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Supporting Online Material for

Asynchronous Diversification in a Specialized Plant-Pollinator Mutualism

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MATERIALS AND METHODS:

Pollinaria preservation and molecular procedures:

We collected a total of 193 pollinaria samples between 2002 and 2007 from 24 localities distributed across the neotropical region (Fig. S1). Male bees were baited with synthetic fragrance compounds (1,8-cineole, methyl salicylate, eugenol, methyl cinnamate, 1,4-dimethoxybenzene) and were immediately captured with hand nets. Upon capture, if present, pollinaria samples were removed from the pollinating bees, placed in vials with silica gel, and subsequently stored at -20°C to prevent DNA degradation. Approximately one third of the samples were obtained during previous expeditions and thus were not immediately preserved in silica gel, but instead were left attached to the pollinating bees, which were later pin-mounted and deposited in the entomological collections of the Museum of Comparative Zoology (Harvard University, MA, USA). The position of attachment of pollinaria samples was scored using eight discrete categories (Fig. 1, Table S3). Only samples recovered from male bees that had been previously identified to species were used. To identify pollinaria samples based on morphological characters, we took digital images (Figures S2-6) using a JVC digital camera (Ref. KYF75U, NJ, USA) mounted on a MZ16 Leica microscope (Leica IL, USA), which we further processed with the Auto-Montage software (*33*). Morphology based identifications are summarized in Table S4.

Molecular and phylogenetic methods for euglossine-pollinated orchids:

We extracted, amplified, and sequenced DNA from individual orchid pollinaria using standard molecular procedures. Genomic DNA was extracted from individual pollinaria using the Qiagen DNeasy Plant Extraction Kit (Qiagen Inc., Valencia, California). We carried out Polymerase

Chain Reactions (PCR) on a Bio-Rad DNA Engine Dyad® Peltier thermal cycler (Bio-Rad Laboratories Inc., Hercules, California). All reactions were prepared in 25 μL with 2.5 mmol/L $MgCl_2$, 2.5 mmol/L PCR buffer, and *Taq* polymerase (Qiagen Inc., Valencia, California) using the following *ITS* and *YCF1* primers sequences:

5’ACGAATTCATGGTCCGGTGAAGTGTTCG3’ (17SEF *ITS*)

5’TAGAATTCCCCGGTTCGCTCGCCGTTAC3’ (26SER *ITS*)

5'TACGTATGTAATGAACGAATGG3' (3720F *YCF1*)

5'GCTGTTATTGGCATCAAACCAATAGCG3' (5500R *YCF1*)

5'GATCTGGACCAATGCACATATT3' (IntF *YCF1*)

5'TTTGATTGGGATGATCCAAGG3' (IntR *YCF1*) (*34*)

We purified PCR products by incubating samples at 37° C for 35 minutes with the *Escherichia coli* enzyme exonuclease I (Fermentas, Glen Burnie, Maryland) and Antarctic phosphatase (New England Biolabs, Hanover, Maryland), and subsequently raised the temperature to 80° C for 20 minutes. We performed cycle-sequencing using *BigDye*™ *Terminator v3.1* Ready Reaction Cycle Sequencing Kit (Applied Biosystems Inc., Foster City, California). Samples were sequenced on an Applied Biosystems Inc. 3100 Genetic Analyzer (Applied Biosystems Inc., Foster City, CA) using forward and reverse strands. Complementary strands were assembled with the software package *SEQUENCER™ v4.2* (Gene Codes Corp. Ann Arbor, MI).

A DNA matrix was assembled for the nuclear ribosomal Internal Transcribed Spacer (*ITS*) and the protein-coding chloroplast gene *YCF1* loci. The matrix, which contained a total of 2690 base pairs, was assembled using *MACCLADE v4.06* (*35*). We implemented exploratory parsimony analyses in the software package *PAUP* v4.1b* (*36*) by assuming unordered transitions, weighting all characters equally, and treating gaps as missing characters. We performed heuristic tree searches with 100 random addition sequences, using the TBR swapping algorithm. In addition, we implemented Bayesian phylogenetic analyses in the software package *MRBAYES v3.1.1 (37)*. We performed 10 independent Markov Chain Monte Carlo (MCMC) tree searches for 20 million generations each, sampling every 2,000 generations, for a total of 10000 trees. We estimated model parameters during runs, and estimated Bayesian posterior probabilities as the proportion of trees sampled via 50% majority rule consensus; trees obtained in the first 1 million generations were discarded as "burnin". Convergence among searches was visually inspected by plotting tree likelihood values against the number of generations. Models of sequence of evolution (GTR + Γ) were determined with the software package *MRMODELTEST2 v.2.3*, and applied to tree searches based on both single and codon-partitioned schemes. We used likelihood-based ancestral reconstruction methods to infer pollination modes of orchid and bee nodes using the software package *MESQUITE v 2.74* (*38*). Transition probabilities were set equal among states, and the reconstructions were performed over a random selection of 100 trees of those obtained via Bayesian tree searches (as indicated above). For each node, we report the proportion of trees in which euglossine-pollination and fragrance collection was inferred.

Molecular clock analysis of euglossine-pollinated orchids:

We performed molecular clock analyses of euglossine-pollinated orchids using both Bayesian Relaxed Molecular Clock (BRMC) and Bayesian Strict Molecular Clock (BSMC) methods (*39*). Unlike BSMC, BRMC does not assume autocorrelation between parent and descendant branches, and thus relies on the more realistic assumption of substitution rate heterogeneity across lineages. We based our molecular clock calibration on the recent discovery (*40, 41*) and analysis (*40, 42*) of three unambiguous fossil orchids that have been analyzed phylogenetically (*Dendrobium*, *Earina* and *Meliorchis*). Cladistic analyses applied to *Meliorchis* and representative neotropical orchid genera assigned this fossil to the subtribe Goodyerinae, in the subfamily Orchidiodeae, which is a sister subfamily of Epidendroideae. Likewise, the raised stomatal subsidiary cells exhibited by the fossilized leaves of fossil *Earina* and the characteristic papilla-like glands and guard cells of *Dendrobium* supported the assignment of these two fossils to their respective extant genera (*41*), both of which are placed in the subfamily Epidendroideae. All orchid lineages exhibiting male-euglossine pollination belong to the subfamily Epidendroideae (subtribe Cymbidieae).

Several recent studies have used these fossils as calibrations points to estimate node ages across the phylogeny of Orchidaceae (*40, 42-44*). We calibrated our molecular clock analyses with the well-supported age of 39 million years for the split between lower and higher Epidendroideae (Figs. S8-9). We used a Laplace prior with a scaling factor of 2 to constrain the age of this node. This prior choice reflects the standard deviation and age ranges that were previously proposed for this node. For both BRCM and BSCM methods, we simultaneously estimated divergence times and phylogenetic relationships as implemented in the software package *BEAST v1.6.1 (39).* For the BRCM method, we specified a lognormal prior for the distribution from which substitution rates were drawn for each branch independently. We used a single model of sequence evolution (GTR + Γ) for both the *ITS* and *YCF1* markers, and allowed rate parameters to be unlinked. We conducted 10 independent MCMC searches each consisting of 50-80 million generations, with convergence monitored with the software *TRACER v.1.5*. The number of generations and the sampling schemes were calibrated to achieve Effective Sample Sizes (ESS) values greater than 200 for all parameters, including posterior, likelihood, and age estimates of the most recent common ancestors of interest. We summarized trees with the software package *TREE ANNOTATOR v.1.6.1*, and produced summary statistics of ages with basic packages in the *R* environment.

