

THE ORCHID POLLINARIA COLLECTION AT LANKESTER BOTANICAL GARDEN, UNIVERSITY OF COSTA RICA

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ABSTRACT. The relevance of pollinaria study in orchid systematics and reproductive biology is summarized. The Orchid Pollinaria Collection and the associate database of Lankester Botanical Garden, University of Costa Rica, are presented. The collection includes 496 pollinaria, belonging to 312 species in 94 genera, with particular emphasis on Neotropical taxa of the tribe Cymbidieae (Epidendroideae). The associated database includes digital images of the pollinaria and is progressively made available to the general public through EPIDENDRA, the online taxonomic and nomenclatural database of Lankester Botanical Garden. Examples are given of the use of the pollinaria collection by researchers of the Center in a broad range of systematic applications.

Key words: Orchid pollinaria, systematic botany, pollination biology, orchid pollinaria collection, Lankester Botanical Garden, Universidad de Costa Rica

INTRODUCTION

The cohesion of pollen into compact units (the pollinia) and the evolution, in the Orchidaceae, of accessory structures for attachment to pollinators, has attracted the attention of scientists since the time of Darwin, who found orchid pollinaria to be “as perfect as any of the most beautiful adaptations in the animal kingdom” (Darwin 1877). If the grouping of pollen grains into tetrads, reduction in exine surrounding inner grains, and pollen consolidation into pollinia are also known in the Asclepiadaceae, only the Orchidaceae show the innovation of pollinaria. This term refers to the entire package, including one or more pollinia and the associate structures, which is removed by pollinators, and its evolution is a key to explain some of the major morphological differences between orchids’ flowers and those of other plant families.

In a family whose flowers are pollinated mostly by insects, powdery pollen (which is more suited for the placement on hairy parts) was less effective in promoting dispersal, and the evolution of an adhesive viscidium was crucial to maximize the efficiency of pollen export through the improvement of its adherence to smooth surfaces such as an insect’s thorax, mouthparts, frons, eyes, and legs (Dressler 1981). The efficiency of pollen transfer depends not only on the selection of visitors by means of specific visual and olfactory cues, but also on the precise deposition of the pollen masses on a specific target area of the pollinator’s body. This involves modifications in perianth parts as well as in gynoeceal and androeceal organs, and eventually the shape and size of the viscidium. The precision of pollen placement on specific parts of the body of pollinators ensures interspecific pollination and, on the other side, allows several sympatric orchids to share the same pollinators without interference in pollen deposition (Dressler 1968, Nilsson 1983, Steiner 1989). Mechan-

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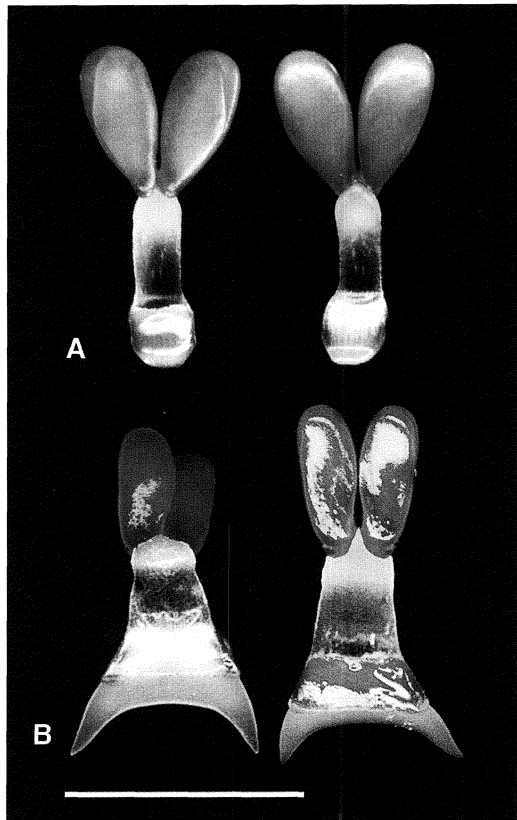


FIGURE 1. Pollinaria in dorsal and ventral views. **A.** *Acineta densa* (JBL-09182). **B.** unidentified *Acineta* species (Pupulin 6291). Scale bar = 5 mm.

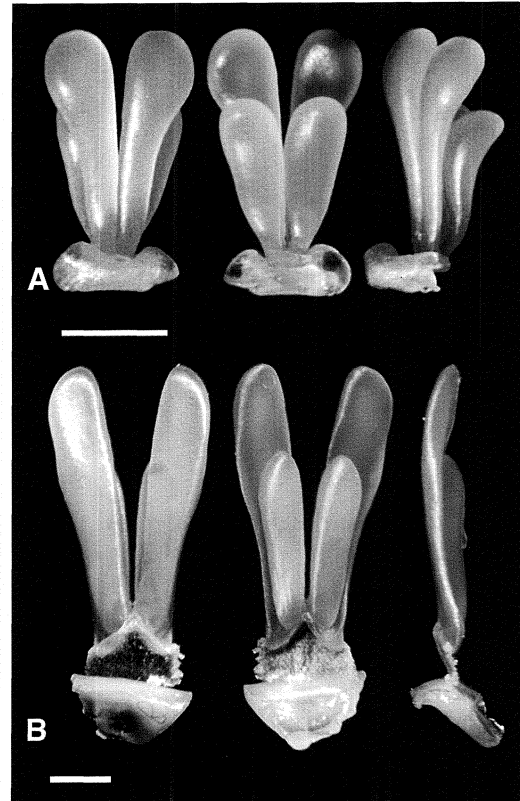


FIGURE 2. Pollinaria in dorsal, ventral, and lateral views. **A.** *Kefersteinia parvilabris* (Bogarín 806). **B.** *Chondroscaphe atrilinguis* (Bogarín 2950). Scale bars = 1 mm.

ical movements of the caudicles and stipe after pollinarium removal re-orient the pollinia and maximize pollen distribution. Bending movements of pollinaria, which correctly orient the pollinia to contact the stigma (Darwin 1877, Nilsson 1980, Johnson & Nilsson 1999), as well as the shrinking of the pollinia to fit the stigmatic entrance (Borba & Semir 1999), prevent geitonogamy and promote effective outcrossing in pollen transfer.

The high degree of variation in pollinaria organization and morphology reflects the central role of this structure in orchid pollination mechanisms, and Johnson and Edwards (2000) suggested it was pivotal in promoting the tremendous radiation of the Orchidaceae, which have more than 25,000 species (Atwood 1986, Cribb & Govaerts 2005).

The characteristics of pollinia and the associated structures have been used as a tool for orchid classification since the early work of John Lindley; Reichenbach (1852) devoted his doc-

toral dissertation to the study of pollinaria as indicators of species relationships. Diversity in number, shape, orientation, and packaging of pollinia (including the degree of tetrad packing, the state of the pollinia, the form, arrangement, orientation, and possible dimorphism of massulae), as well as the structure, development, organization and shape of pollinaria (including the presence of caudicles and their composition, and the presence, number and shape of stipes), have been employed as sources of characters at various systematic levels to define taxa from species to subfamilies. The use of pollinaria information as an additional tool in taxonomic work is a current practice at Lankester Botanical Garden (LBG), where researchers make use of their morphological features in a broad range of systematic applications (i.e., Dressler & Klikunas 2006, Pupulin 2007a, 2007b; Bogarín 2007, Pupulin in press). As pollinaria are less subject to parallelism than other floral features, their morphology also played a significant role in the

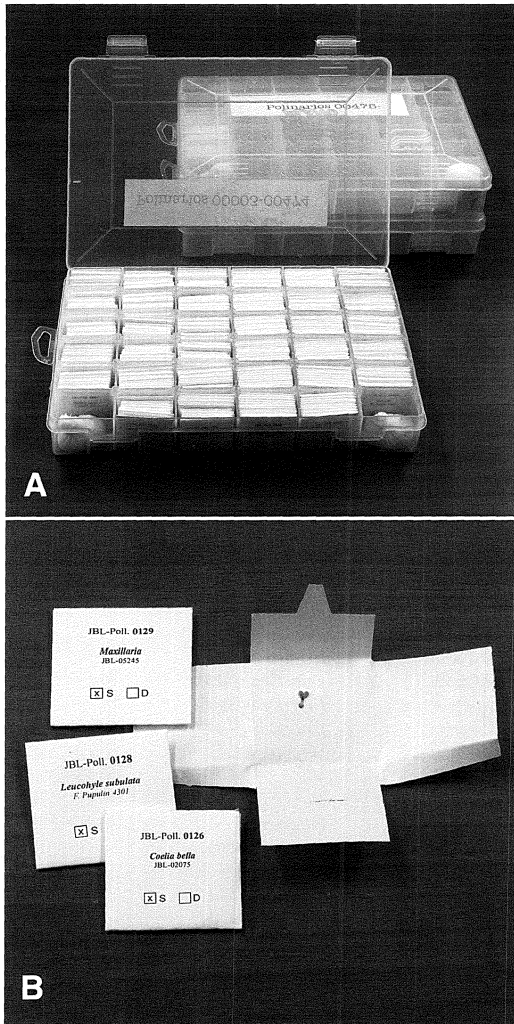


FIGURE 3. **A.** Cases hosting the collection of pollinaria. **B.** Envelopes to store pollinaria in the collection of Lankester Botanical Garden.

construction of phylogenetic hypotheses (i.e., Williams 1970a, 1970b, 1972; Ackerman & Williams 1981, Burns- Balogh 1982, Dressler 1986, 1993; Chase 1987, Freudenstein & Rasmussen 1997).

Accumulating evidence shows that floral evolution in the Orchidaceae is essentially driven by pollinator traits, linking the study of pollination to evolutionary biology. New, intricate orchid-pollinator interactions are continuously revealed through the application of accurate empirical studies that improve our understanding of plant evolution in general. However, direct observation of pollination acts is notoriously difficult,

and the lack of direct records inhibits a better understanding of the pollination biology of many orchid taxa, and particularly of the real degree of pollinator specificity. The study of mating patterns and male fitness in orchid reproduction is dependent on a precise identification of pollinaria. Pollinaria found on insects are often informative of the presence of rare species or of orchids that occupy difficult to reach habitats and ecological niches. During a preliminary census of the orchid flora of the large (<400 hectares) Alberto M. Brenes Biological Reserve in Costa Rica, staff of LBG managed to record the presence of *Houlletia tigrina* on the basis of a single pollinarium found on an insect that had been captured at the Reserve during a course on entomology. Dressler (1976) makes an interesting case of the study of orchid pollination without any orchids, through the identification of orchid genera and species from the pollinaria borne by captured insects, stressing the importance of a reference collection to compare pollinaria. Recent work by Widmer and collaborators addressed the problem of the relative paucity of field observations by means of a molecular approach, based on the analysis of DNA recovered from pollinaria found on insects (Widmer et al. 2000). The study demonstrates that the analysis of the nuclear ribosomal ITS region of the recovered pollen allows the identification of the species or species-group from which the pollinaria originated, disclosing previously unrecorded orchid-pollinator relationships.

ORCHID POLLINARIA COLLECTION AT LANKESTER BOTANICAL GARDEN

To support studies in systematic botany and pollination biology, LBG began in 2003 an effort to build and maintain a large collection of orchid pollinaria, with emphasis on Neotropical taxa and special groups of interest to the research staff.

