventral, incumbent, motile, dorsiventrally compressed, ellipsoid-cordate, obscurely 2-chambered. Connective narrow, thin. Pollinia 2, slightly dorsiventrally compressed, obovoid to clavate, rather hard. Caudiculae amorphous, sticky. Apical clinandrium well-developed, forming a very high collar hiding completely the anther, entire or irregularly denticulate on margin. Stigma elliptic, concave. Rostellum very short. Viscidium single, relatively large, elliptic-obovate, thin, lamellate. Tegula single, linear, very small, thin, lamellate. Rostellum remnant very shortly bilobed at the apex (Figs. 1, 9).

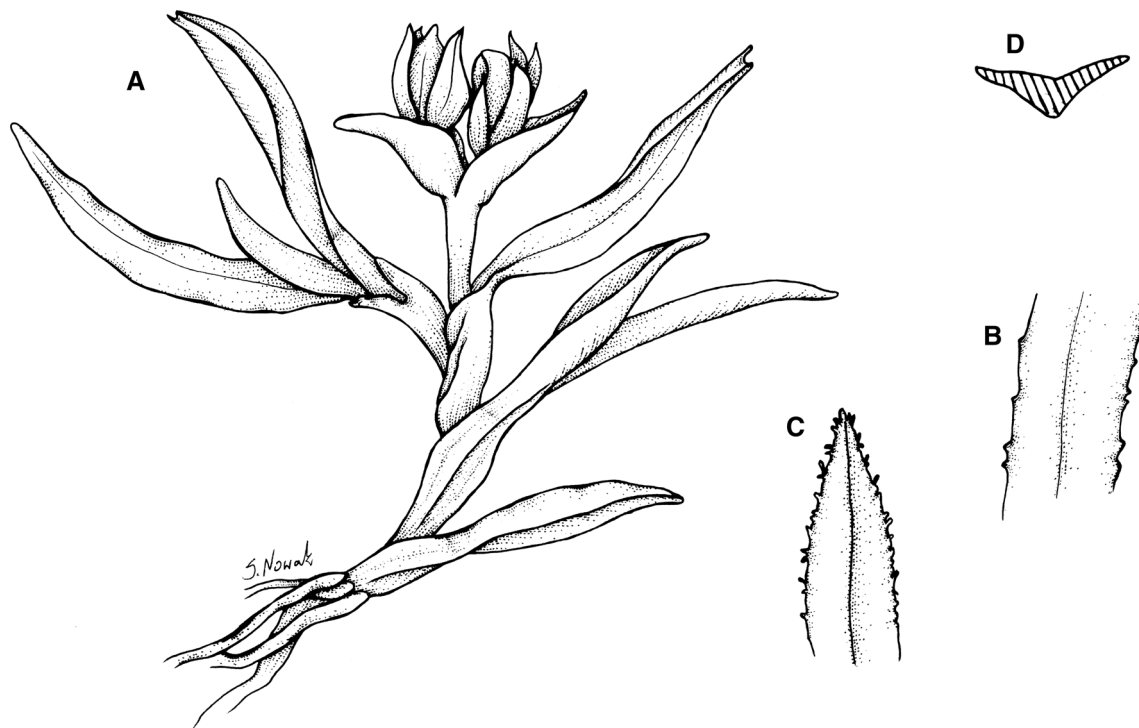


Fig. 12 *Valdiviesoa debedoutii*. **A** Habit. **B** Details of leaf margin. **C** Leaf apex. **D** Leaf section

The genus embraces about seven species distributed from Peru to Venezuela. The occurrence of *Orchidotypus* was reported from the altitudes of 2,500–3,600 m. The species are usually found in high-Andean forest. According to Senghas (1995) the genus is characterized by the presence of two elongate stipes (caudiculae?), but it was not confirmed during the studies.

***Valdiviesoa* Szlach. & Kolan., gen. nov.**—GENERITYPE: *Valdiviesoa debedoutii* (P. Ortiz) Szlach. & Kolan. [= *Pachyphyllum debedoutii* P. Ortiz].

The genus appears to be related to *Pachyphyllum* and *Fernandezia*. Plants monopodial, small. Leaves thick, coriaceous, basally twisted. Inflorescence lateral, subcapitate. Flowers small, inconspicuous. Lip connate with the base of gynostemium forming a sac. Gynostemium broadly alate. Apical clinandrium obscure, narrow. Anther motile, not operculate. Pollinia 2, suborbicular-globose, tegula single, filiform, viscidium lamellar, thin.