Molecular and phylogenetic methods for euglossine bees:

We sampled the entire tribe Euglossini, including all five genera, all eight subgenera, 25 of the 26 species groups, and a total of 126 of the ~200 species. Most specimens were collected between 2002 and 2006 from 12 neotropical countries. DNA extraction and sequencing was conducted as described in Ramírez et al. 2010 (*45*). We sequenced a total of ~4.0 kb from four different loci, including the mitochondrial protein-coding gene cytochrome oxidase (*CO1*, 1.2 kb) and the nuclear protein-coding genes elongation factor 1-alpha (*EF1-α*, F2 copy, ~1.2 kb), arginine kinase (*ArgK*, ~0.7 kb), and RNA polymerase II (*Pol-II,* 0.8 kb).

We assembled a DNA matrix containing all four loci using the software package *MACCLADE v4.06*, and implemented exploratory parsimony analyses in the software package *PAUP* v4.1b* by assuming unordered transitions and weighting all characters equally. We implemented Bayesian phylogenetic analyses in the software package *MRBAYES v3.1.1.* Tree searches were performed assuming both single and multiple models of sequence evolution for each locus, and MCMC searches were made for 50 million generations, sampling every 5,000 generations, for a total of 10,000 trees. We estimated model parameters during runs, and estimated Bayesian posterior probabilities as the proportion of trees sampled; the trees obtained in the first 1 million generations were discarded. Tree searches were conducted using a codon-specific model sequence evolution. Models of sequence of evolution were determined with the software package *MRMODELTEST2 v.2.3* and applied to tree searches based on both single and codon-partitioned schemes.

Molecular clock analysis of euglossine bees:

We estimated absolute divergence times using the same methodology we used for euglossine-pollinated Orchidaceae (see above). Several bee specimens are known from Miocene Dominican amber deposits, and several corbiculate bees are known from amber and shale deposits elsewhere. The amber-preserved orchid bee *Euglossa moronei* (*46*) (15-20 My) from Dominican deposits, has synapomorphic characters that place it unambiguously within extant lineages of *Euglossa*. The giant honey bee *Apis lithohermaea* from Pliocene-Pleistocene (14-16 My old) olivine basalts of Japan is placed within extant lineages of giant honey bees (*47*). Lastly, the stingless bee *Proplebeia dominicana* from Miocene (15-20 Myr old) lignite, sandy clay beds of Dominican amber deposits is placed within extant neotropical stingless bees (*48*). Several recent studies have used these fossils as calibration points to estimate divergence times among corbiculate bees (*45, 49, 50*). These molecular clock studies converge on an estimated age for the most recent common ancestor of the genus *Euglossa* of ~20 million years. Thus, we used a Laplace prior with a scaling factor of 1.5 to constrain the age of this node. This prior choice reflects the range of ages previously proposed for this node (17-21 My). For both BRCM and BSCM methods, we simultaneously estimated divergence times and phylogenetic relationships as implemented in the software package *BEAST v1.6.1 (39).* For BRCM, we specified a lognormal distribution as the prior distribution from which substitution rates were drawn independently for each branch in the phylogeny. We used a single model of sequence evolution (GTR + Γ) for all gene fragments, where rate parameters were allowed to be unlinked. We conducted 10 independent MCMC searches, each consisting of 50-80 million generations, with convergence monitored with the software *TRACER v.1.5*. The number of generations and the sampling schemes were calibrated to achieve ESS values equal or greater than 200 for all parameters (*e.g.* posterior, likelihood, and age estimates). We summarized trees with the software package *TREE ANNOTATOR v.1.6.1* and produced summary statistics using *R* packages.

Analysis of diversification in euglossine bees and euglossine-pollinated orchids:

We examined the diversification patterns of bees and orchids based on molecular clock chronograms obtained via Bayesian Relaxed Clock Methods (BRCM) only. Lineage-through-time (LTT) plots were estimated for in-group taxa to investigate whether and when bee and/or orchid lineages experienced significant departures from a constant diversification rate. Diversification statistics, like the γ-statistic of Pybus and Harvey (*51*) and the survival-based models of Paradis (*52*), can be used to test whether and how LTT plots deviate from a constant diversification rate. Because the γ-statistic can be biased due to incomplete lineage sampling, we adjusted the null distribution to account for missing taxa. We use the software package *TREESIM* to simulate 1000 trees using pure-birth parameters (speciation λ= 2; extinction μ = 0). Using the same software, we simulated incomplete sampling for each tree by randomly pruning taxa to match the actual number of species that we sampled from the total estimated diversity in each clade (Table S2). These simulated trees were then used to obtain a null distribution of the γ-statistic. Simulated trees under pure-birth should have a mean γ-statistic equal to zero, but those with incomplete sampling should have a mean value less than zero, depending on the fraction of missing taxa. The adjusted critical values (below and above 5% and 95% confidence intervals, respectively) for the γ-statistic in each lineage are presented in Table S1. To calculate the empirical values for the γ-statistic in each lineage, we used a random subsample of 100 trees from the 10,000 posterior trees obtained in the *BEAST* analyses. Because the euglossine-pollinated orchids are paraphyletic, each monophyletic lineage corresponding to a subtribe was analyzed independently. We implemented likelihood-based statistical tests available in the software packages *APE v2.6-2 (53)* and *GEIGER v1.3.1* (*54*).

The γ-statistic of constant diversification for euglossine bees indicates that lineage accumulation in this group decreased towards the recent, but a constant model of diversification cannot be rejected. A model of constant diversification (Model A) had a log-likelihood = -394.358 (AIC = 790.716; δ = 0.127). A model where diversification constantly increased or decreased following the Weibull law (Model B) had a log-likelihood = -388.23 (AIC = 780.46, α= 0.117, β= 1.26). A model in which diversification abruptly changed with a breakpoint (Model C) 5.75 million years ago, had a log-likelihood = -392.285 (AIC = 788.57; $\delta 1$ = 0.108, $\delta 2$ = 0.155). Likelihood ratio tests among these alternative models favored a model of diversification following a Weibull law (model B) (χ^2 = 12.255, df = 1, p = 5×10^{-4}). Because the parameter β for Model B is greater than 1, this model suggests a modest decrease in net diversification towards the recent. Table S1 summarizes these parameters and statistics.

The γ-statistic of constant diversification for all three lineages of euglossine-pollinated orchids suggests that there is a higher accumulation of branching times towards the recent (Fig. 2A; Table S1). On the other hand, the likelihood-based survival models carried out to detect diversification rate shifts indicate that a constant rate of lineage accumulation could not be rejected in Catasetinae, Stanhopeinae and Zygopetalinae (Table S2). This discrepancy is explained by the fact that our γ-statistic critical values were corrected for incomplete lineage sampling, whereas this was not the case for the likelihood model fitting.

Bipartite network analyses:

To investigate the patterns of plant-pollinator association between euglossine bees and their orchid hosts, we generated bipartite network plots and the corresponding phylogenetic trees using the *cophylo* function from the *R* software package *APE v2.6-2* (*53*). Character mapping and co-extinction analyses were conducted as described by Rezende *et al.* 2007 (*55*). Network plots and phylogenetic statistical analyses were carried out using the *R* software packages *BIPARTITE v1.14 (56, 57)*, and *PICANTE v1.20* (*58*).

We simulated co-extinction cascades by removing either pollinator (or orchid) species and observing which orchid (or pollinator) species remained left as a result. We carried out this procedure for three versions of the network from Figure 1, where orchid species were delimited based on a 1%, 3% and 5% sequence divergence cutoff (Fig. S13). Orchid sequence divergences were estimated using the *dist.dna* function in the software package *APE.* In the co-extinction cascade analysis, a given orchid (or bee) species was considered extinct upon loss of all their pollinators (or hosts). We repeated this procedure 100 times for each partner on each network; we report the average survival as a function of the percentage of complementary lineages that were removed.