Pollinaria are mostly removed from plants grown in the living collection of the center, including more than 15,000 accessions belonging to approximately 1300 species. Priority was given to Neotropical and Mesoamerican genera and species, and to the groups that exhibit potentially informative pollinarium morphology, with emphasis on taxa with highly specialized reproductive biology. It is not insignificant that the mostly Neotropical advanced Cymbidieae account for almost 88% of the entire collection. Unlike the generalized use of mounting pollinaria on small paper triangles, to which they are attached by the natural glue of the viscidium, the pollinaria intended for the collection are removed with a thin-pointed instrument, trying to mini-

TABLE 1. Orchid pollinaria in the collection of Lankester Botanical Garden, University of Costa Rica.

No.	Genus/species	Country	Collector	Date
P0340	<i>Acineta</i>	Costa Rica		14.11.2006
P0359	<i>Acineta</i>	Costa Rica		14.11.2006
P0347	<i>Acineta</i>	Costa Rica	<i>Pupulin 6291</i>	14.11.2006
P0362	<i>Acineta densa</i>	Costa Rica		14.11.2006
P0303	<i>Acineta densa</i>	Costa Rica	<i>Gómez 7</i>	13.09.2006
P0358	<i>Acineta densa</i>	Costa Rica	<i>Pupulin 4200</i>	14.11.2006
P0117	<i>Acineta densa</i>	Costa Rica		09.06.2005
P0118	<i>Acineta densa</i>	Costa Rica		09.06.2005
P0119	<i>Acineta densa</i>	Costa Rica		09.06.2005
P0120	<i>Acineta densa</i>	Costa Rica	<i>Pupulin 4200</i>	09.06.2005
P0467	<i>Ada aurantiaca</i>	Colombia		20.07.2007
P0403	<i>Ada aurantiaca</i>	Colombia		19.07.2007
P0086	<i>Ada chlorops</i>	Costa Rica		13.05.2005
P0278	<i>Aerides falcata</i>	Thailand		01.09.2006
P0171	<i>Aerides multiflora</i>	Thailand		07.07.2005
P0013	<i>Angraecum eburneum</i>	Madagascar		15.12.2003
P0121	<i>Angraecum eichlerianum</i>	Africa		09.06.2005
P0336	<i>Arpophyllum giganteum</i>	Costa Rica		26.10.2006
P0071	<i>Ascocentrum curvifolium</i>	Thailand		13.05.2005
P0087	<i>Aspasia epidendroides</i>	Costa Rica	<i>Vargas s.n.</i>	13.05.2005
P0122	<i>Barkeria lindleyana</i>	Costa Rica		09.06.2005
P0246	<i>Batemanian leferenzii</i>	Peru	<i>Pupulin 6224</i>	13.06.2006
P0405	<i>Bensteinia ramonensis</i>	Costa Rica	<i>Bogarín 1923</i>	19.07.2007
P0194	<i>Bensteinia ramonensis</i>	Ecuador	<i>Bogarín 1923</i>	17.03.2006
P0224	<i>Benzingia cornuta</i>	Ecuador	<i>Pupulin 5989</i>	16.05.2006
P0411	<i>Benzingia reichenbachiana</i>	Costa Rica	<i>Bogarín 1890</i>	19.07.2007
P0153	<i>Benzingia caudata</i>	Ecuador	<i>Pupulin 5989</i>	19.04.2006
P0045	<i>Benzingia reichenbachiana</i>	Costa Rica	<i>Whitten 2052</i>	13.05.2005
P0123	<i>Brassavola nodosa</i>	Costa Rica		09.06.2005
P0450	<i>Brassia arcuigera</i>	Costa Rica	<i>Bogarín 2416</i>	20.07.2007
P0456	<i>Brassia arcuigera</i>	Costa Rica	<i>Bogarín 1640</i>	20.07.2007
P0149	<i>Brassia arcuigera</i>	Costa Rica	<i>Pupulin 4886</i>	14.06.2005
P0186	<i>Brassia arcuigera</i>	Costa Rica	<i>Pupulin 5646</i>	22.12.2005
P0404	<i>Brassia arcuigera</i>	Costa Rica	<i>Bogarín 2416</i>	19.07.2007
P0468	<i>Brassia caudata</i>	Costa Rica	<i>Bogarín 2554</i>	20.07.2007
P0021	<i>Brassia caudata</i>	Costa Rica		22.10.2005
P0088	<i>Brassia gireoudiana</i>	Costa Rica		13.05.2005
P0188	<i>Brassia gireoudiana</i>	Costa Rica		22.12.2005
P0261	<i>Brassia suavissima</i>	Costa Rica	<i>Bogarín 2855</i>	30.06.2006
P0150	<i>Brassia verrucosa</i>	Costa Rica		14.06.2005
P0170	<i>Brassia caudata</i>	Costa Rica	<i>Herra 1</i>	07.07.2005
P0164	<i>Brassia caudata</i>	Jamaica	<i>Hamlyn s.n.</i>	07.07.2005
P0005	<i>Brassia arcuigera</i>	Costa Rica	<i>Pupulin s.n.</i>	06.08.2003
P0386	<i>Bulbophyllum lobbii</i>	Thailand		07.03.2006
P0302	<i>Catasetum maculatum</i>	Costa Rica	<i>Bogarín 2609</i>	13.09.2006
P0001	<i>Catasetum maculatum</i>	Costa Rica	<i>Elizondo s.n.</i>	20.07.2004
P0354	<i>Catasetum maculatum</i>	Costa Rica	<i>Rojas 137</i>	14.11.2006
P0124	<i>Cattleya intermedia</i>	Brazil		09.06.2005
P0381	<i>Chaubardia heteroclita</i>	Peru	<i>Pupulin 6518</i>	05.03.2006
P0287	<i>Chaubardiella pubescens</i>	Costa Rica	<i>Pupulin 6240</i>	05.09.2006
P0308	<i>Chaubardiella subquadrata</i>	Costa Rica		20.09.2006
P0044	<i>Chaubardiella pacuarensis</i>	Costa Rica		13.05.2005
P0042	<i>Chaubardiella pacuarensis</i>	Costa Rica	<i>Blanco 1072</i>	13.05.2005
P0282	<i>Chondrorhyncha thienii</i>	Colombia	<i>Pupulin 6281</i>	05.09.2006
P0481	<i>Chondrorhyncha thienii</i>	Ecuador		19.08.2007
P0380	<i>Chondroscaphe amabilis</i>	Ecuador	<i>Pupulin 6513</i>	05.03.2006
P0376	<i>Chondroscaphe atrilinguis</i>	Panama	<i>Bogarín 2950</i>	12.03.2006
P0409	<i>Chondroscaphe atrilinguis</i>	Panama	<i>Bogarín 2950</i>	19.07.2007
P0465	<i>Chondroscaphe bicolor</i>	Costa Rica	<i>Pupulin 3508</i>	20.07.2007
P0396	<i>Chondroscaphe bicolor</i>	Costa Rica		12.03.2006
P0339	<i>Chondroscaphe bicolor</i>	Costa Rica	<i>Bogarín 1894</i>	14.11.2006

TABLE 1. Continued.

No.	Genus/species	Country	Collector	Date
P0341	<i>Chondroscaphe bicolor</i>	Costa Rica	<i>Bogarín 2203</i>	14.11.2006
P0326	<i>Chondroscaphe bicolor</i>	Panama		03.10.2006
P0408	<i>Chondroscaphe bicolor</i>	Costa Rica	<i>Bogarín 1914</i>	19.07.2007
P0410	<i>Chondroscaphe bicolor</i>	Costa Rica	<i>Bogarín 996</i>	19.07.2007
P0412	<i>Chondroscaphe bicolor</i>	Costa Rica	<i>Bogarín 426</i>	19.07.2007
P0413	<i>Chondroscaphe bicolor</i>	Costa Rica	<i>Bogarín 2874</i>	19.07.2007
P0429	<i>Chondroscaphe bicolor</i>	Costa Rica	<i>Bogarín 984</i>	19.07.2007
P0355	<i>Chondroscaphe bicolor</i>	Costa Rica	<i>Hoffman s.n.</i>	14.11.2006
P0050	<i>Chondroscaphe bicolor</i>	Costa Rica		13.05.2005
P0049	<i>Chondroscaphe bicolor</i>	Costa Rica		13.05.2005
P0048	<i>Chondroscaphe bicolor</i>	Costa Rica	<i>Pupulin 3525</i>	13.05.2005
P0416	<i>Chondroscaphe bicolor</i>	Costa Rica	<i>Pupulin 3525</i>	19.07.2007
P0168	<i>Chondroscaphe bicolor</i>	Costa Rica	<i>Bianchi 68</i>	07.07.2005
P0346	<i>Chondroscaphe bicolor</i>	Costa Rica	<i>Bianchi 68</i>	14.11.2006
P0394	<i>Chondroscaphe bicolor</i>	Costa Rica	<i>Bogarín 996</i>	12.03.2006
P0342	<i>Chondroscaphe bicolor</i>	Costa Rica	<i>Karremans 883</i>	14.11.2006
P0473	<i>Chondroscaphe eburnea</i>	Panama	<i>Dressler 6826</i>	19.08.2007
P0439	<i>Chondroscaphe eburnea</i>	Panama	<i>Dressler 6826</i>	20.07.2007
P0379	<i>Chondroscaphe embreei</i>	Ecuador	<i>Pupulin 6510</i>	05.03.2006
P0464	<i>Chondroscaphe embreei</i>	Ecuador	<i>Pupulin 6510</i>	20.07.2007
P0329	<i>Chondroscaphe escobariana</i>	Ecuador	<i>Pupulin 6289</i>	17.10.2006
P0469	<i>Chondroscaphe flaveola</i>	Ecuador	<i>Pupulin 6474</i>	20.07.2007
P0378	<i>Chondroscaphe flaveola</i>	Ecuador	<i>Pupulin 6474</i>	05.03.2006
P0425	<i>Chondroscaphe flaveola</i>	Ecuador	<i>Pupulin 6474</i>	19.07.2007
P0325	<i>Chondroscaphe yamilethiae</i>	Costa Rica	<i>Pupulin 4637</i>	03.10.2006
P0398	<i>Chondroscaphe yamilethiae</i>	Costa Rica	<i>Pupulin 4637</i>	12.03.2006
P0322	<i>Chondroscaphe yamilethiae</i>	Costa Rica	<i>Pupulin 4701</i>	03.10.2006
P0110	<i>Chondroscaphe yamilethiae</i>	Costa Rica	<i>Pupulin 4638</i>	24.05.2003
P0047	<i>Chondroscaphe yamilethiae</i>	Costa Rica	<i>Pupulin 4637</i>	13.05.2005
P0125	<i>Coccineorchis standleyi</i>	Costa Rica	<i>Pupulin 4229</i>	09.06.2005
P0156	<i>Cochleanthes aromatica</i>	Costa Rica		16.05.2005
P0067	<i>Cochleanthes aromatica</i>	Costa Rica		13.05.2005
P0126	<i>Coelia bella</i>	Guatemala (?)		09.06.2005
P0185	<i>Coeliopsis hyacinthosma</i>	Costa Rica	<i>Pupulin 4477</i>	22.12.2005
P0475	<i>Coeliopsis hyacinthosma</i>	Costa Rica	<i>Pupulin 4377</i>	19.08.2007
P0089	<i>Comparettia falcata</i>	Costa Rica	<i>Aguilar 1</i>	13.05.2005
P0310	<i>Cynoches amparoanum</i>	Costa Rica	<i>Rojas 114</i>	20.09.2006
P0352	<i>Cymbidium iridioides</i>	India	<i>Pupulin 6416</i>	14.11.2006
P0026	<i>Cymbidium iridoiides</i>	India		22.10.2005
P0216	<i>Cyrtopodium macrobulbon</i>	Costa Rica	<i>Salazar s.n.</i>	03.05.2006
P0301	<i>Daiotyla albicans</i>	Costa Rica	<i>Pupulin 4372</i>	07.09.2006
P0479	<i>Daiotyla albicans</i>	Costa Rica	<i>Pupulin 4372</i>	19.08.2007
P0300	<i>Daiotyla crassa</i>	Costa Rica	<i>Pupulin 4257</i>	07.09.2006
P0003	<i>Daiotyla crassa</i>	Costa Rica	<i>Pupulin 4257</i>	18.03.2004
P0478	<i>Daiotyla crassa</i>	Costa Rica	<i>Pupulin 4257</i>	19.08.2007
P0428	<i>Daiotyla xanthina</i>	Colombia	<i>Pupulin 5891</i>	19.07.2007
P0388	<i>Dendrobium antennatum</i>	New Guinea		07.03.2006
P0286	<i>Dichaea</i>	Costa Rica	<i>Pupulin 5049</i>	05.09.2006
P0037	<i>Dichaea acrolephara</i>	Costa Rica	<i>Bogarín 1009</i>	13.05.2005
P0029	<i>Dichaea acrolephara</i>	Costa Rica	<i>Pupulin 4945</i>	13.05.2005
P0030	<i>Dichaea acrolephara</i>	Costa Rica	<i>Pupulin 5049</i>	13.05.2005
P0069	<i>Dichaea amparoana</i>	Costa Rica	<i>Bogarín 679</i>	13.05.2005
P0272	<i>Dichaea cryptarrhena</i>	Costa Rica	<i>Pupulin 5662</i>	29.08.2006
P0275	<i>Dichaea elliptica</i>	Costa Rica	<i>Pupulin 5133</i>	01.09.2006
P0038	<i>Dichaea elliptica</i>	Costa Rica	<i>Pupulin 5133</i>	13.05.2005
P0274	<i>Dichaea fragrantissima</i> subsp. <i>eburnea</i>	Costa Rica	<i>Blanco 513</i>	01.09.2006
P0031	<i>Dichaea fragrantissima</i> subsp. <i>eburnea</i>	Costa Rica	<i>Blanco 513</i>	13.05.2005
P0032	<i>Dichaea fragrantissima</i> subsp. <i>eburnea</i>	Costa Rica	<i>Pupulin 4601</i>	13.05.2005
P0281	<i>Dichaea globosa</i>	Costa Rica	<i>Pupulin 4517</i>	05.09.2006
P0033	<i>Dichaea globosa</i>	Costa Rica	<i>Pupulin 4517</i>	13.05.2005
P0163	<i>Dichaea globosa</i>	Costa Rica	<i>Klark 286</i>	07.07.2005