Monopodial epiphytic plants. Leaves several per stem, linear-lanceolate, acute, thick, basally twisted. Inflorescence lateral, erect, subcapitate, 2–4-flowered. Flowers sessile, non-resupinate, erect, slightly asymmetric, semi-transparent, white. Dorsal sepal oblong-elliptic to ligulate, obtuse. Petals obliquely oblong-elliptic, acute at apex. Lateral sepals oblong-ligulate, acute. Lip ovate to broadly ovate, truncate at apex, shortly apiculate, with

obscure callus below the middle, basally asymmetrical, shallowly saccate. Gynostemium erect, broadly winged; wings basally connate with the lip margins forming spacious sac. Filament digitate, erect. Anther thin-walled, motile, not operculate, anther partitions reduced. Rostellum digitate, curved over stigmatic surface. Stigma cordate-obovate in general outline, concave, covered by sticky matter. Pollinarium 0.4 mm long. Pollinia 2, suborbicular-obovoid, hard, split at the apex. Tegula filiform, sticky. Viscidium triangular-ovate, lamellar, thin (Fig. 10).

Etymology: The generic name is dedicated to Pedro Ortiz Valdivieso, an eminent Colombian orchidologist (1926–2012).

Habitat and Ecology: *Valdiviesoa* was found growing epiphytically in Andean cloud forest and subparamo at the altitudes between 2,400 and 3,500 m. *Valdiviesoa* representatives are almost indistinguishable in their habit from the small-sized *Orchidotypus* species. The leaves in both genera are relatively soft in comparison to stiff foliation observed in *Pachyphyllum* species. Similar habit, representatives of *Orchidotypus* are easily distinguished from *Valdiviesoa* in the connation of their tepals and lip into a conspicuous tube and the presence of the prominent apical clinandrium. Moreover, tepals of *Valdiviesoa* are ciliolate or papillate, at least in the apical part, while all perianth segments of *Orchidotypus* representatives are entire, glabrous. Both *O. hispidulus* and