In addition to the network mentioned above, we conducted co-extinction cascades analyses using a larger data set of bee-orchid associations derived from the literature, museum collections, and field notes (*31*). This data set consisted of 583 bee-orchid associations (Fig. S13); and only bee and orchid taxa that were identified to the species level were included. This dataset only included orchids in the tribe Cymbidieae, but included other subtribes in addition to Catasetinae, Stanhopeinae, and Zygopetalinae (*e.g.* Oncidiinae)

Chemical analysis of bee perfumes, orchid scents, and non-orchid scent sources:

We assembled and compared three data matrices containing chemical data, including volatile compounds 1) produced by flowers of 64 species of euglossine-pollinated Orchidaceae 2) produced by 34 species of non-orchid scent sources (both floral and non-floral), and 3) collected and stored by 23 species of euglossine bees. These data sets were derived both from literature sources (see Table S5) and our own chemical analyses using GC-MS techniques (see below). We filtered these data sets to exclude minor (trace) compounds (<1% total integrated area).

A large set of volatile compounds produced by orchid and non-orchid sources were derived from the literature (Table S5). An additional subset of samples were obtained in collaboration with Roman Kaiser (Givaudan) using the methodologies and instruments indicated in Kaiser 1993 (*59*). The bee chemical data set consisted of 23 species in the genus *Euglossa*, *Eulaema, Eufriesea*, and *Exaerete* (Table S6). Male perfumes were extracted from hind legs in 0.5 ml hexane. The extracts were subsequently injected in one of two Gas Chromatography/Mass Spectrometry (GC/MS) instruments. One instrument (HP 5890 II) is housed at the University of Bochum, Germany, and it was fitted with a DB-5 column (30 m x 0.25 mm Ø x 0.25 μm film thickness) and a HP 5972 MSD. The other GC/MS instrument (7890A Agilent) is housed at the University of California Berkeley, and it was coupled with a 5975C Agilent Mass Selective Detector (Agilent Technologies, Santa Clara, CA, USA). The GC was fitted with a non-polar Agilent HP-5MS 0.25 mm Ø x 0.25 μm film thickness capillary column (cat. # 19091S-433). In all cases injection was splitless, the oven programmed from 60 to 300°C at 10°C/min. We carried out structure assignment of individual compounds by comparing the mass spectra and retention indices with those of authentic reference samples or those available in the literature (*60*). We excluded straight chain lipids (alkanes, alkenes, alcohols, acetates, diacetates, and wax esters) from the analysis since these compounds are produced by the bees themselves (*61*).

SUPPLEMENTARY FIGURES:

Figure S1. Sites where euglossine bee and orchid pollinaria were collected using chemical baits between 2002 and 2007.

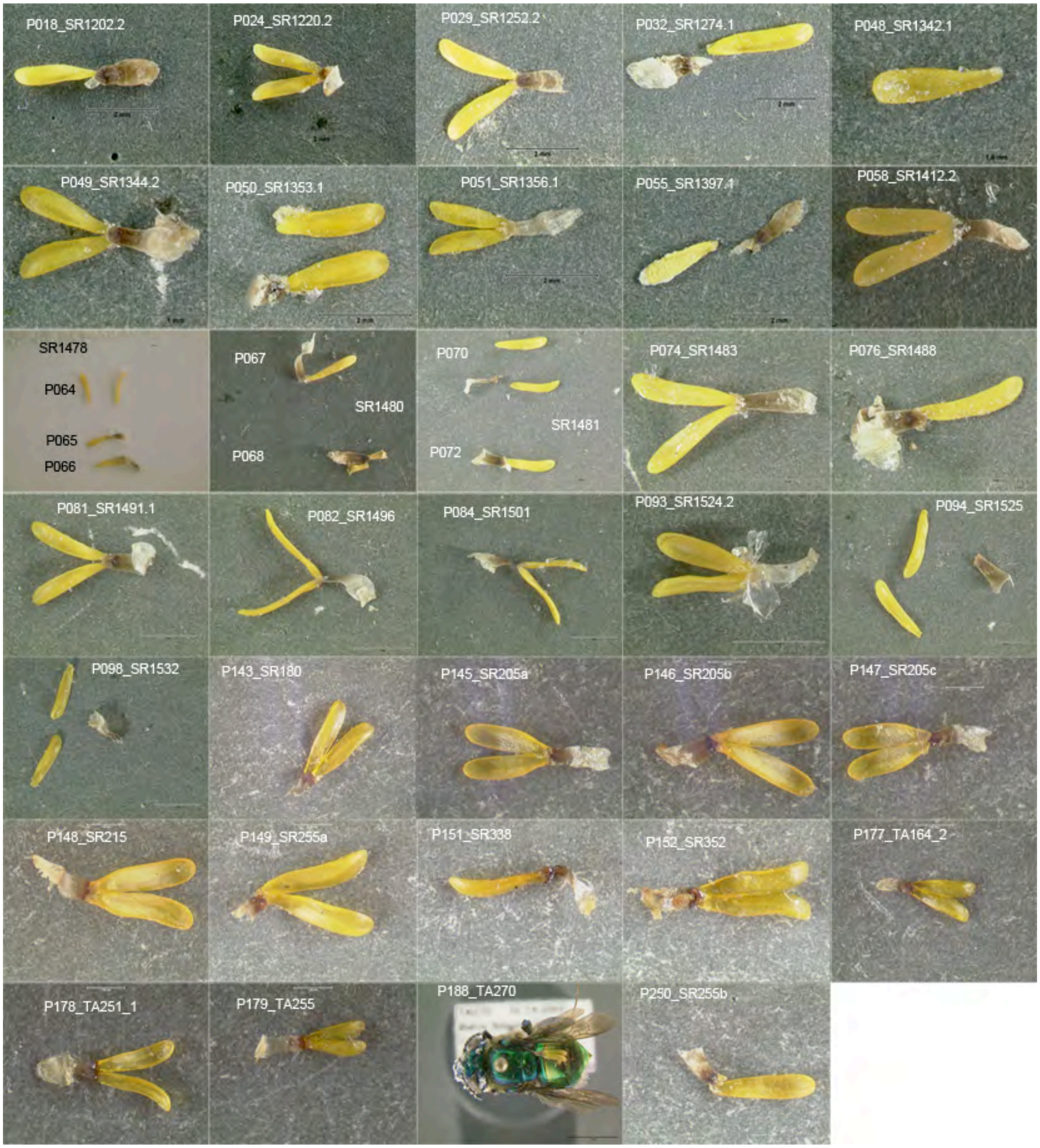

Figure S2. Pollinaria samples belonging to the orchid genus *Gongora*.