TABLE 1. Continued.

No.	Genus/species	Country	Collector	Date
P0027	<i>Dichaea morrisii</i>	Costa Rica	Whitten 2171	04.12.2003
P0284	<i>Dichaea obovatipetala</i>	Costa Rica	Pupulin 5059	05.09.2006
P0012	<i>Dichaea obovatipetala</i>	Costa Rica	Pupulin 5059	13.01.2004
P0036	<i>Dichaea panamensis</i>	Costa Rica	Bogarín 1075	13.05.2005
P0035	<i>Dichaea panamensis</i>	Costa Rica	Karremans 621	13.05.2005
P0040	<i>Dichaea poicillantha</i>	Costa Rica	Bogarín 187	13.05.2005
P0039	<i>Dichaea poicillantha</i>	Costa Rica	Pupulin 4662	13.05.2005
P0406	<i>Dichaea poicillantha</i>	Nicaragua	Karremans 1140	19.07.2007
P0271	<i>Dichaea trulla</i>	Costa Rica	Pupulin 5130	29.08.2006
P0174	<i>Dichaea similis</i>	Costa Rica	Pupulin 5644	17.07.2005
P0041	<i>Dichaea similis</i>	Costa Rica	Pupulin 4089	13.05.2005
P0159	<i>Dichaea trulla</i>	Costa Rica	Blanco 2812	07.07.2005
P0221	<i>Dressleria dilecta</i>	Costa Rica	Pupulin 5156	09.05.2006
P0390	<i>Encyclia ambigua</i>	Mexico		07.03.2006
P0222	<i>Encyclia cordigera</i>	Costa Rica		12.05.2006
P0172	<i>Encyclia ceratistes</i>	Costa Rica	Pupulin 5520	17.07.2005
P0025	<i>Epidendrum</i>	Costa Rica		22.12.2005
P0043	<i>Epidendrum</i>	Costa Rica		22.12.2005
P0046	<i>Epidendrum</i>	Costa Rica	Pupulin 5570	22.12.2005
P0132	<i>Epidendrum centradenia</i>	Costa Rica		09.06.2005
P0008	<i>Epidendrum odontochilum</i>	Costa Rica	Montealegre 114	22.12.2005
P0131	<i>Epidendrum schumannianum</i>	Costa Rica	Pupulin 4864	09.06.2005
P0130	<i>Epidendrum wallisii</i>	Costa Rica	Pupulin 3832	09.06.2005
P0127	<i>Epigeneium cymbidioides</i>	Philippines		09.06.2005
P0488	<i>Eriopsis wercklei</i>	Costa Rica		14.01.2008
P0489	<i>Eriopsis wercklei</i>	Costa Rica		14.01.2008
P0006	<i>Erycina crista-galli</i>	Costa Rica	Pupulin s.n.	25.02.2005
P0218	<i>Erythroxes tridax</i>	Costa Rica	Bogarín 993	03.05.2006
P0480	<i>Euryblema anatonum</i>	Panama		19.08.2007
P0307	<i>Euryblema andreae</i>	Colombia	Pupulin 6282	13.09.2006
P0299	<i>Euryblema andreae</i>	Colombia	Pupulin 6282	06.09.2006
P0166	<i>Eurychone rothschildiana</i>	Africa		07.07.2005
P0154	<i>Galeandra lacustris</i>	Ecuador		14.06.2005
P0419	<i>Galeottia grandiflora</i>	Costa Rica		19.07.2007
P0115	<i>Galeottia grandiflora</i>	Costa Rica	Whitten 2138	08.05.2004
P0060	<i>Galeottia grandiflora</i>	Costa Rica	Whitten 2058	13.05.2005
P0196	<i>Gastrochilus calceolaris</i>	Thailand		17.03.2006
P0195	<i>Gastrochilus formosanum</i>	Asia		17.03.2006
P0447	<i>Gongora</i>	Costa Rica	Blanco 2609	20.07.2007
P0219	<i>Gongora</i>	Costa Rica		03.05.2006
P0228	<i>Gongora</i>	Costa Rica		17.05.2006
P0461	<i>Gongora</i>	Costa Rica	Blanco 2598	20.07.2007
P0319	<i>Gongora</i>	Costa Rica	Gómez 60	29.09.2006
P0255	<i>Gongora</i>	Costa Rica	Rojas 111	21.06.2006
P0317	<i>Gongora</i>	Costa Rica		29.09.2006
P0312	<i>Gongora armeniaca</i>	Costa Rica	Pupulin 5214	29.09.2006
P0436	<i>Gongora armeniaca</i>	Costa Rica	Pupulin 5758	20.07.2007
P0442	<i>Gongora claviadora</i>	Costa Rica	Serrano 125	20.07.2007
P0227	<i>Gongora galeata</i>	Ecuador		17.05.2006
P0313	<i>Gongora galeata</i>	Mexico		29.09.2006
P0015	<i>Gongora leucochila</i>	Costa Rica		19.01.2004
P0226	<i>Gongora truncata</i>	Venezuela		17.05.2006
P0316	<i>Gongora unicolor</i>	Costa Rica		29.09.2006
P0311	<i>Gongora unicolor</i>	Costa Rica	Pupulin 4954	29.09.2006
P0229	<i>Govenia ciliilabia</i>	Costa Rica	Pupulin 6217	06.06.2006
P0332	<i>Grammatophyllum multiflorum</i>	Philippines		26.10.2006
P0017	<i>Grammatophyllum scriptum</i>	Philippines		12.05.2004
P0493	<i>Guarianthe skinneri</i>	Costa Rica		05.02.2008
P0014	<i>Haraella retrocalla</i>	Taiwan		30.10.2002
P0105	<i>Heterotaxis sessilis</i>	Costa Rica	Clark 209	19.05.2005
P0324	<i>Houlletia tigrina</i>	Costa Rica	Bogarín 2480	03.10.2006

TABLE 1. Continued.