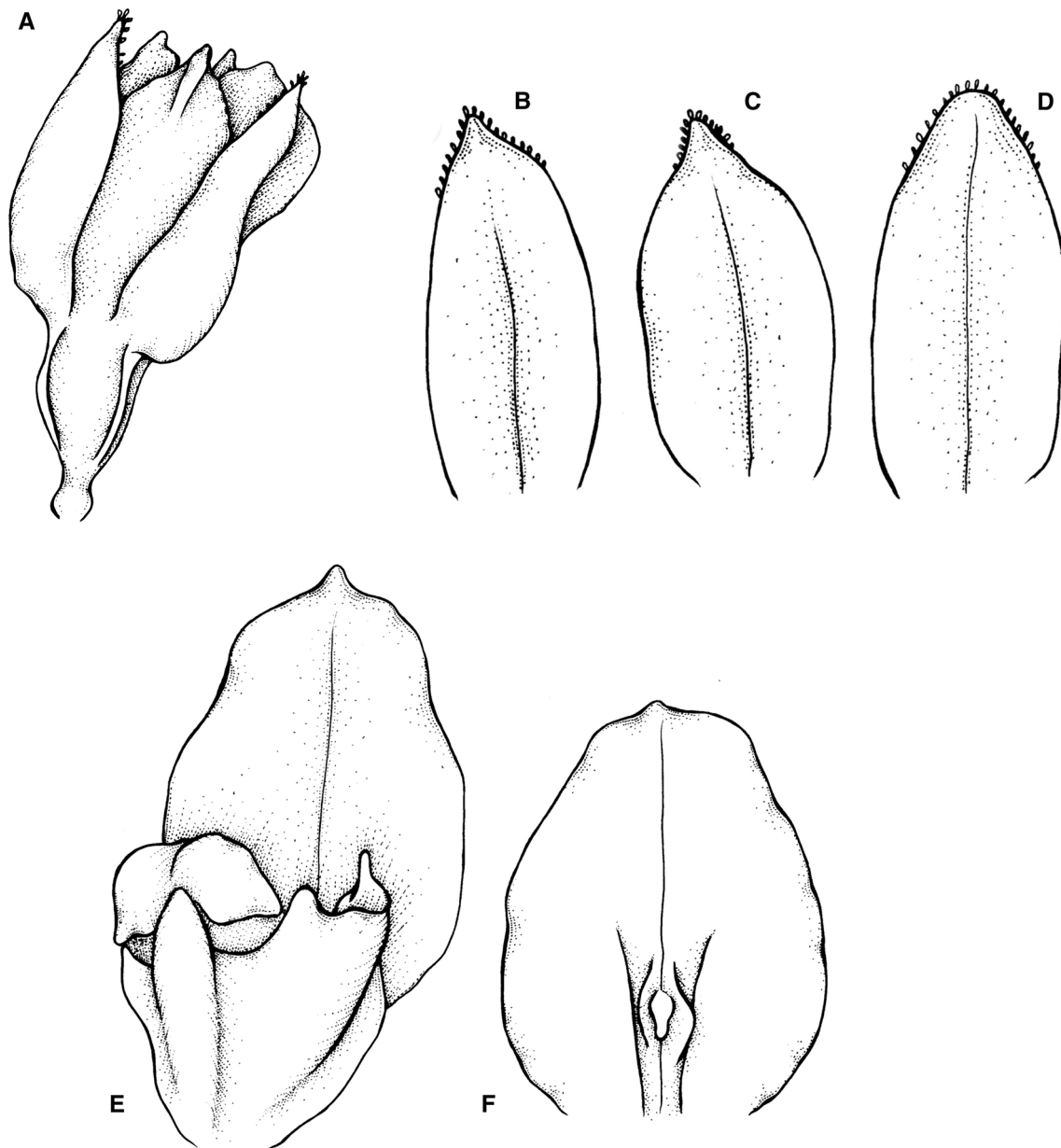


Fig. 13 *Valdiviesoa debedoutii*. **A** Flower. **B** Petal. **C** Lateral sepal. **D** Dorsal sepal. **E** Gynostemium and lip. **F** Lip

O. schultesii were found in the same region of Cundinamarca where the type specimen of *V. debedoutii* was collected.

Distribution: The genus includes only two species. While the geographic range of *V. tortuosa* extends from Bolivia to the border between Colombia and Venezuela, *V. debedoutii* is known so far exclusively from Colombia (Fig. 11).

Key to the species of *Valdiviesoa*

Dorsal sepal narrowly ovate, subobtuse, lip ovate with an obtuse apicule...*V. debedoutii*

Dorsal sepal ovate-lanceolate, acute, lip elliptic-suborbicular, rounded...*V. tortuosa*

***Valdiviesoa debedoutii* (P. Ortiz) Szlach. & Kolan., comb. nov.**

Basionym: *Pachyphyllum debedoutii* P.Ortiz, Orquideología 13: 13. 2009. *Fernandezia debedoutii* (P. Ortiz) M. W. Chase, Phytotaxa 20: 30. 2011.—TYPE: COLOMBIA. Cundinamarca. Guasca, Hacienda La Esperanza, Alt. 2,950 m. Ortiz P., de Bedout R. & Alvarez L. E. 1298 (holotype: HPUJ!) (Figs. 12, 13, 14).



Fig. 14 *Valdiviesoa debedoutii*—inflorescence (photo: R. de Bedout Herrera)

Representative Specimens: COLOMBIA. Boyacá. Carretera de Guateque a Santa María. Entre Santa María y Piedra Campana, Alt. 800–1,200 m, 10–12 Mar 1960, *García Barriga 17209a* (COL!). Cundinamarca. [Distr. Capital Bogotá]. Usaquén. Matorrales y bisques, Alt. 2,900 m. Epífita. Periantio verdoso claro, con manchitas pardusco-violáceas. Labelo verde claro, con 2 callos amarillos, *Schneider 196/1* (COL!). Mpio. La Calera. Carretera via Club la Calima. Hierba epífita, inconspicua debido a su pequeño tamaño. Sepalos y petalos transparentes, blanco rosados, labelo blanco, antera morada. Entre 0.5 y 2 m de altura del suelo, formando pequeñas poblaciones. Árboles solitarios en un potrero. 04°41'02"N 73°58'24"W, Alt. 3,027 m, 15 Apr 2006, *R. Arevalo, A. Barona & J. Chacon 539* (COL!). Mpio. Chocontá. El Sisga. Carretera a Chocontá. A 2 km al N del Puente, Alt. 2,800 m. 12 Oct 1972. Epífita sobre árboles. Petalos verde con manchitas carmelitas, sepalos del mismo color, labelo Rosado con manchas rojas, *H. García Barriga 20356* (COL!); El Sisga. Chocontá, parte alta de La Represa, Alt. 2,700–2,800 m. Muy pequeña, de caliz ferrugineo y petalos amarillos, 14 Jan 1962, *H. García Barriga 17383* (COL!). Mpio. Guasca.