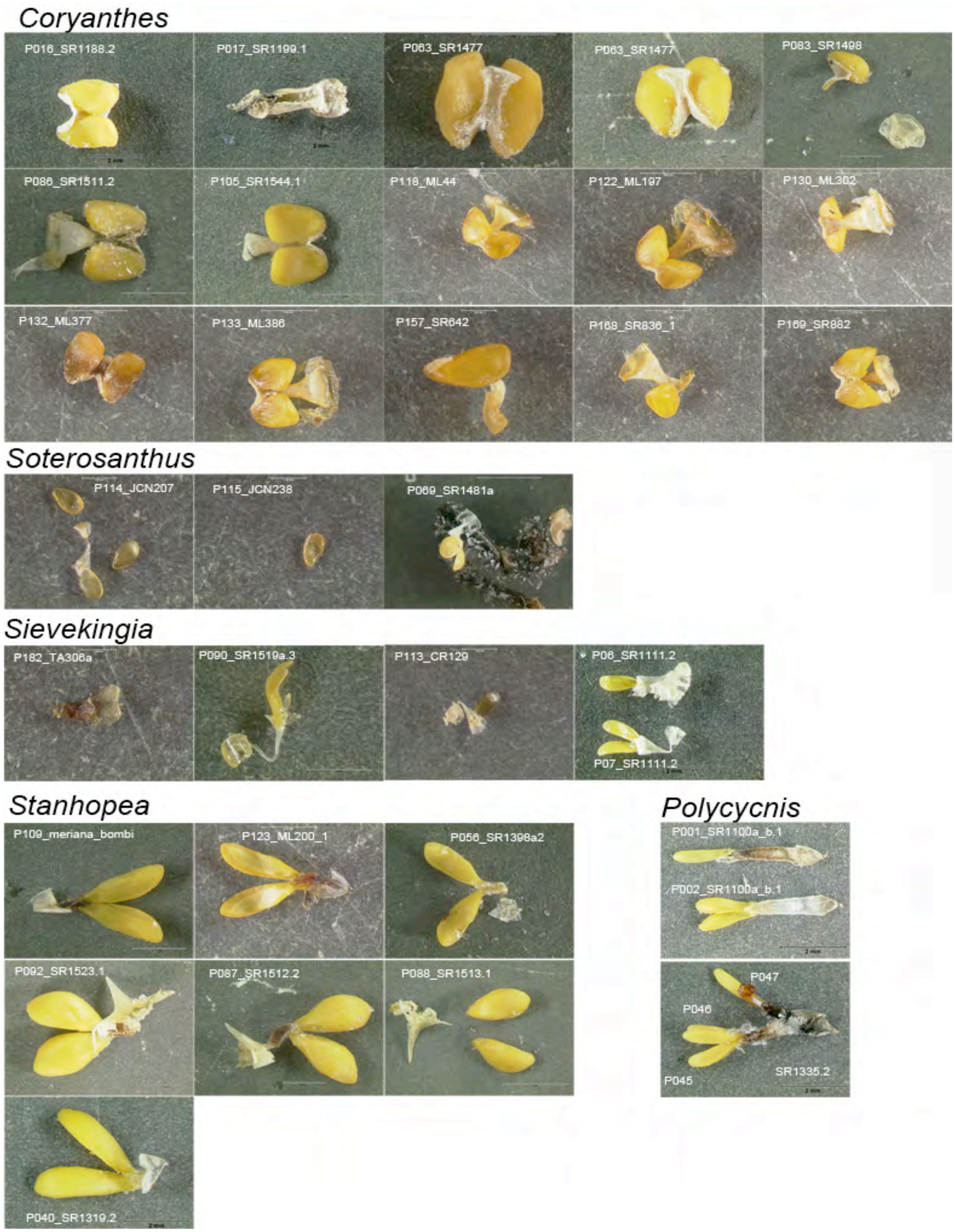

Figure S3. Pollinaria samples belonging to orchid genera in subtribe Stanhopeinae.

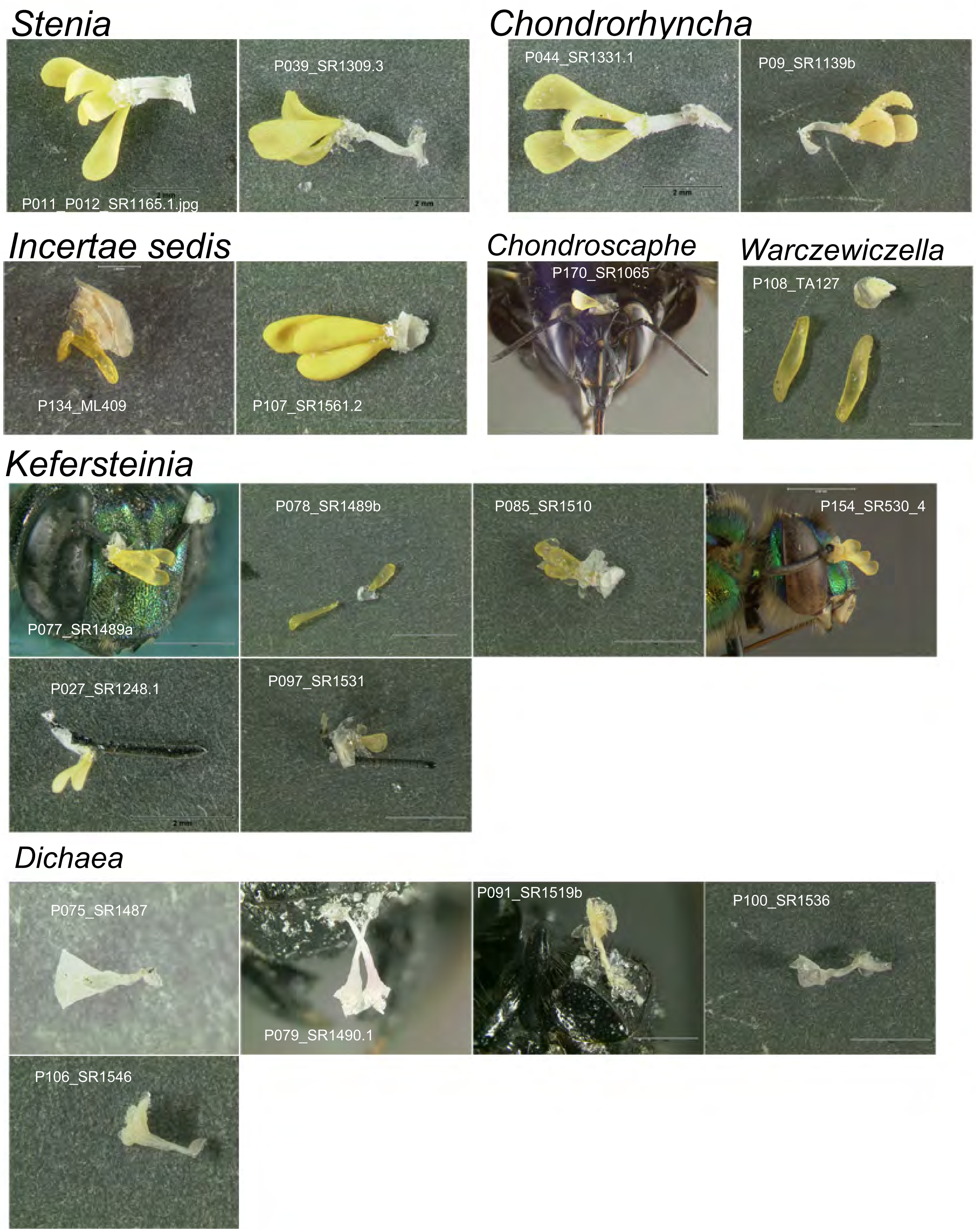

Figure S4. Pollinaria samples belonging to orchid genera in the subtribe Zygopetalinae.