No.	Genus/species	Country	Collector	Date
P0051	<i>Huntleya burtii</i>	Costa Rica		13.05.2005
P0402	<i>Huntleya burtii</i>	Costa Rica		19.07.2007
P0092	<i>Hygrochilus parishii</i>	Philippines		13.05.2005
P0200	<i>Kefersteinia</i>	Costa Rica	<i>Bogarín 806</i>	09.05.2006
P0197	<i>Kefersteinia andreettae</i>	Ecuador		02.05.2006
P0395	<i>Kefersteinia auriculata</i>	Panama	<i>Dressler 6831</i>	12.03.2006
P0417	<i>Kefersteinia costaricensis</i>	Costa Rica	<i>Bogarín 761</i>	19.07.2007
P0056	<i>Kefersteinia costaricensis</i>	Costa Rica	<i>Pupulin 5029</i>	13.05.2005
P0052	<i>Kefersteinia excentrica</i>	Costa Rica	<i>Blanco 1053</i>	13.05.2005
P0426	<i>Kefersteinia laminata</i>	Ecuador	<i>Pupulin 6551</i>	19.07.2007
P0385	<i>Kefersteinia orbicularis</i>	Costa Rica	<i>Holst 8773</i>	07.03.2006
P0155	<i>Kefersteinia orbicularis</i>	Costa Rica	<i>Pupulin s.n.</i>	13.05.2005
P0057	<i>Kefersteinia orbicularis</i>	Costa Rica	<i>Pupulin s.n.</i>	13.05.2005
P0055	<i>Kefersteinia parvilabris</i>	Costa Rica	<i>Bogarín 143</i>	13.05.2005
P0198	<i>Kefersteinia pellita</i>	Ecuador	<i>Pupulin 5998</i>	02.05.2006
P0231	<i>Kefersteinia retanae</i>	Costa Rica	<i>Cambronero s.n.</i>	06.06.2006
P0427	<i>Kefersteinia taurina</i>	Ecuador	<i>Pupulin 6550</i>	19.07.2007
P0193	<i>Kefersteinia taurina</i>	Ecuador	<i>Pupulin 5892</i>	17.03.2006
P0004	<i>Kefersteinia tolimensis</i>	Colombia	<i>Pupulin 4205</i>	30.10.2002
P0420	<i>Kefersteinia tolimensis</i>	Colombia	<i>Pupulin 4205</i>	19.07.2007
P0054	<i>Kefersteinia tolimensis</i>	Colombia	<i>Pupulin 4205</i>	13.05.2005
P0053	<i>Kefersteinia wercklei</i>	Costa Rica	<i>Pupulin 3039</i>	13.05.2005
P0441	<i>Koellensteinia graminea</i>	Ecuador	<i>Pupulin 6517</i>	20.07.2007
P0165	<i>Leochilus tricuspidatus</i>	Costa Rica	<i>Pupulin 5648</i>	07.07.2005
P0128	<i>Leucohyle subulata</i>	Nicaragua	<i>Pupulin 4301</i>	09.06.2005
P0090	<i>Lockhartia amoena</i>	Costa Rica	<i>Pupulin 4515</i>	13.05.2005
P0091	<i>Lockhartia pittieri</i>	Costa Rica	<i>Blanco 2653</i>	13.05.2005
P0184	<i>Lycaste</i>	Costa Rica		22.12.2005
P0187	<i>Lycaste</i>	Costa Rica		29.12.2005
P0217	<i>Lycaste</i>	Costa Rica		03.05.2006
P0393	<i>Lycaste</i>	Costa Rica		07.03.2006
P0454	<i>Lycaste</i>	Costa Rica		20.07.2007
P0462	<i>Lycaste</i>	Costa Rica	<i>Pupulin 2780</i>	20.07.2007
P0444	<i>Lycaste deppei</i>	México- Nicaragua		20.07.2007
P0230	<i>Lycaste deppei</i>	México- Nicaragua		06.06.2006
P0460	<i>Lycaste leucantha</i>	Costa Rica		20.07.2007
P0437	<i>Lycaste leucantha</i>	Costa Rica	<i>Bogarín 2070</i>	20.07.2007
P0024	<i>Lycaste leucantha</i>	Costa Rica		03.10.2002
P0334	<i>Lycaste x Michellii</i>			26.10.2006
P0476	<i>Lycaste schilleriana</i>	Panama		19.08.2007
P0201	<i>Lycaste tricolor</i>	Costa Rica		09.05.2006
P0383	<i>Lycaste tricolor</i>	Costa Rica		07.03.2006
P0391	<i>Masdevallia reichenbachiana</i>	Costa Rica	<i>Vega s.n.</i>	07.03.2006
P0129	<i>Maxillaria</i>	Costa Rica		22.12.2005
P0180	<i>Maxillaria</i>	Costa Rica		22.12.2005
P0357	<i>Maxillaria</i>	Costa Rica		14.11.2006
P0361	<i>Maxillaria</i>	Costa Rica		14.11.2006
P0364	<i>Maxillaria</i>	Costa Rica	<i>Blanco 2808</i>	14.11.2006
P0235	<i>Maxillaria</i>	Costa Rica	<i>Blanco 2808</i>	06.06.2006
P0178	<i>Maxillaria</i>	Costa Rica	<i>Gómez 40</i>	22.12.2005
P0240	<i>Maxillaria</i>	Costa Rica	<i>Pupulin 3023</i>	13.06.2006
P0028	<i>Maxillaria</i>	Costa Rica	<i>Whitten 2045</i>	05.05.2006
P0107	<i>Maxillaria acostae</i>	Costa Rica	<i>Blanco 941</i>	19.05.2005
P0103	<i>Maxillaria alba</i>	Costa Rica	<i>Pupulin 2850</i>	19.05.2005
P0101	<i>Maxillaria angustissima</i>	Costa Rica		19.05.2005
P0167	<i>Maxillaria arachnitiflora</i>	Costa Rica	<i>Bogarín 344</i>	22.12.2005
P0262	<i>Maxillaria arachnitiflora</i>	Costa Rica	<i>Blanco 2262</i>	30.06.2006
P0095	<i>Maxillaria atwoodiana</i>	Costa Rica		18.05.2005
P0234	<i>Maxillaria atwoodiana</i>	Costa Rica		06.06.2006
P0104	<i>Maxillaria brachybulbon</i>	Costa Rica	<i>Bogarín 874</i>	19.05.2005

TABLE 1. Continued.

No.	Genus/species	Country	Collector	Date
P0249	<i>Maxillaria brunnea</i>	Costa Rica	Whitten 2028	16.06.2006
P0189	<i>Maxillaria caespitifica</i>	Costa Rica	Blanco 1076	22.12.2005
P0268	<i>Maxillaria campanulata</i>	Costa Rica	Bogarín 1801	12.07.2006
P0179	<i>Maxillaria campanulata</i>	Costa Rica	Gómez 48	22.12.2005
P0259	<i>Maxillaria confusa</i>	Costa Rica	Bogarín 1324	30.06.2006
P0236	<i>Maxillaria confusa</i>	Costa Rica	Whitten 2030	06.06.2006
P0365	<i>Maxillaria confusa</i>	Costa Rica	Whitten 2030	14.11.2006
P0181	<i>Maxillaria endresii</i>	Costa Rica	Whitten 2089	22.12.2005
P0097	<i>Maxillaria endresii</i>	Costa Rica		18.05.2005
P0264	<i>Maxillaria haberi</i>	Costa Rica	Bogarín 1868	05.07.2006
P0093	<i>Maxillaria hedwigae</i>	Costa Rica	Pupulin 1859	18.05.2005
P0176	<i>Maxillaria inaudita</i>	Costa Rica	Gómez s.n.	22.12.2005
P0106	<i>Maxillaria lueri</i>	Costa Rica		19.05.2005
P0009	<i>Maxillaria luteoalba</i>	Colombia		06.11.2002
P0244	<i>Maxillaria meridensis</i>	Costa Rica	Gómez 19	13.06.2006
P0099	<i>Maxillaria moralesii</i>	Costa Rica		18.05.2005
P0248	<i>Maxillaria moralesii</i>	Costa Rica	Pupulin 4682	16.06.2006
P0102	<i>Maxillaria nasuta</i>	Costa Rica	Pupulin 3247	19.05.2005
P0108	<i>Maxillaria pseudoneglecta</i>	Costa Rica		19.05.2005
P0177	<i>Maxillaria punctostriata</i>	Costa Rica	Gómez 1	22.12.2005
P0094	<i>Maxillaria ramonensis</i>	Costa Rica		18.05.2005
P0242	<i>Maxillaria reichenheimiana</i>	Costa Rica	Blanco 2107	13.06.2006
P0096	<i>Maxillaria reichenheimiana</i>	Costa Rica		18.05.2005
P0010	<i>Maxillaria ringens</i>	Costa Rica		21.11.2002
P0366	<i>Maxillaria ringens</i>	Costa Rica	Gómez 24	14.11.2006
P0100	<i>Maxillaria ringens</i>	Costa Rica	Gómez 24	18.05.2005
P0098	<i>Maxillaria rodrigueziana</i>	Costa Rica		18.05.2005
P0232	<i>Maxillaria rodrigueziana</i>	Costa Rica		06.06.2006
P0239	<i>Maxillaria sanguinea</i>	Costa Rica		07.06.2006
P0109	<i>Maxillaria schlechteriana</i>	Costa Rica	Whitten 2181	19.05.2005
P0157	<i>Maxillaria scorpioidea</i>	Costa Rica		22.12.2005
P0321	<i>Maxillaria serrulata</i>	Costa Rica	Bogarín 1135	03.10.2006
P0241	<i>Maxillaria tonduzii</i>	Costa Rica	Blanco 3179	13.06.2006
P0243	<i>Maxillaria wercklei</i>	Costa Rica	Blanco 3179	13.06.2006
P0371	<i>Mesospinidium horichii</i>	Costa Rica	Pupulin 5357	25.01.2006
P0369	<i>Mesospinidium panamense</i>	Panama	Dressler s.n.	25.01.2006
P0370	<i>Mesospinidium warszewiczii</i>	Costa Rica		25.01.2006
P0470	<i>Micochilus bimentatus</i>	Costa Rica	Pupulin 6690	13.08.2007
P0074	<i>Miltonia regnellii</i>	Brazil		13.05.2005
P0080	<i>Miltoniopsis phalaenopsis</i>	Colombia		13.05.2005
P0078	<i>Miltoniopsis roezlii</i>	Colombia		13.05.2005
P0079	<i>Miltoniopsis vexillaria</i>	Colombia		13.05.2005
P0077	<i>Miltoniopsis warszewiczii</i>	Costa Rica		13.05.2005
P0382	<i>Mormodes colossa</i>	Costa Rica	Blanco 2691	07.03.2006
P0443	<i>Mormodes fractiflexa</i>	Costa Rica	Bogarín 2705	20.07.2007
P0223	<i>Mormodes horichii</i>	Costa Rica	Bogarín 2561	12.05.2006
P0023	<i>Mormodes atropurpurea</i>	Costa Rica		04.03.2005
P0190	<i>Mormodes colossa</i>	Costa Rica	Blanco 2192	22.12.2005
P0081	<i>Mormolyca ringens</i>	Costa Rica		13.05.2005
P0215	<i>Oncidium</i>	Costa Rica		03.05.2006
P0214	<i>Oncidium</i>	Costa Rica	Gómez 18	03.05.2006
P0034	<i>Oncidium coquianum</i>	Costa Rica	Pupulin 3438	19.04.2006
P0375	<i>Oncidium dichromaticum</i>	Costa Rica		28.02.2006
P0434	<i>Oncidium dichromaticum</i>	Costa Rica	Pupulin 2495	19.07.2007
P0373	<i>Oncidium ensatum</i>	Ecuador	Pupulin 6421	05.02.2006
P0372	<i>Oncidium fuscatum</i>	Nicaragua	Pupulin 6420	05.02.2006
P0374	<i>Oncidium hyphaematicum</i>	Nicaragua	Pupulin 6422	05.02.2006
P0432	<i>Oncidium hyphaematicum</i>	Nicaragua	Bogarín 3793	19.07.2007
P0431	<i>Oncidium kotzchianum</i>	Costa Rica	Pupulin 5455	19.07.2007
P0331	<i>Oncidium luteum</i>	Costa Rica	Pupulin 6197	26.10.2006
P0182	<i>Oncidium luteum</i>	Costa Rica	Whitten 2192	22.12.2005
P0113	<i>Oncidium oliganthum</i>	Guatemala	Pupulin 3378	24.05.2003

TABLE 1. Continued.