El Salitre, Reserva Biológica El Encenillo, en la parcela no 3, cercana a el sender Julio Carrizosa. Bosque nublado andino de 30 años de regeneración muy denso con dosel de 8 m. Orquídea pequeña epífita, flores crema-transparentes, anteras moradas, stigma naranja, Alt. 2,900–3,200 m, 28 Mar 2009, *Rodrigo Camara Leret 224* (COL, COL–spirit); Vereda Potreritos, canon del río Tunjo. Epífita, poco abundante, perianto verde claro, labelo tenido de morado, Alt. 2,480 m, 21 Jun 1989, *E. Linares & R. Sanchez 2818* (COL! 440290). Mpio. Subachoque. Entre La Pradera y Zipaquira, finca Pie de Loma. En un bosque con *Wienmannia*, *Oreopanax*, *Gaiadendron*, *Diplostegium*, *Myrsine*, *Cavendishia*, etc. Desde de 6–8 m de altura, Alt. 2,900 m, 29 Mar 2003, *M. Hernandez Schmidt 1133* (COL!). Mpio. Zipaquirá. El Gaque, Alt. 3,150 m, 15 Jul 1942, *Camargo & Huertas 1104* (COL!).

***Valdiviesoa tortuosa* (Foldats) Szlach. & Kolan., comb. nov.**

Basionym: *Pachyphyllum tortuosum* Foldats, Bol. Soc. Venez. Ci. Nat. 28: 252. 1969. *Fernandezia tortuosa* (Foldats) M.W. Chase, Phytotaxa 20: 31. 2011, *syn. nov.*—TYPE: Venezuela. Edo Tachira: Río Quinimari. Quebrada Las Copas, Alt. 2,600–2,630 m. *G. C. K. Dunsterville & E. Dunsterville 90* (Holotype: VEN; Iso-type: K) (Fig. 15).

Representative Specimens: BOLIVIA. Department. La Paz. Prov. Nor Yungas. Senda Chojllapata, poco después de la torre de energía eléctrica. 16°17'S 067°53'W, Alt. 3,500 m, *I. Jiménez 5280* (LPB), PN-ANMI Cotapata, sendero Sillutinkara. 16°17'S 067°53'W, Alt. 3,400 m, *I. Jiménez 4079* (LPB). COLOMBIA. Department. Norte de Santander. Below the Paramo de Jurisdicciones. Epiphytic in cloud forest. Flowers yellow; anther red, Alt. 3,150 m, 10 May 1984, *C.A. Luer et al. 10235* (MO). ECUADOR. Prov. Azuay. Cuenca-Molleturo, Alt. 2,700 m, 14 Jul 1982, *C. H. Dodson & A. Embree 13345* (SEL); Prov. Loja. Parque Nacional Podocarpus. E. of Nudo de Cajanuma, just N. of Centro de Información Sample plot site. Epiphyte on twigs. Flowers white. 04°05'S 079°10'W, Alt. 2,900 m, 20 Sep–16 Nov 1989, *A. Bøgh Pedersen 47947* (AAU, MO); Prov. Zamora-Chinchipe. Yangana-Valladolid, Alt. 3,000 m, 23 Mar 1985, *A. Hirtz 2301* (RPSC), Loja-Zamora, Alt. 2,750 m, 18 Nov 1961, *C. H. Dodson & L.B. Thien 1331* (SEL).