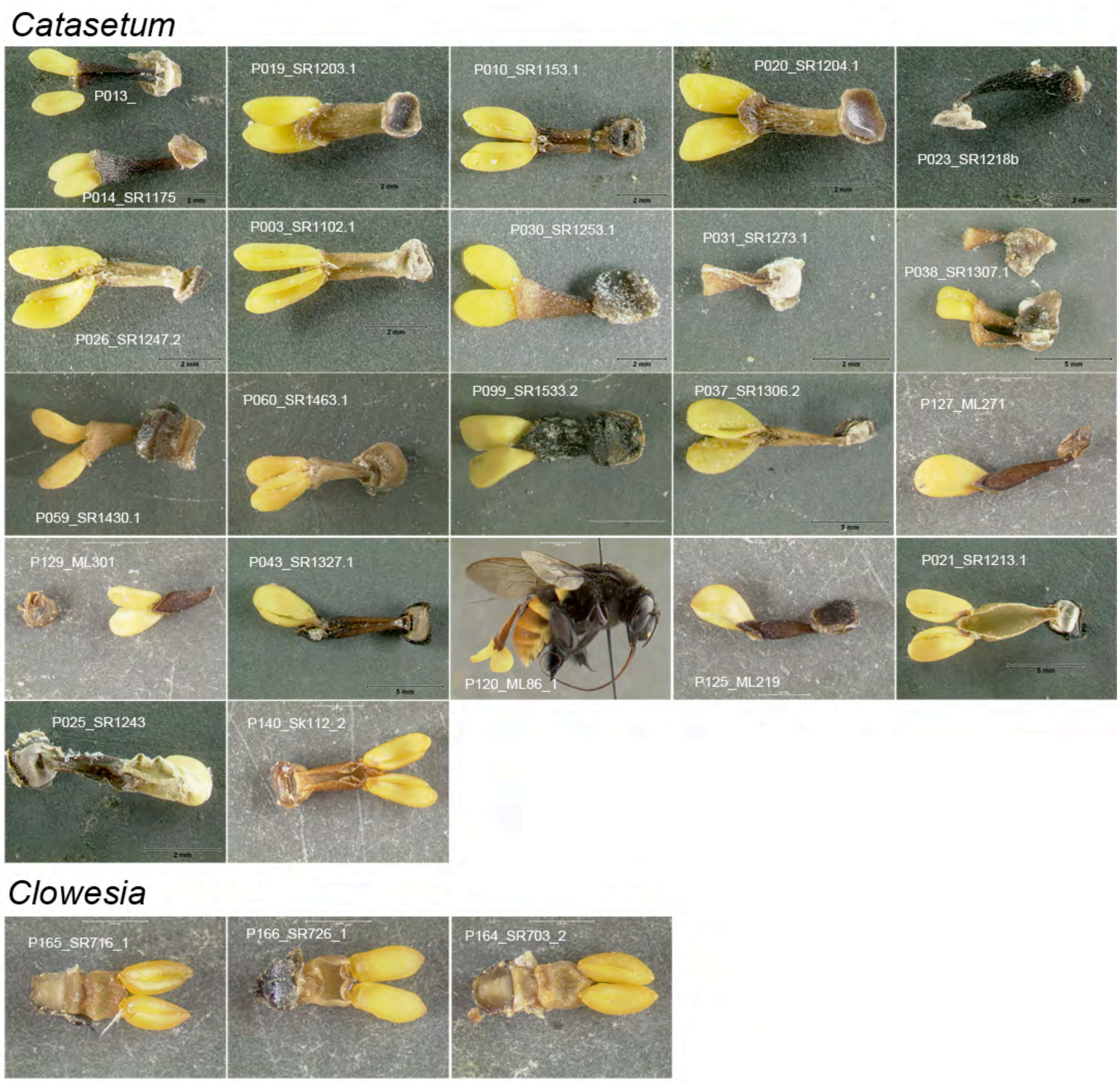

Figure S5. Pollinaria samples belonging to orchid genera in the subtribe Catasetinae.

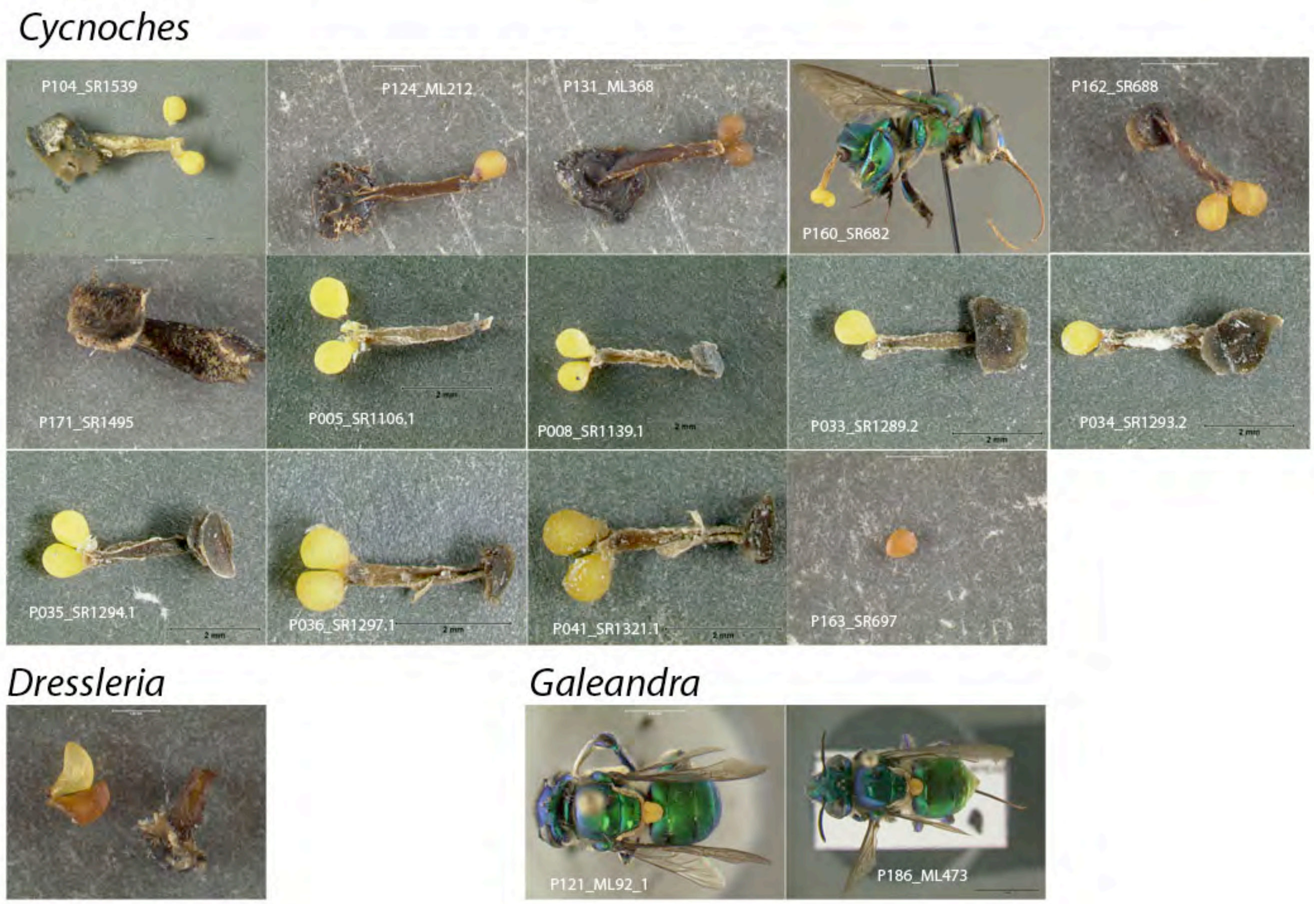

Figure S6. Pollinaria samples belonging to genera in the subtribe Catasetinae.