No.	Genus/species	Country	Collector	Date
P0111	<i>Oncidium parviflorum</i>	Costa Rica		24.05.2003
P0458	<i>Oncidium parviflorum</i>	Costa Rica	Bogarín 2468	20.07.2007
P0183	<i>Oncidium schroederianum</i>	Costa Rica		22.12.2005
P0440	<i>Oncidium schroederianum</i>	Costa Rica	Pupulin 6254	20.07.2007
P0418	<i>Oncidium sp.nov.</i>	Costa Rica	Karremans 1650	19.07.2007
P0333	<i>Oncidium stenobulbon</i>	Costa Rica	Bogarín 1065	26.10.2006
P0114	<i>Oncidium storkii</i>	Costa Rica		24.05.2003
P0250	<i>Osmoglossum egertonii</i>	Costa Rica		16.06.2006
P0266	<i>Otoglossum chiriquense</i>	Costa Rica	Pupulin 6235	12.07.2006
P0082	<i>Otoglossum globuliferum</i>	Costa Rica	Pupulin 5296	13.05.2005
P0273	<i>Paphinia subclausa</i>	Costa Rica	Dressler 6590	01.09.2006
P0455	<i>Paphinia subclausa</i>	Costa Rica	Dressler 6590	20.07.2007
P0161	<i>Paphinia subclausa</i>	Costa Rica	Pupulin 4665	07.07.2005
P0446	<i>Pescatorea cerina</i>	Costa Rica	Blanco 2642	20.07.2007
P0389	<i>Pescatorea cerina</i>	Costa Rica	Pupulin 2993	07.03.2006
P0068	<i>Pescatorea cerina</i>	Costa Rica	Pupulin 2097	17.07.2005
P0061	<i>Pescatorea cerina</i>	Costa Rica		13.05.2005
P0007	<i>Pescatorea cerina</i>	Costa Rica		06.08.2003
P0062	<i>Pescatorea dayana</i>	Colombia		13.05.2005
P0192	<i>Phalaenopsis amabilis</i>	Asia	Pupulin 5713	17.03.2006
P0002	<i>Phalaenopsis schilleriana</i>	Philippines		12.05.2004
P0173	<i>Phalaenopsis amabilis</i>	Indonesia	Pupulin 5713	17.07.2005
P0397	<i>Phalaenopsis lueddemanniana</i>	Philippines		28.03.2006
P0018	<i>Phalaenopsis violacea</i>	Malasya		22.10.2005
P0472	<i>Polycynis barbata</i>	Costa Rica	Bogarín 1898	19.08.2007
P0022	<i>Polycynis barbata</i>	Costa Rica		04.03.2005
P0265	<i>Polycynis barbata</i>	Costa Rica	Bogarín 1898	12.07.2006
P0314	<i>Polycynis barbata</i>	Costa Rica	Bogarín 1845	29.09.2006
P0063	<i>Prosthechea brassavolae</i>	Costa Rica		22.12.2005
P0392	<i>Prosthechea chacaoensis</i>	Costa Rica		07.03.2006
P0134	<i>Prosthechea neglecta</i>	Costa Rica		10.06.2005
P0162	<i>Prosthechea chacaoensis</i>	Costa Rica		07.07.2005
P0133	<i>Prosthechea vitellina</i>	Mexico		10.06.2005
P0116	<i>Rodriguezia venusta</i>	Ecuador	Pupulin 5281	08.06.2005
P0158	<i>Rodriguezia venusta</i>	Ecuador		16.05.2005
P0270	<i>Rossioglossum schlieperianum</i>	Costa Rica	Bogarín 2851	18.07.2006
P0083	<i>Rossioglossum schlieperianum</i>	Costa Rica		13.05.2005
P0112	<i>Rudolfiella aurantiaca</i>	Ecuador		24.05.2003
P0135	<i>Schomburgkia lueddemannii</i>	Costa Rica		13.06.2005
P0011	<i>Sedirea japonica</i>	Japan		12.05.2004
P0463	<i>Sievekingia fimbriata</i>	Costa Rica	Bogarín 2813	20.07.2007
P0445	<i>Sievekingia fimbriata</i>	Costa Rica		20.07.2007
P0136	<i>Sievekingia fimbriata</i>	Costa Rica		13.06.2005
P0209	<i>Sievekingia fimbriata</i>	Costa Rica		03.05.2006
P0433	<i>Sievekingia suavis</i>	Costa Rica	Bogarín 2575	19.07.2007
P0438	<i>Sigmatostalix cardioglossa</i>	Costa Rica	Pupulin 3499	20.07.2007
P0233	<i>Sigmatostalix dulcineae</i>	Costa Rica	Bogarín 2079	06.06.2006
P0356	<i>Sobralia</i>	Costa Rica	Aguilar 13	14.11.2006
P0338	<i>Sobralia</i>	Costa Rica	Bogarín 913	14.11.2006
P0306	<i>Sobralia</i>	Costa Rica	Dressler 6723	13.09.2006
P0337	<i>Sobralia</i>	Costa Rica	Dressler 6621	14.11.2006
P0363	<i>Sobralia</i>	Costa Rica	Karremans 661	14.11.2006
P0260	<i>Sobralia amabilis</i>	Costa Rica	Dressler 6713	30.06.2006
P0367	<i>Sobralia andreae</i>	Colombia		14.11.2006
P0251	<i>Sobralia helleri</i>	Costa Rica	Dressler 6539	21.06.2006
P0492	<i>Sobralia luteola</i>	Costa Rica	Pupulin 2629	05.02.2008
P0343	<i>Sobralia macra</i>	Costa Rica		14.11.2006
P0259	<i>Sobralia macrophylla</i>	Costa Rica	Castelfranco 155	30.06.2006
P0256	<i>Sobralia quinata</i>	Costa Rica	Pupulin 3664	30.06.2006
P0160	<i>Sobralia leucoxantha</i>	Costa Rica	Pupulin 4184	07.07.2005
P0448	<i>Stanhopea</i>	Costa Rica		20.07.2007
P0263	<i>Stanhopea</i>	Costa Rica		05.07.2006

TABLE 1. Continued.

No.	Genus/species	Country	Collector	Date
P0267	<i>Stanhopea</i>	Costa Rica		12.07.2006
P0294	<i>Stanhopea</i>	Costa Rica		05.09.2006
P0430	<i>Stanhopea</i>	Costa Rica		19.07.2007
P0452	<i>Stanhopea</i>	Costa Rica		20.07.2007
P0277	<i>Stanhopea</i>	Costa Rica	<i>Bogarín 1639</i>	01.09.2006
P0387	<i>Stanhopea</i>	Costa Rica	<i>Bogarín 757</i>	07.03.2006
P0276	<i>Stanhopea</i>	Costa Rica	<i>Pupulin 2960</i>	01.09.2006
P0291	<i>Stanhopea</i>	Costa Rica	<i>Pupulin 2960</i>	05.09.2006
P0280	<i>Stanhopea</i>	Costa Rica	<i>Rojas 112</i>	05.09.2006
P0285	<i>Stanhopea</i>	Ecuador	<i>Pupulin 6279</i>	05.09.2006
P0292	<i>Stanhopea</i>	Nicaragua	<i>Karremans 557</i>	05.09.2006
P0210	<i>Stanhopea</i>	Venezuela		03.05.2006
P0257	<i>Stanhopea</i>	Venezuela		30.06.2006
P0247	<i>Stanhopea cf. costaricensis</i>	Costa Rica		13.06.2006
P0290	<i>Stanhopea cirrhata</i>	Costa Rica	<i>Bogarín 1021</i>	05.09.2006
P0204	<i>Stanhopea cirrhata</i>	Costa Rica	<i>Bogarín 1021</i>	03.05.2006
P0203	<i>Stanhopea cirrhata</i>	Costa Rica	<i>Castelfranco 153</i>	03.05.2006
P0295	<i>Stanhopea cirrhata</i>	Costa Rica	<i>Pupulin 2843</i>	05.09.2006
P0315	<i>Stanhopea cirrhata</i>	Costa Rica	<i>Pupulin 5827</i>	29.09.2006
P0485	<i>Stanhopea confusa</i>	Costa Rica	<i>Flores s.n.</i>	02.10.2007
P0466	<i>Stanhopea costaricensis</i>	Costa Rica		20.07.2007
P0225	<i>Stanhopea costaricensis</i>	Costa Rica		16.05.2006
P0451	<i>Stanhopea costaricensis</i>	Costa Rica		20.07.2007
P0457	<i>Stanhopea costaricensis</i>	Costa Rica		20.07.2007
P0474	<i>Stanhopea costaricensis</i>	Costa Rica		19.08.2007
P0205	<i>Stanhopea costaricensis</i>	Costa Rica		03.05.2006
P0368	<i>Stanhopea costaricensis x cirrhata</i>	Costa Rica	<i>Rojas 113</i>	26.11.2006
P0254	<i>Stanhopea ecornuta</i>	Costa Rica	<i>Rojas 110</i>	21.06.2006
P0283	<i>Stanhopea ecornuta</i>	Costa Rica		05.09.2006
P0288	<i>Stanhopea ecornuta</i>	Costa Rica		05.09.2006
P0289	<i>Stanhopea ecornuta</i>	Costa Rica		05.09.2006
P0137	<i>Stanhopea ecornuta</i>	Costa Rica		13.06.2005
P0305	<i>Stanhopea ecornuta</i>	Costa Rica		13.09.2006
P0471	<i>Stanhopea ecornuta</i>	Costa Rica		19.08.2007
P0202	<i>Stanhopea x fowlieana</i>	Costa Rica		03.05.2006
P0253	<i>Stanhopea x fowlieana</i>	Costa Rica		21.06.2006
P0252	<i>Stanhopea gibbosa</i>	Costa Rica		21.06.2006
P0459	<i>Stanhopea gibbosa</i>	Costa Rica		20.07.2007
P0140	<i>Stanhopea gibbosa</i>	Costa Rica		13.06.2005
P0449	<i>Stanhopea grandiflora</i>			20.07.2007
P0330	<i>Stanhopea oculata</i>	Mexico	<i>Rojas 134</i>	26.10.2006
P0345	<i>Stanhopea oculata</i>	Mexico	<i>Rojas 135</i>	14.11.2006
P0353	<i>Stanhopea pulla</i>	Costa Rica	<i>Rojas 136</i>	14.11.2006
P0206	<i>Stanhopea pulla</i>	Costa Rica		03.05.2006
P0208	<i>Stanhopea pulla</i>	Costa Rica		03.05.2006
P0020	<i>Stanhopea pulla</i>	Costa Rica		21.06.2003
P0344	<i>Stanhopea wardii</i>	Costa Rica	<i>Bogarín 630</i>	14.11.2006
P0328	<i>Stanhopea wardii</i>	Costa Rica	<i>Dressler 6564</i>	17.10.2006
P0335	<i>Stanhopea wardii</i>	Costa Rica	<i>Gómez 51</i>	26.10.2006
P0296	<i>Stanhopea wardii</i>	Costa Rica	<i>Pupulin 4930</i>	05.09.2006
P0484	<i>Stanhopea wardii</i>	Costa Rica	<i>Pupulin 4390</i>	02.10.2007
P0016	<i>Stanhopea wardii</i>	Costa Rica	<i>Pupulin 1179</i>	20.07.2004
P0146	<i>Stanhopea wardii</i>	Costa Rica	<i>Pupulin 4930</i>	13.06.2005
P0147	<i>Stanhopea wardii</i>	Costa Rica	<i>Pupulin 1179</i>	13.06.2005
P0207	<i>Stanhopea wardii</i>	Costa Rica		03.05.2006
P0482	<i>Stanhopea wardii</i>	Costa Rica		28.09.2007
P0483	<i>Stanhopea wardii</i>	Costa Rica		28.09.2007
P0487	<i>Stanhopea wardii</i>	Costa Rica		25.10.2007
P0019	<i>Stanhopea wardii</i>	Costa Rica		05.08.2003
P0138	<i>Stanhopea wardii</i>	Costa Rica		13.06.2005
P0139	<i>Stanhopea wardii</i>	Costa Rica		13.06.2005
P0141	<i>Stanhopea wardii</i>	Costa Rica		13.06.2005
P0142	<i>Stanhopea wardii</i>	Costa Rica		13.06.2005

TABLE 1. Continued.