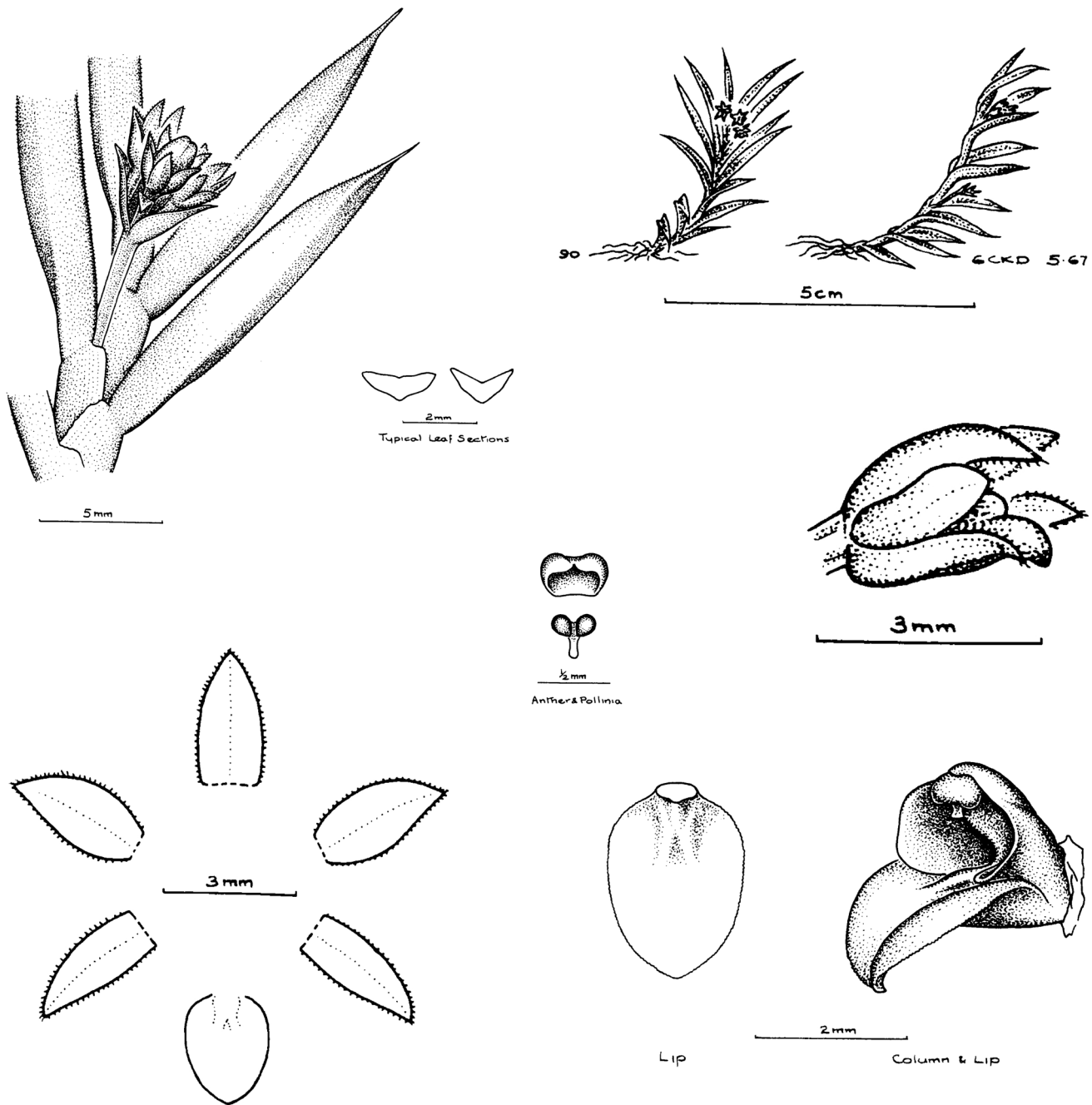


Fig. 15 *Valdiviesoa tortuosa* (reproduced from Dunsterville and Garay 1976, with kind permission of AMES)

VENEZUELA. Edo Tachira. Rio Quinimari. Quebrada Las Copas, Alt. 2,600–2,630 m, G. C. K. *Dunsterville* & E. *Dunsterville* 90 (K, VEN).

Acknowledgments The authors are grateful to the Curators and staff of the cited herbaria for their assistance during the visits in the herbarium and for making specimens available on loan. We wish to thank the anonymous referees whose comments contributed considerably to the improvement of the manuscript and Sławomir Nowak for his help in preparing the illustrations. We are grateful to the Swiss

Orchid Foundation and their collaborators for providing photographs and to Dr G. A. Romero-González for his kind permission to reproduce Dunsterville's illustration. The paper is a part of a project supported with a grant from the Polish Ministry of Science and Higher Education (8124/B/PO1/2011/40) and Synthesys grants (AT-TAF-2483, GB-TAF-2445).