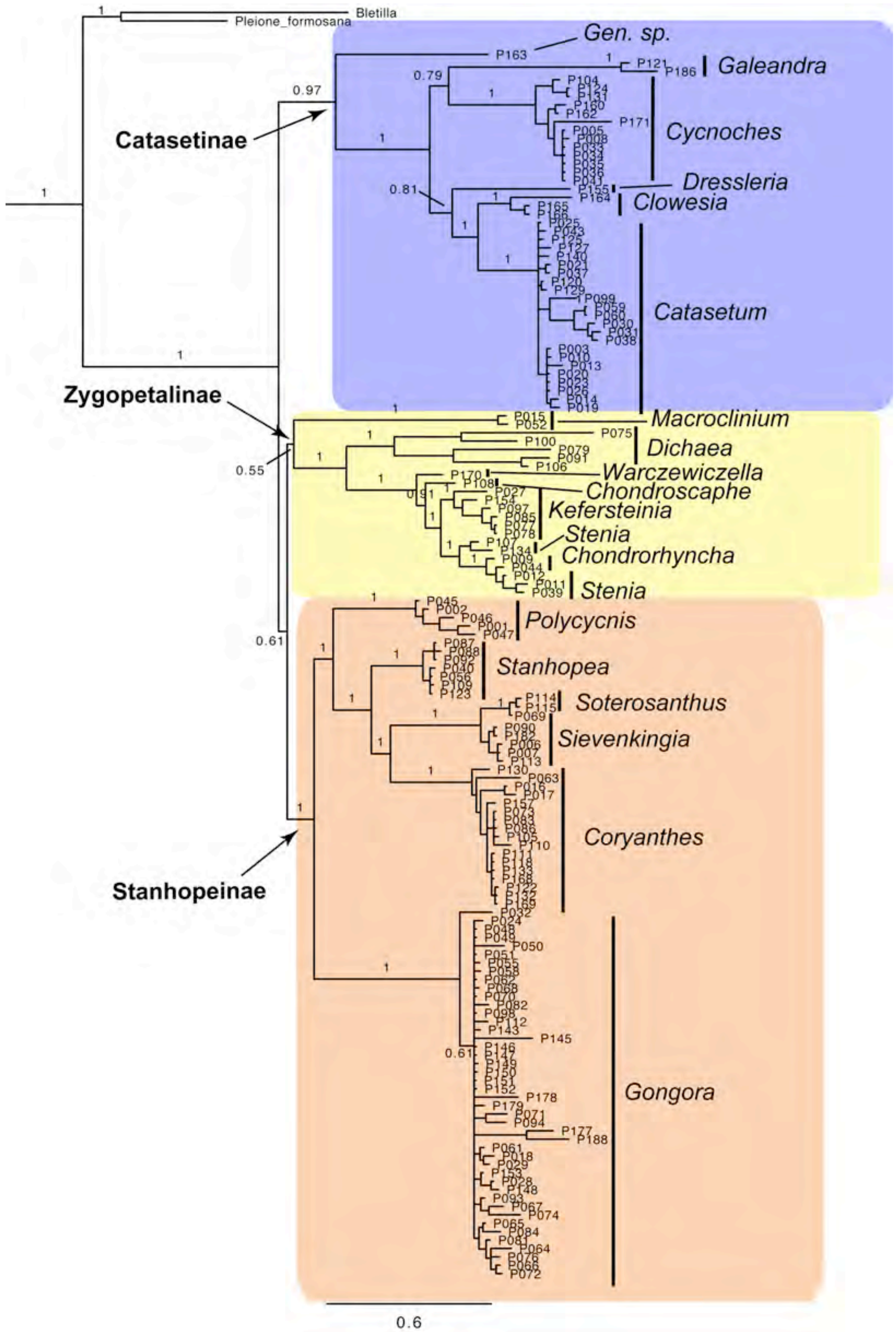

Figure S7. Bayesian phylogram of euglossine-pollinated orchids based on nuclear ribosomal (*ITS*) and chloroplast protein-coding (*YCF1*) loci. Tree searches were conducted using a partitioned model of sequence evolution (by codon for *YCF1* only) as implemented in the software *MRBAYES*. Numbers beside nodes indicate posterior Bayesian probabilities.

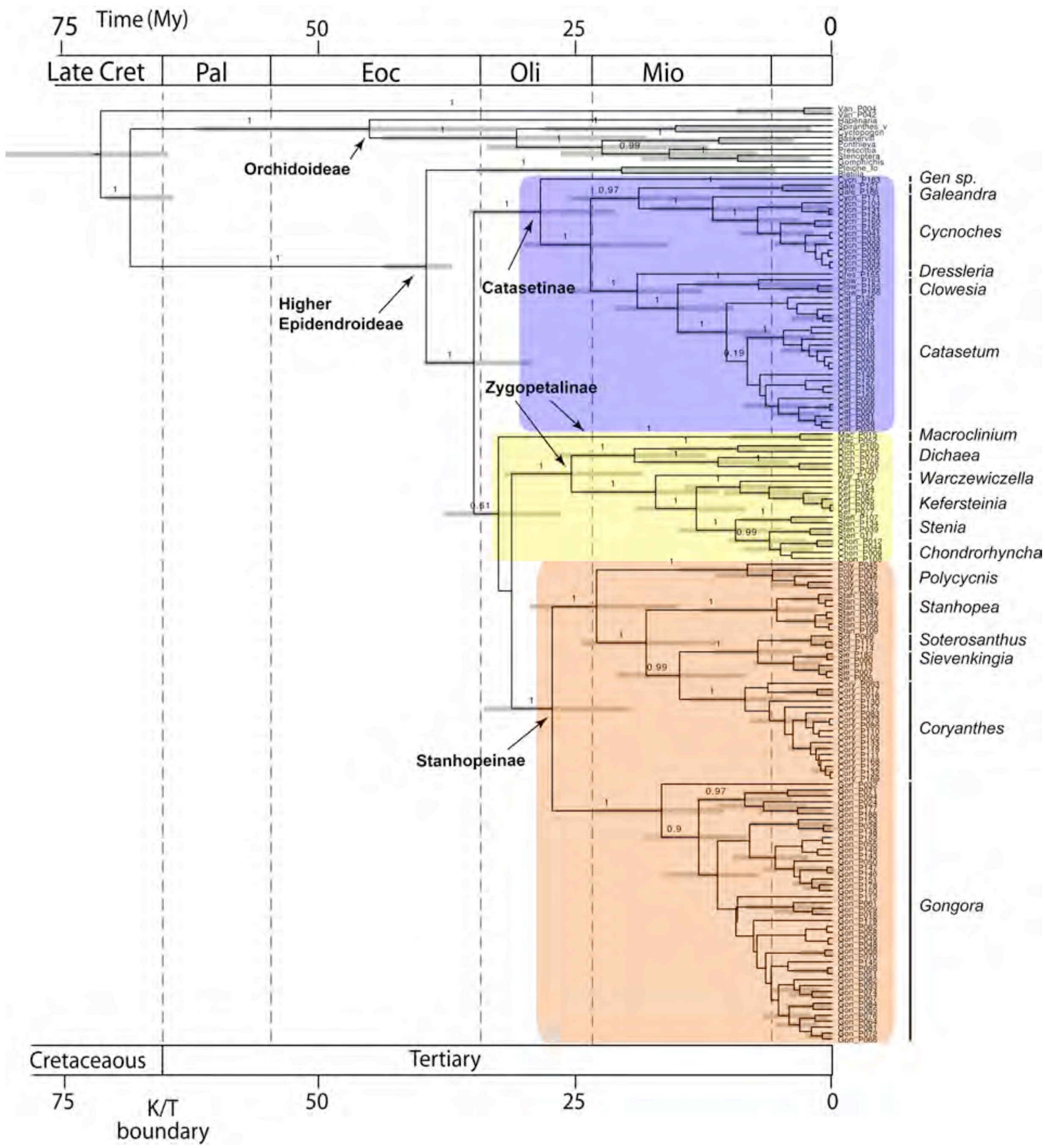

Figure S8. Bayesian chronogram of euglossine-pollinated orchids based on nuclear ribosomal (*ITS*) and chloroplast coding (*YCF1*) loci. A single model of evolution was applied to all characters (GTR+Γ) as implemented in the software package *BEAST.* To ease visualization, posterior probabilities and 95% highest posterior density (HPD) age bars are shown only for selected nodes above genus level.