No.	Genus/species	Country	Collector	Date
P0144	<i>Stanhopea wardii</i>	Costa Rica		13.06.2005
P0145	<i>Stanhopea wardii</i>	Costa Rica		13.06.2005
P0293	<i>Stanhopea warscewicziana</i>	Costa Rica		05.09.2006
P0297	<i>Stanhopea warscewicziana</i>	Costa Rica		06.09.2006
P0304	<i>Stanhopea warscewicziana</i>	Costa Rica		13.09.2006
P0327	<i>Stanhopea warscewicziana</i>	Costa Rica		10.10.2006
P0143	<i>Stanhopea warscewicziana</i>	Costa Rica		13.06.2005
P0269	<i>Stenia</i>	Ecuador	<i>Pupulin 6239</i>	18.07.2006
P0348	<i>Stenia calceolaris</i>	Ecuador	<i>Pupulin 6332</i>	14.11.2006
P0350	<i>Stenia dodsoniana</i>	Ecuador	<i>Pupulin 6340</i>	14.11.2006
P0279	<i>Stenia guttata</i>	Ecuador	<i>Pupulin 5937</i>	05.09.2006
P0318	<i>Stenia pallida</i>	Ecuador	<i>Pupulin 6286</i>	29.09.2006
P0415	<i>Stenia pallida</i>	Ecuador		19.07.2007
P0191	<i>Stenia stenoides</i>	Ecuador	<i>Pupulin 5893</i>	17.03.2006
P0407	<i>Stenia stenoides</i>	Ecuador	<i>Pupulin 5893</i>	19.07.2007
P0199	<i>Stenotyla lankesteriana</i>	Costa Rica		02.05.2006
P0152	<i>Stenotyla lankesteriana</i>	Costa Rica		19.04.2006
P0066	<i>Stenotyla lendyana</i>	Guatemala	<i>Hubein s.n.</i>	13.05.2005
P0065	<i>Stenotyla lendyana</i>	Guatemala		13.05.2005
P0421	<i>Stenotyla lendyana</i>	Guatemala		19.07.2007
P0245	<i>Stenotyla panamensis</i>	Panama	<i>Pupulin 5868</i>	13.06.2006
P0477	<i>Stenotyla panamensis</i>	Panama	<i>Pupulin 5869</i>	19.08.2007
P0064	<i>Stenotyla picta</i>	Costa Rica	<i>Pupulin 3031</i>	13.05.2005
P0422	<i>Stenotyla picta</i>	Costa Rica		19.07.2007
P0423	<i>Stenotyla picta</i>	Costa Rica		19.07.2007
P0384	<i>Stenotyla picta</i>	Costa Rica	<i>Dressler s.n.</i>	07.03.2006
P0435	<i>Stenotyla picta</i>	Panama	<i>Bogarín 2960</i>	19.07.2007
P0298	<i>Telipogon biolleyi</i>	Costa Rica	<i>Karremans 1317</i>	06.09.2006
P0237	<i>Telipogon costaricensis</i>	Costa Rica	<i>Rojas 7148</i>	06.06.2006
P0238	<i>Telipogon monticola</i>	Costa Rica	<i>Rojas 7157</i>	06.06.2006
P0148	<i>Telipogon ampliflorus</i>	Costa Rica		13.06.2005
P0073	<i>Ticoglossum krameri</i>	Costa Rica		13.05.2005
P0070	<i>Ticoglossum oerstedii</i>	Costa Rica		13.05.2005
P0220	<i>Tolumnia triquetra</i>	Jamaica		03.05.2006
P0323	<i>Trevoria zalhbrukneriana</i>	Costa Rica	<i>Bogarín 1900</i>	03.10.2006
P0211	<i>Trevoria zalhbrukneriana</i>	Costa Rica	<i>Gómez 39</i>	03.05.2006
P0085	<i>Trichocentrum capistratum</i>	Costa Rica	<i>Pupulin 2075</i>	13.05.2005
P0084	<i>Trichocentrum cymbiglossum</i>	Costa Rica	<i>Pupulin 4754</i>	13.05.2005
P0377	<i>Trichocentrum pfavii</i>	Costa Rica	<i>Pupulin 5826</i>	05.03.2006
P0360	<i>Trichoglottis</i>	Philippines		14.11.2006
P0424	<i>Trichopilia</i>	Colombia	<i>Dressler 6807</i>	19.07.2007
P0349	<i>Trichopilia</i>	Colombia	<i>Pupulin 6333</i>	14.11.2006
P0490	<i>Trichopilia</i>	Costa Rica	<i>Pupulin 6418</i>	14.01.2008
P0399	<i>Trichopilia eneidae</i>	Panama		28.03.2006
P0491	<i>Trichopilia fragrans</i>	Colombia		14.01.2008
P0486	<i>Trichopilia fragrans</i>	Colombia	<i>Pupulin 6341</i>	25.10.2007
P0351	<i>Trichopilia aff. fragrans</i>	Colombia	<i>Pupulin 6341</i>	14.11.2006
P0169	<i>Trichopilia galeottiana</i>	Costa Rica	<i>Bogarín 145</i>	07.07.2005
P0400	<i>Trichopilia hennisiana</i>	Colombia		28.03.2006
P0151	<i>Trichopilia marginata</i>	Costa Rica		14.06.2005
P0076	<i>Trichopilia marginata</i>	Costa Rica	<i>Pupulin 4382</i>	13.05.2005
P0175	<i>Trichopilia marginata</i>	Costa Rica	<i>Pupulin 4433</i>	17.07.2005
P0309	<i>Trichopilia nobilis</i>	Colombia		20.09.2006
P0453	<i>Trichopilia olmosii</i>	Panama	<i>Bogarín 2948</i>	20.07.2007
P0075	<i>Trichopilia punicea</i>	Costa Rica	<i>Pupulin 5213</i>	13.05.2005
P0072	<i>Trichopilia punicea</i>	Costa Rica		13.05.2005
P0320	<i>Trichopilia turrialbae</i>	Costa Rica		03.10.2006
P0212	<i>Vanda coerulea</i>	Philippines		03.05.2006
P0213	<i>Vanda lamellata</i>	Philippines		03.05.2006
P0414	<i>Warszewiczella discolor</i>	Costa Rica		19.07.2007
P0059	<i>Warszewiczella discolor</i>	Costa Rica		13.05.2005
P0058	<i>Warszewiczella ionoleuca</i>	Ecuador	<i>Pupulin 5235</i>	13.05.2005
P0401	<i>Warszewiczella ionoleuca</i>	Ecuador	<i>Pupulin 5235</i>	19.07.2007

Browse

Layout: Layout 1

Record: 470


Total: 493

Unsorted

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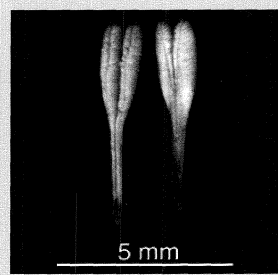
museo + UCR



The botanical databases by Jardín Botánico Lankester

POLLINARIA COLLECTION

SEARCH BACK TO RECORDS << PREVIOUS >> NEXT



RASTREO / SCAN

IDNUMBER	P0470	JBL-INVENT	JBL-s.n.	FAMILY	Orchidaceae
GENUS	<i>Microchilus</i>	SPECIES	<i>bimentatus</i>		
INFRAFRANK		INFRASP			
COUNTRY	Costa Rica.				
COLLDATE	30.07.2007.	COLLECTOR	F. Pupulin	COLLNUMBER	6690.
TAXONDET	Det. F. Pupulin, 8.2007.	DATADATE	13.08.2007.		
POLLMAT	JBL-PollColl.	HERBMAT		FAAMAT	JBL-Spirit.
		ILLUSTRMAT			

EPIDENDRA

Browse

Layout: Layout 1

Record: 492


Total: 493

Unsorted

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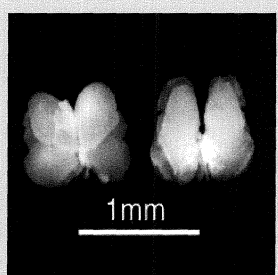
museo + UCR



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POLLINARIA COLLECTION

SEARCH BACK TO RECORDS << PREVIOUS >> NEXT



RASTREO / SCAN

IDNUMBER	P0492	JBL-INVENT	JBL-09442	FAMILY	Orchidaceae
GENUS	<i>Sobralia</i>	SPECIES	<i>luteola</i>		
INFRAFRANK		INFRASP			
COUNTRY	Costa Rica.				
COLLDATE	10.12.2000.	COLLECTOR	F. Pupulin	COLLNUMBER	2629.
TAXONDET	Det. R. L. Dressler, 03.2007.	DATADATE	05.2.2008.		
POLLMAT	JBL-PollColl.	HERBMAT		FAAMAT	
		ILLUSTRMAT	Foto.		

EPIDENDRA

FIGURE 4. Two pages from the pollinaria database at Lankester Botanical Garden.

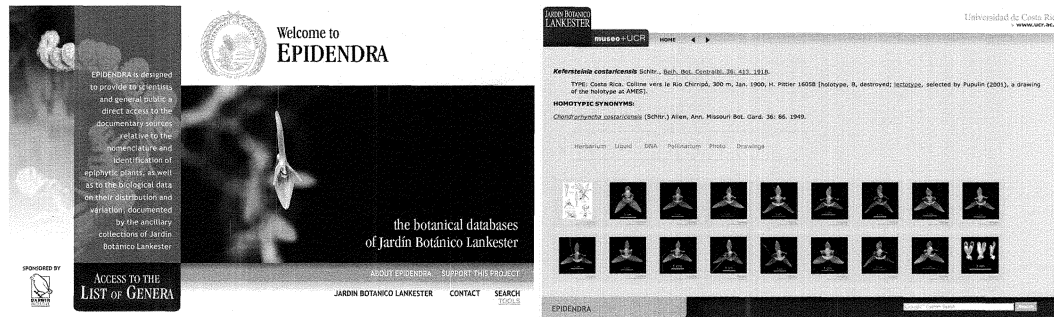


FIGURE 5. Two pages from "EPIDENDRA," the online taxonomic and nomenclatural database of Lankester Botanical Garden.

mize the damage to the viscidium or the caudicles. This is to permit the documentation of the pollinaria from as many views as possible. After removal, the pollinaria are scanned on a flatbed scanner (Epson Perfection 4490 Photo and Epson Perfection V200 Photo) at 2400 to 3200 dpi resolution, and saved as TIFF files including relative scales. Dorsal and ventral views are recorded (FIGURE 1), and a lateral view is included when feasible (FIGURE 2). The pollinaria are then stored in specifically designed white paper envelopes and kept in hermetic plastic boxes (FIGURE 3). The internal humidity of the boxes is controlled by means of silica gel envelopes. High-resolution digital images of the pollinaria (approx. 2 Mb) are permanently stored in external hard drives, while low-resolution images (approx. 170 Kb) are included as visual references in a database designed for that purpose (FileMaker Pro 9.0) (FIGURE 4). This includes locality and collecting data, as well as a cross-reference to the spirit-preserved vouchers from which pollinaria were removed. Copies of the entire database on CD may be sent on request to researchers and institutions, addressing the correspondence to the senior author. In order to improve public access to the information of the database, digital images of selected pollinaria from the collection are progressively displayed in the main taxonomic and nomenclatorial database of LBG, "EPIDENDRA," which will be available soon through the Internet (FIGURE 5).

The collection at LBG actually includes 496 pollinaria, belonging to 312 species in 94 genera (Table. 1). Although the collection also includes pollinaria of the subfamily Orchidoideae (subtribes Cranichidinae and Spiranthinae), the complex pollinaria of the Epidendroideae are the best represented. In this subfamily, we have representative species of the Sobralieae (13 pollinaria), Calypsoeae (1), Epidendreae (23), Cymbidieae (427), and Vandaeae (19) (TABLE 2). Par-

ticularly well represented are pollinaria from the more highly evolved Neotropical groups, where the pollinia are accompanied by distinct viscidia and stipes, with emphasis on the subtribes Oncidiinae (89 pollinaria), Maxillarinae (69), Stanhopeinae (110), and Zygopetalinae (149). Also present are pollinaria of Paletropical Epidendroideae, among which are species of Aeridinae (16), Angraecinae (2), Aerangidinae (1), and Dendrobiinae (3).

Works are in progress at LBG to use the large collections of pollinaria of the Zygopetalinae (FIGURE 6) to reconstruct phylogenetic tendencies in the organization of pollen and associate structures in this subtribe (Pupulin in prep.), and designed to use pollinaria morphology for species identification in the genus *Stanhopea* (FIGURE 7).