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References

- Chase MW (2009) Subtribe Oncidiinae. In: Pridgeon AM, Chase MW, Cribb PJ, Rasmussen FN (eds) *Genera Orchidacearum*, vol 5. Epidendroideae (part two). Oxford University Press, Oxford, pp 211–394
- Chase MW, Whitten WM (2011) Further taxonomic transfers in Oncidiinae (Orchidaceae). *Phytotaxa* 20:26–32
- Chase MW, Cameron KM, Barrett RL, Freudenstein JV (2003) DNA data and Orchidaceae systematics: a new phylogenetic classification. In: Dixon KW, Kell SP, Barrett RL, Cribb PJ (eds) *Orchid conservation*. Natural History Publications, Kota Kinabalu, pp 69–89
- Christenson EA (2008) A synopsis of *Pachyphyllum* (Orchidaceae). *J Bot Res Inst Texas* 2(1):285–289
- Dodson CH (1989) *Raycadenco ecuadorensis*. In: Dodson CH, Dodson PM (eds) *Icon Pl Trop* 2(6):pl 0577
- Dodson CH (1997) New Orchid species from Ecuador 5. *Orquideologia* 20(3):271–279
- Dressler RL (1971) Nomenclatural notes on the Orchidaceae V. *Phytologia* 21:440–443
- Dressler RL (1981) *The Orchids: natural history and classification*. Harvard University Press, Cambridge
- Dressler RL (2003) Orchidaceae. In: Hammel BE, Grayum MH, Herrera C, Zamora N (eds) *Manual de Plantas de Costa Rica*. vol. 3. *Monogr Syst Bot Mo Bot Gard* 93:1–595
- Dressler RL, Dodson CH (1960) Classification and phylogeny in the Orchidaceae. *Ann Missouri Bot Gard* 47:25–68
- Dunsterville GCK, Garay LA (1976) Venezuelan orchids illustrated, vol 6. Andre Deutsch, London
- Dunsterville GCK, Garay LA (1979) *Orchids of Venezuela, an Illustrated Field Guide*. Botanical Museum of Harvard University, Cambridge, Massachusetts
- Garay LA (1972) On the systematics of the monopodial orchids I. *Bot Mus Lealf Harv Univ* 23:149–212
- Garay LA, Dunsterville GCK (1972) Venezuelan orchids illustrated 5. Andre Deutsch, London
- Lindley J (1824) *Sarcanthus*. *Bot Reg* 9: p 875
- Lindley J (1826) *Collectanea botanica, or, Figures and botanical illustrations of rare and curious exotic plants*. R. and A. Taylor, London
- Lindley J (1838) *Sertum Orchidaceum, a wreath of the most beautiful Orchidaceous flowers*. James Ridgeway, London
- Lindley J (1844) *Orchidaceae Loxenses*. In: Bentham G (ed) *Plantas Hartwegianas imprimis Mexicanas adjectis nunnallis Grahamianis enumerat novasque describit. Part 2. Plantarum Hartwegianarum*. George Bentham, London, pp 149–156
- Mora-Retana DE, Atwood JT (1992) *Pachyphyllum hispidulum*. In: Atwood JT (ed) *Orchids of Costa Rica. Icon Pl Trop* 15:pl 1476
- Neubig KM, Whitten WM, Williams NH, Blanco MA, Endara L, Burleigh JG, Silvera K, Cushman JC, Chase MW (2012) Generic recircumscriptions of Oncidiinae (Orchidaceae: Cymbidieae) based on maximum likelihood analysis of combined DNA datasets. *Bot J Linean Soc* 168:117–146
- Pfitzer E (1887) Orchidaceae. In: Engler A, Prantl KE (eds) *Die natürlichen Pflanzenfamilien*. Wilhelm Engelmann, Leipzig, pp 52–224
- Schlechter R (1915) *Die Orchideen: ihre Beschreibung, Kultur und Züchtung*. Handbuch für Orchideenliebhaber, Züchter und Botaniker. P. Parey, Berlin
- Schlechter R (1921) *Orchideenfloren der Suedamerikanischen Kordillerenstaaten, Peru. Beschreibungen neuer Arten*. *Feddes Repert Spec Nov Regni Veg Beih* 9:41–118
- Schlechter R (1929) *Figuren-Atlas zu den Orchideenfloren der südamerikanischen Kordillerenstaaten*. *Repert Sp Nov Regni Veg Beih* 57:1–142
- Schweinfurth C (1961) *Orchidaceae, Orchids of Peru*. *Fieldiana, Bot* 30(4):787–1005
- Senghas K (1995) 749. *Chytroglossa-770. Sutrina*. *Orchideen* (Schlechter) (ed 3), Vol. 1B, Lieferung 31:1905–1976
- Szlachetko DL (1995) *Systema Orchidialium*. *Fragm Florist Geobot Pol Suppl.* 3:1–137
- Szlachetko DL, Mytnik-Ejsmont J (2009) *Gynostemia Orchidialium IV*. *Acta Bot Fenn* 180:1–313