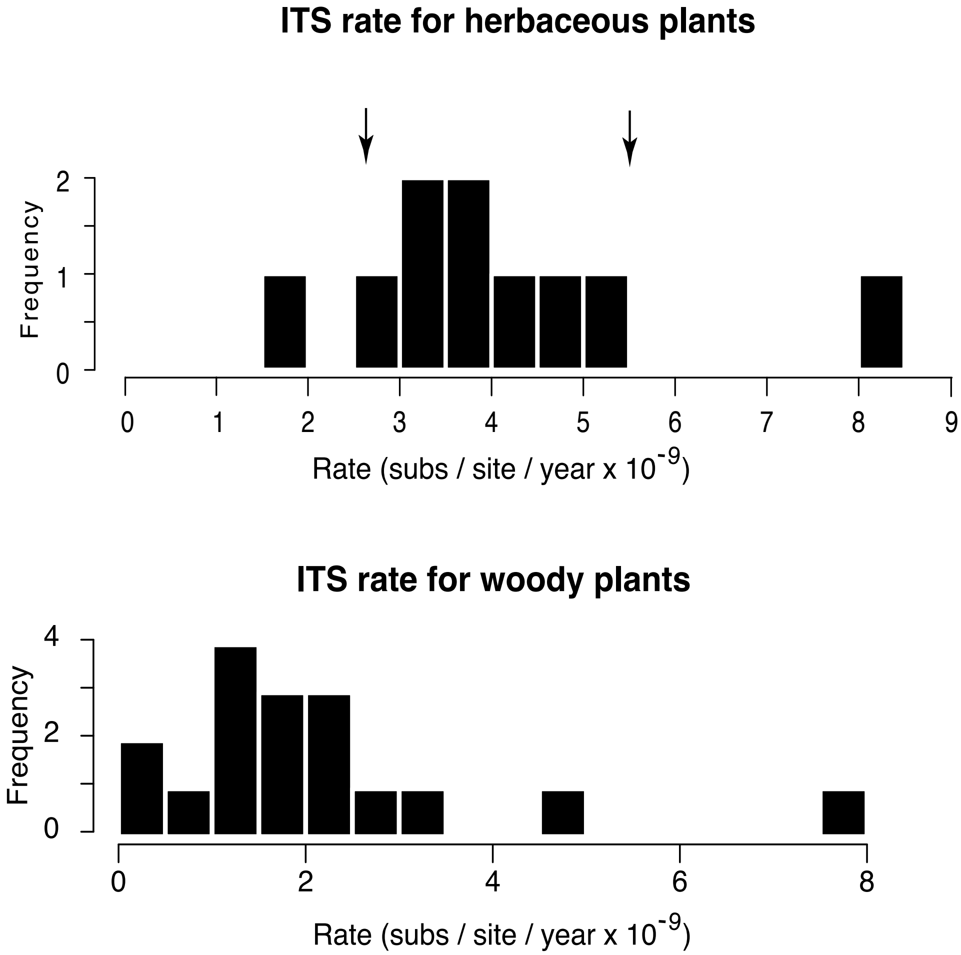

Figure S9. Frequency histogram of substitution rates for the Internal Transcribed Spacer (*ITS*) locus for both herbaceous and woody angiosperms, estimated from 28 independently calibrated molecular clock studies (reviewed by Kay et al. 2006 (*32*). Arrows indicate minimum and maximum rate estimates of euglossine-pollinated orchids as calculated via fossil-calibrated molecular clocks.

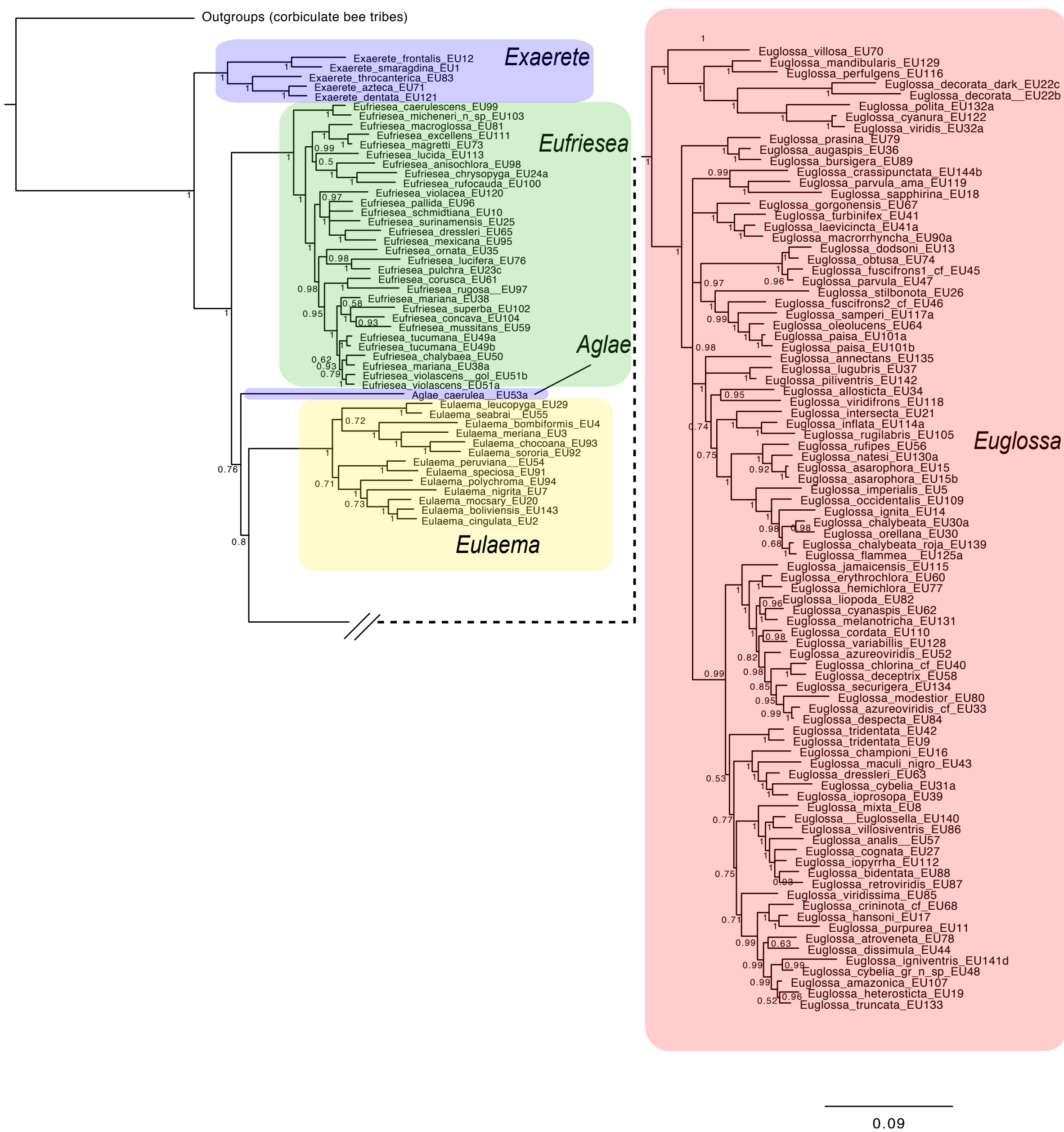

Figure S10. Bayesian phylogram of euglossine bees based on nuclear *EF1-α*, *ArgK*, *RNApol* (*Pol-II*), and mitochondrial *CO1* loci. A partitioned model of sequence evolution, based on codon positions and genes was used (see methods).