ACKNOWLEDGMENTS

We are indebted to all the colleagues at LBG who helped through the years documenting pollinaria for collection, and in particular to Diego Bogarín, Gustavo Rojas, Hilda León-Páez, Jaime Aguilar, and Emily Serrano. We thank Margherita Pupulin and Carlotta Pupulin, who devoted part of their summer holidays to substantially improve the collection. All the pollinaria included in the collection were removed from plants collected in the field or obtained through scientific interchange, thanks to scientific passports and the import permits issued by the Ministry of the Environment of Costa Rica (MINAE) and its National System of Protected Areas (SINAC). We sincerely acknowledge their continuous cooperation. The Orchid Pollinaria Collection at LBG is part of the general Collections of the University of Costa Rica, and its maintenance and management are supported by the University Collections Committee.



FIGURE 6. Representative pollinaria of the Zygotetralinae. 1–8: *Dichaea*. 1—*D. trulla* (Pupulin 5130); 2—*D. calyculata* (Pupulin 6923); 3—*D. globosa* (Pupulin 5319); 4—*D. globosa* (JBL-09172); 5—*Dichaea* sp. (Pupulin 6891); 6—*D. morrisii* (Whitten 2171); 7—*D. poicillantha* (Karremans 1140); 8—*D. obovatipetala* (JBL-08203). 9–13: *Daiotyia*. 9—*D. xanthina* (Pupulin 5891); 10,11—*D. albicans* (Pupulin 4372); 12,13—*D. crassa* (Pupulin 4257). 14–16: *Chondroscaphe*. 14—*C. amabilis* (Pupulin 6553); 15—*D. escobariana* (Pupulin 6289); 16—*D. flaveola* (Pupulin 6474). 17–27: *Kefersteinia*. 17—*K. costaricensis* (Bogarín 761); 18—*K. laminata* (Pupulin 6551); 19—*K. orbicularis* (Pupulin 2068); 20—*K. retanae* (JBL-01113);

←

(Continued) 21—*K. wercklei* (JBL-03465); 22—*K. excentrica* (Pupulin 5225); 23—*K. excentrica* (JBL-00469); 24—*K. parvilabris* (JBL-05186); 25—*K. tolimensis* (Pupulin 4205); 26—*K. mystacina* (Pupulin 6559); 27—*K. taurina* (Pupulin 6550). 28—32: *Benzingia*. 28—*B. reichenbachiana* (Bogarín 1890); 29, 30—*B. reichenbachiana* (JBL-07994); 31—*B. cornuta* (Pupulin 5879); 32—*B. caudata* (Pupulin 6544). 33: *Bensteinia ramonensis* (Bogarín 1923). 34: *Batemannia leferenzii* (Pupulin 6224). 35: *Zygopetalinae* gen. ined. (Pupulin 6605). 36—41: *Chaubardiella*. 36—*C. pubescens* (Pupulin 6240); 37—*C. aff. pubescens* (Pupulin 6566); 38—*C. subquadrata* (Pupulin 5716); 39, 40—*C. pacuarensis* (JBL-01117, JBL-05422); 41—*C. aff. subquadrata* (Pupulin 6564). 42—48: *Stenotyta*. 42, 43—*S. lankesteriana* (JBL-01651); 44, 45—*S. picta* (JBL-01970, JBL-01905); 46, 47—*S. lendyana* (JBL-02053, JBL-0896); 48—*S. panamensis* (Pupulin 5868). 49—56: *Stenia*. 49—*S. guttata* (Pupulin 6567); 50—*S. dodsoniana* (Pupulin 6340); 51—*S. stenioides* (Pupulin 5893); 52—*S. angustilabia* (Pupulin 6570); 53—*S. calceolaris* (Pupulin 6332); 54, 55—*S. pallida* (Pupulin 6286; Pupulin 6548); 56—*S. lillianae* (Pupulin 6557). 57—62: *Warczewiczella*. 57, 58—*W. discolor* (Pupulin 3939; JBL-04925); 59—*W. marginata* (Pupulin 6516); 60, 61—*W. ionoleuca* (Pupulin 5235; JBL-00873); 62—*W. palatina* (Pupulin 6909). 63—65: *Cochleanthes*. 63, 64—*C. aromatica* (JBL-02932; JBL-07583); 65—*C. flabelliformis* (Pupulin 6621). 66: *Zygosepalum lindeniae* (Pupulin 6643). 67: *Ixyophora viridisejala* (Pupulin 6554). 68: “*Chondrorhyncha*” *velastiguii* (Pupulin 6622). 69—72: *Pescatorea*. 69, 70, 71—*P. cerina* (JBL-09435; JBL-09430; JBL-06217); 72—*P. dayana* (JBL-03943). 73: *Zygosepalum intermedium* (Pupulin s.n.). 74: *Galeottia grandiflora* (JBL-14627). 75—78: *Huntleya*. 75, 76—*H. burtii* (JBL-14492; Pupulin 3829); 77—*H. citrina* (Pupulin 6645); 78—*H. lucida* (Pupulin 6642). 79—80: *Euryblema andreae* (Pupulin 6282). Scale bar = 5 mm.



FIGURE 7. Pollinaria of *Stanhopea* species. 1–16: *S. wardii*. 1—Dressler 6564; 2 - JBL-04360; 3 - JBL-06666; 4 - DB 630; 5 - JBL-07741; 6 - R. Gómez 51; 7 - JBL-06133; 8 - FP 1179; 9 - JBL-04363; 10 - FP 4390; 11 - JBL-09981; 12 - JBL-07743; 13 - FP 4930; 14 - JBL-06126; 15 - JBL-06151; 16 - FP 4930. 17–21: *S. warscewicziana*. 17 - JBL-14610; 18 - JBL-08955; 19 - JBL-06148; 20 - JBL-14605; 21 - JBL-07747. 22–28: *S. costaricensis*. 22 - JBL-05094; 23 - JBL-05659; 24 - JBL-07726; 25 - JBL-05094; 26 - JBL-05066; 27 - JBL-09988; 28 - JBL-05069. 29–35: *S. ecornuta*. 29 - JBL-09867; 30 - JBL-11353; 31 - JBL-12602; 32 - JBL-11696; 33 - JBL-06132; 34 - Rojas 110; 35 - JBL-11698. 36–39: *S. pulla*. 36 - JBL-05657; 37

TABLE 2. Pollinaria included in the collection, arranged systematically (phylogentic classification according to Chase et al. 2003). Numbers in brackets refer to the number of pollinaria for each species or morphospecies.

Orchidoideae
Cranichideae
Goodyerinae: <i>Erythrodes tridax</i> , <i>Microchilus bimentatus</i>
Spiranthinae: <i>Coccineorchis standleyi</i>
Epidendroideae
Sobralieae: <i>Sobralia amabilis</i> , <i>S. andreae</i> , <i>S. helleri</i> , <i>S. luteola</i> , <i>S. macra</i> , <i>S. macrophylla</i> , <i>S. quinata</i> , <i>S. leucoxantha</i> , <i>Sobralia</i> ssp. (5)
Calypsoeae: <i>Govenia ciliilabia</i>
Epidendreae
Pleurothallidinae: <i>Masdevallia reichenbachiana</i>
Laeliinae: <i>Arpophyllum giganteum</i> , <i>Barkeria lindleyana</i> , <i>Brassavola nodosa</i> , <i>Cattleya intermedia</i> , <i>Encyclia ambigua</i> , <i>E. cordigera</i> , <i>E. ceratistes</i> , <i>Epidendrum centradenia</i> , <i>E. odontochilum</i> , <i>E. schumannianum</i> , <i>E. wallisii</i> , <i>Epidendrum</i> spp. (3), <i>Guarianthe skinneri</i> , <i>Prosthechea brassavolae</i> , <i>P. chacaoensis</i> (2), <i>P. neglecta</i> , <i>P. vitellina</i> , <i>Schomburgkia lueddemannii</i>
Coeliinae [?]: <i>Coelia bella</i>
Cymbidiaceae
Catasetinae: <i>Catasetum maculatum</i> (3), <i>Cynoches amparoana</i> , <i>Cyrtopodium macrobulbon</i> , <i>Dressleria dilecta</i> , <i>Galeandra lacustris</i> , <i>Mormodes atropurpurea</i> , <i>M. colossa</i> (2), <i>M. fractiflexa</i> , <i>M. horichii</i>
Cymbidiinae: <i>Cymbidium iridioides</i> (2), <i>Grammatophyllum multiflorum</i> , <i>G. scriptum</i>
Eriopsidinae: <i>Eriopsis wercklei</i> (2)
Oncidiinae: <i>Ada aurantiaca</i> (2), <i>A. chlorops</i> , <i>Aspasia epidendroides</i> , <i>Brassia arcuigera</i> (6), <i>B. caudata</i> (4), <i>B. gireoudiana</i> (2), <i>B. suavissima</i> , <i>B. verrucosa</i> , <i>Comparettia falcata</i> , <i>Erycina cristagalli</i> , <i>Leochilus tricuspidatus</i> , <i>Lockhartia amoena</i> , <i>L. pittieri</i> , <i>Mesospinidium horichii</i> , <i>M. panamense</i> , <i>M. warszewiczii</i> , <i>Miltonia regnellii</i> , <i>Miltoniopsis phalaenopsis</i> , <i>M. roezlii</i> , <i>M. vexillaria</i> , <i>M. warszewiczii</i> , <i>Oncidium coquianum</i> , <i>O. dichromaticum</i> , <i>O. dichromaticum</i> , <i>O. ensatum</i> , <i>O. fuscatum</i> , <i>O. hyphaematicum</i> (2), <i>O. klotzchianum</i> , <i>O. luteum</i> (2), <i>O. oliganthum</i> , <i>O. parviflorum</i> (2), <i>O. parviflorum</i> , <i>O. schroederianum</i> (2), <i>O. stenobulbon</i> , <i>O. storkii</i> , <i>Oncidium</i> spp. (3), <i>Osmoglossum egertonii</i> , <i>Otoglossum chiriquense</i> , <i>O. globuliferum</i> , <i>Rodriguezia venusta</i> (2), <i>Rossioglossum schlieperianum</i> (2), <i>Sigmatostalix dulcinea</i> , <i>S. cardioglossa</i> , <i>Telipogon ampliflorum</i> , <i>T. biolleyi</i> , <i>T. costaricensis</i> , <i>T. monticola</i> , <i>Ticoglossum krameri</i> , <i>T. oerstedii</i> , <i>Tolumnia triquetra</i> , <i>Trichocentrum capistratum</i> , <i>T. cymbiglossum</i> , <i>T. pfavii</i> ,

TABLE 2. Continued.

<i>Trichopilia eneidae</i> , <i>T. fragrans</i> (2), <i>T. aff. fragrans</i> , <i>T. galeottiana</i> , <i>T. hennisiana</i> , <i>T. marginata</i> (3), <i>T. nobilis</i> , <i>T. olmosii</i> , <i>T. punicea</i> (2), <i>T. subulata</i> , <i>T. turrialbae</i> , <i>Trichopilia</i> spp. (3)
Maxillariinae: <i>Heterotaxis sessilis</i> , <i>Lycaste borucana</i> (2), <i>L. deppei</i> (2), <i>L. leucantha</i> (3), <i>L. michelii</i> (<i>lassioglossa</i> × <i>cochleata</i>), <i>L. schilleriana</i> , <i>L. tricolor</i> (2), <i>Lycaste</i> spp. (4), <i>Maxillaria acostae</i> , <i>M. alba</i> , <i>M. angustissima</i> , <i>M. arachnitiiflora</i> (2), <i>M. atwoodiana</i> (2), <i>M. brachybulbon</i> , <i>M. cf. brunnea</i> , <i>M. caespitifica</i> , <i>M. campanulata</i> (2), <i>M. confuse</i> (3), <i>M. endresii</i> (2), <i>M. haberi</i> , <i>M. hedwigae</i> , <i>M. inaudita</i> , <i>M. lueri</i> , <i>M. luteoalba</i> , <i>M. meridensis</i> , <i>M. moralesii</i> (2), <i>M. nasuta</i> , <i>M. pseudoneglecta</i> , <i>M. punctostriata</i> , <i>M. ramonensis</i> , <i>M. reichenheimiana</i> (2), <i>M. ringens</i> (3), <i>M. rodrigueziana</i> (2), <i>M. sanguinea</i> , <i>M. schlechteriana</i> , <i>M. scorpiodea</i> , <i>M. serulata</i> , <i>M. tonduzii</i> , <i>M. wercklei</i> , <i>Maxillaria</i> spp. (9), <i>Mormolyca ringens</i> , <i>Rudolfiella aurantiaca</i>
Stanhopeinae: <i>Acineta densa</i> (7), <i>Acineta</i> sp. (2), <i>Gongora armeniaca</i> (2), <i>G. claviodora</i> , <i>G. galeata</i> (2), <i>G. leucochila</i> (2), <i>G. truncata</i> , <i>G. unicolor</i> (2), <i>Gongora</i> spp. (6), <i>Houlletia tigrina</i> , <i>Paphinia subclausa</i> (3), <i>Polycicnis barbata</i> (4), <i>Stevekingia fimbriata</i> (3), <i>S. suavis</i> , <i>Stanhopea cirrhata</i> (5), <i>S. confusa</i> , <i>S. costaricensis</i> (6), <i>S. cf. costaricensis</i> , <i>S. costaricensis</i> × <i>cirrhata</i> , <i>S. ecornuta</i> (7), <i>S. gibbosa</i> (3), <i>S. grandiflora</i> , <i>S. oculata</i> (2), <i>S. pulla</i> (4), <i>S. wardii</i> (19), <i>S. warszewicziana</i> (5), <i>S. × fowllieana</i> (2), <i>Stanhopea</i> spp. (14), <i>Trevoria zalhbrukneriana</i> (2)
Coeliopsidinae: <i>Coeliopsis hyacinthosma</i> (2)
Zygopetalinae: <i>Batemanina leferenzii</i> , × <i>Bensteinia ramonensis</i> (2), <i>Benzingia caudata</i> , <i>B. cornuta</i> , <i>B. reichenbachiana</i> (2), <i>Chaubardia heteroclita</i> , <i>Chaubardiella pubescens</i> , <i>C. subquadrata</i> , <i>C. pacuarensis</i> (2), <i>Chondroryncha thienii</i> (2), <i>Chondroscaphe amabilis</i> , <i>C. atrilinguis</i> (2), <i>C. bicolor</i> (9), <i>C. aff. bicolor</i> (15), <i>C. endresii</i> (2), <i>C. eburnea</i> (2), <i>C. embreei</i> (2), <i>C. escobariana</i> , <i>C. flaveola</i> (3), <i>C. cf. laevis</i> (2), <i>C. yamilethiae</i> (5), <i>Cochleanthes aromatica</i> (2), <i>Daiotyla albicans</i> (2), <i>D. crassa</i> (3), <i>D. xanthina</i> , <i>Dichaea acrolephara</i> (3), <i>D. amparoana</i> , <i>D. cryptarrhena</i> , <i>D. elliptica</i> (3), <i>D. fragrantissima</i> subsp. <i>eburnea</i> (2), <i>D. globosa</i> (3), <i>D. morrisii</i> (2), <i>D. ovoidipetalata</i> (2), <i>D. panamensis</i> (2), <i>D. poicillantha</i> (3), <i>D. similis</i> , <i>D. cf. similis</i> , <i>D. trulla</i> (2), <i>Euryblema anatonum</i> , <i>E. andreae</i> (2), <i>Galeottia grandiflora</i> (3), <i>Huntleya burtii</i> (2), <i>Kefersteinia andreetae</i> , <i>K. auriculata</i> , <i>K. costaricensis</i> (2), <i>K. excentrica</i> , <i>K. laminata</i> , <i>K. orbicularis</i> (2), <i>K. parvilabris</i> , <i>K. pellita</i> , <i>K. retanae</i> , <i>K. taurina</i> (2), <i>K. tolimensis</i> (3), <i>K. wercklei</i> , <i>Kefersteinia</i> spp. (2), <i>Koellensteinia graminea</i> , <i>Pescatorea cerina</i> (5), <i>P. dayana</i> , <i>Stenia calceolaris</i> , <i>S. dodsoniana</i> , <i>S. guttata</i> , <i>Stenia pallida</i> (2), <i>Stenia stenoides</i> (2), <i>Stenotyla lankesteriana</i> (2), <i>S. len-</i>

←

(Continued) - JBL-06155; 38 - Rojas 136; 39 - JBL-07727. 40-44: *S. cirrhata*. 40 - DB 1021; 41 - DB 1021; 42 - FP 2843; 43 - FP 583; 44 - Castelfranco 153. 45-47: *S. gibbosa*. 45 - JBL-04956; 46 - JBL-07529; 47 - JBL-07529. 48 - *S. confusa* (JBL-09484). 49 - *S. grandiflora* (JBL-09988). 50, 51 - *S. oculata* (Rojas 134; Rojas 135). 52, 53 - *S. x fowlliana* (JBL-13031; JBL-13031). 54 - *S. costaricensis* × *cirrhata* (Rojas 113). 55-65: *Stanhopea* spp. 55 - JBL-05654; 56 - FP. 2960; 57 - JBL-09988; 58 - FP. 2960; 59 - AK 557; 60 - FP 6279; 61 - JBL-08970; 62 - JBL-12004; 63 - JBL-08970; 64 - DB 1639; 65 - Rojas 112. Scale bar = 5 mm.

TABLE 2. Continued.

dyana (3), *S. panamensis*, *S. picta* (5), *Warczewiczella discolor* (2), *W. ionoleuca* (2)

Vandaeae

Aeridinae: *Aerides falcata*, *A. multiflora*, *Asco centrum curvifolium*, *Gastrochilus calceolaris*, *G. formosanum*, *Haraella retrocalla*, *Hygrochilus parishii*, *Phalaenopsis amabilis* (2), *P. lueddemanniana*, *P. schilleriana*, *P. violacea*, *Sedirea japonica*, *Trichoglottis* sp., *Vanda coerulea*, *V. lamellata*

Angraecinae: *Angraecum eburneum*, *A. eichlerianum*

Aerangidinae: *Eurychone rothschildiana*

Unplaced subtribes within Epidendroideae

Dendrobinae: *Bulbophyllum lobbii*, *Dendrobium antennatum*, *Epigeneium cymbidioides*

LITERATURE CITED

- Atwood, J.T. 1986. The size of the Orchidaceae and the systematic distribution of epiphytic orchids. *Selbyana* 9: 171–186.
- Bogarín, D. 2007. A new *Lycaste* (Orchidaceae: Maxillariinae) from Costa Rica. *Lankesteriana* 7(3): 543–549.
- Borba, E.L. and J. Semir. 1999. Temporal variation in pollinarium size after its removal in species of *Bulbophyllum*: a different mechanism preventing self-pollination in Orchidaceae. *Plant Syst. Evol.* 217: 197–204.
- Chase, M.W. 1987. Systematic implications of pollinarium morphology in *Oncidium* Sw., *Odontoglossum* Kunth, and allied genera (Orchidaceae). *Lindleyana* 2: 8–28.
- Chase, M.W., K.M. Cameron, R.L. Barrett, and J.V. Freudenstein. 2003. DNA data and Orchidaceae systematics: a new phylogenetic classification. Pp. 69–89 in K.W. Dixon, S.P. Kell, R.L. Barrett, and P.J. Cribb, eds. *Orchid conservation. Natural History Publications, Kota Kinabalu, Sabah.*
- Cribb, P. and R. Govaerts. 2005. Just how many orchids are there? Pp. 161–172 in A. Raynal-Roques, A. Roguenant, and D. Prat, eds. *Proc. 18 World Orch. Conf. Naturalia Publ., Turriers, France.*
- Darwin, C. 1877. *The various contrivances by which orchids are fertilized by insects.* 2nd ed. John Murray, London.
- Dressler, R.L. 1968. Pollination by euglossine bees. *Evolution* 22: 202–210.
- . 1976. How to study orchid pollination without any orchids. Pp. 534–537 in K. Senghas, ed. *Proc. 8th World Orch. Conf. Deutsche Orchideen Gesellschaft, Frankfurt.*
- . 1981. *The Orchids: Natural History and Classification.* Harvard University Press, Cambridge, Mass.
- . 1986. Features of pollinaria and orchid classification. *Lindleyana* 1: 125–130.
- . 1993. *Phylogeny and Classification of the Orchid Family.* Timber Press, Portland.
- and W. Kikunas. 2006. A Sectional Classification of *Trichopilia* Lindley (Orchidaceae). *Selbyana* 27: 30–33.
- Freudenstein, J.V. and F.N. Rasmussen. 1997. Sessile pollinia and relationships in the Orchidaceae. *Pl. Syst. Evol.* 205:125–146.
- Johnson, S.D. and L.A. Nilsson. 1999. Pollen carry-over, geitonogamy and the evolution of deception in orchids. *Ecology* 80: 2607–2619.
- Johnson, S.D. and T.J. Edwards. 2000. The structure and function of orchid pollinaria. *Plant Syst. Evol.* 222: 243–269.
- Nilsson, L.A. 1980. The pollination ecology of *Dactylorhiza sambucina* (Orchidaceae). *Bot. Notiser* 133: 367–385.
- . 1983. Processes of isolation and introgressive interplay between *Platanthera bifolia* (L.) Rich. and *P. chlorantha* (Custer) Reichb. (Orchidaceae). *Bot. J. Linn. Soc.* 87: 325–350.
- Pupulin, F. 2007a. Contributions toward a reassessment of Costa Rican Zygopetalinae (Orchidaceae). A systematic revision of *Dichaea* in Costa Rica. *Harvard Pap. Bot.* 12(1): 15–154.
- . 2007b. Those violet things: the elusive *Dichaea* of Costa Rica, an overview of *Dichaea* phylogeny and classification. 14th EOCCE Proceedings. *Caesiana n.s.* 4: 37–49.
- . In press. The natural and taxonomic history of *Chondrorhyncha* (Orchidaceae—Zygopetalinae). *Proc. 19th World Orch. Conf. Miami.*
- Reichenbach, H.G. 1852. “De pollinis orchidearum generi ac structura et de orchideis in arte ac systema ridigendis” Ph.D. diss., Leipzig.
- Steiner, K.E. 1989. The pollination of *Disperis* (Orchidaceae) by oil-collecting bees in southern Africa. *Lindleyana* 4:164–183.
- Widmer, A., S. Cozzolino, G. Pellegrino, M. Soliva, and A. Dafni. 2000. Molecular analysis of orchid pollinaria and pollinaria remains found on insects. *Molec. Ecol.* 9: 1911–1914.
- Williams, N.H. 1970a. Some observations on pollinaria in the Oncidiinae. *Amer. Orch. Soc. Bull.* 39: 32–43.
- . 1970b. Some observations on pollinaria in the Oncidiinae—II. *Amer. Orch. Soc. Bull.* 39: 207–220.
- . 1972. Additional studies on pollinaria in the Oncidiinae. *Amer. Orch. Soc. Bull.* 41: 222–230.