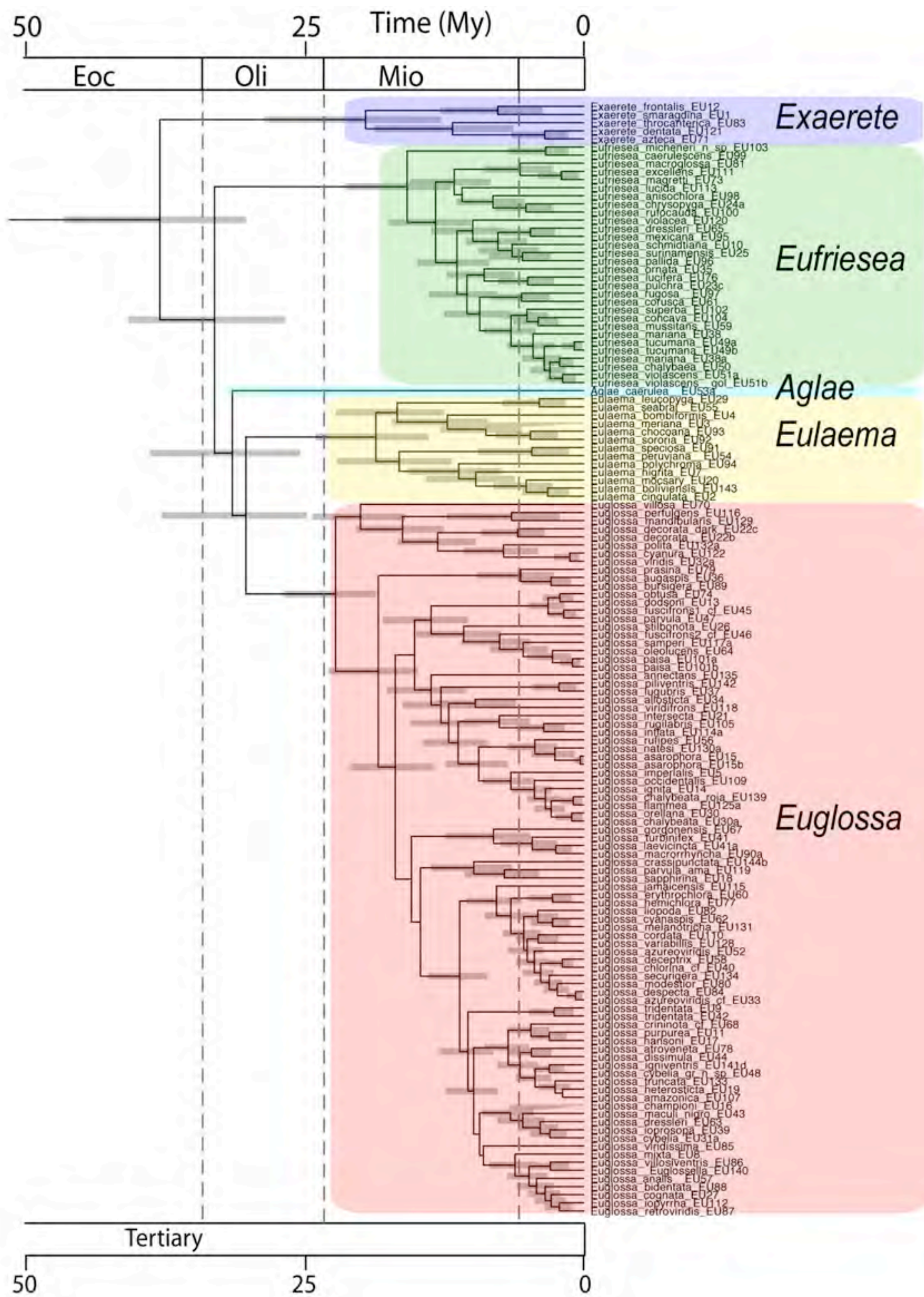

Figure S11. Bayesian chronogram of euglossine bees based on nuclear (*EF1-α*, *ArgK*, *RNApol* [*Pol-II*]) and mitochondrial (*CO1*) loci. Node divergences were estimated with a Bayesian relaxed clock model (lognormal) and a single model of sequence evolution (GTR+Γ) as implemented in the software package *BEAST*.

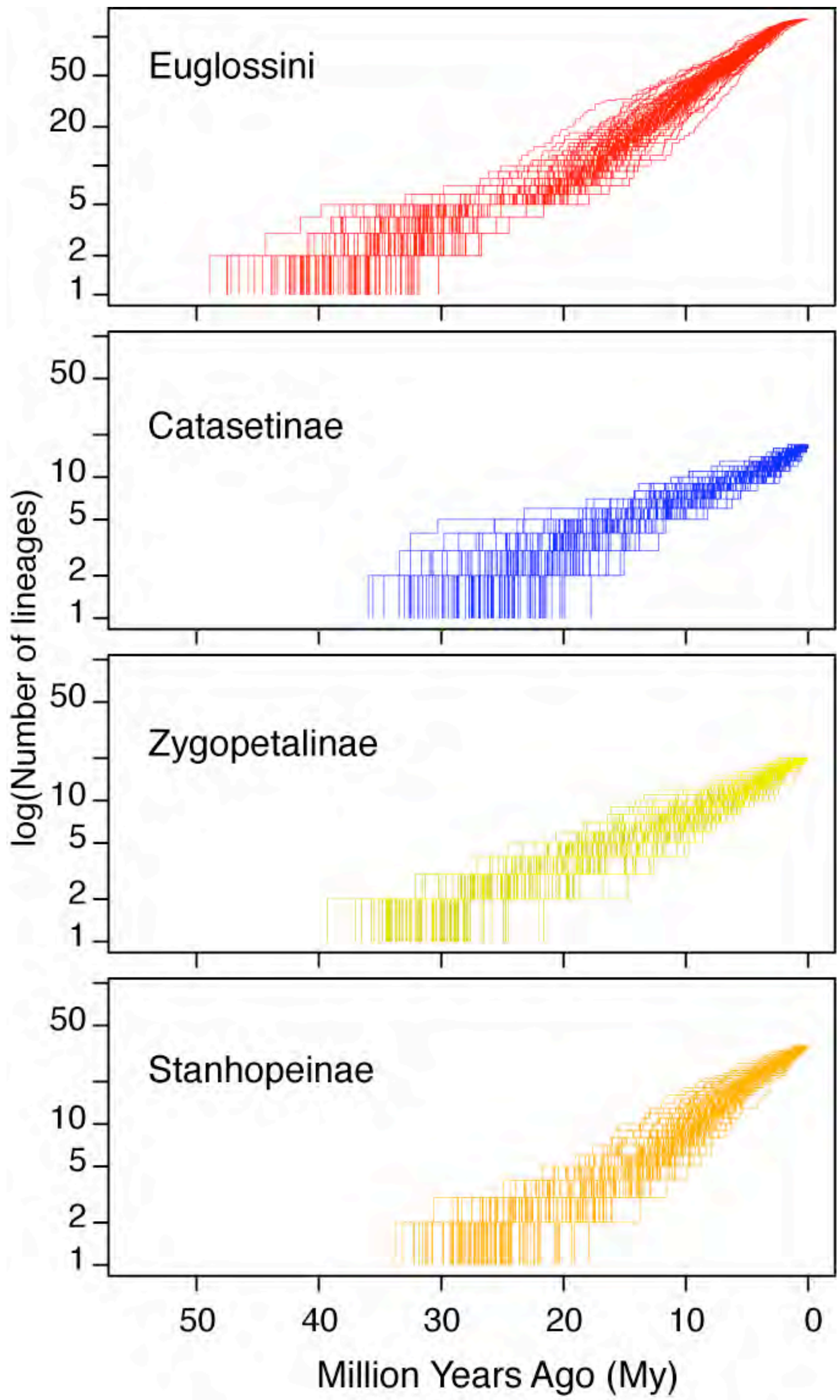

Figure S12. Lineage-through-time plots of euglossine bees and euglossine-pollinated Orchidaceae. Orchid lineages with less than 3% sequence divergence were excluded as they likely corresponded to samples of the same species.

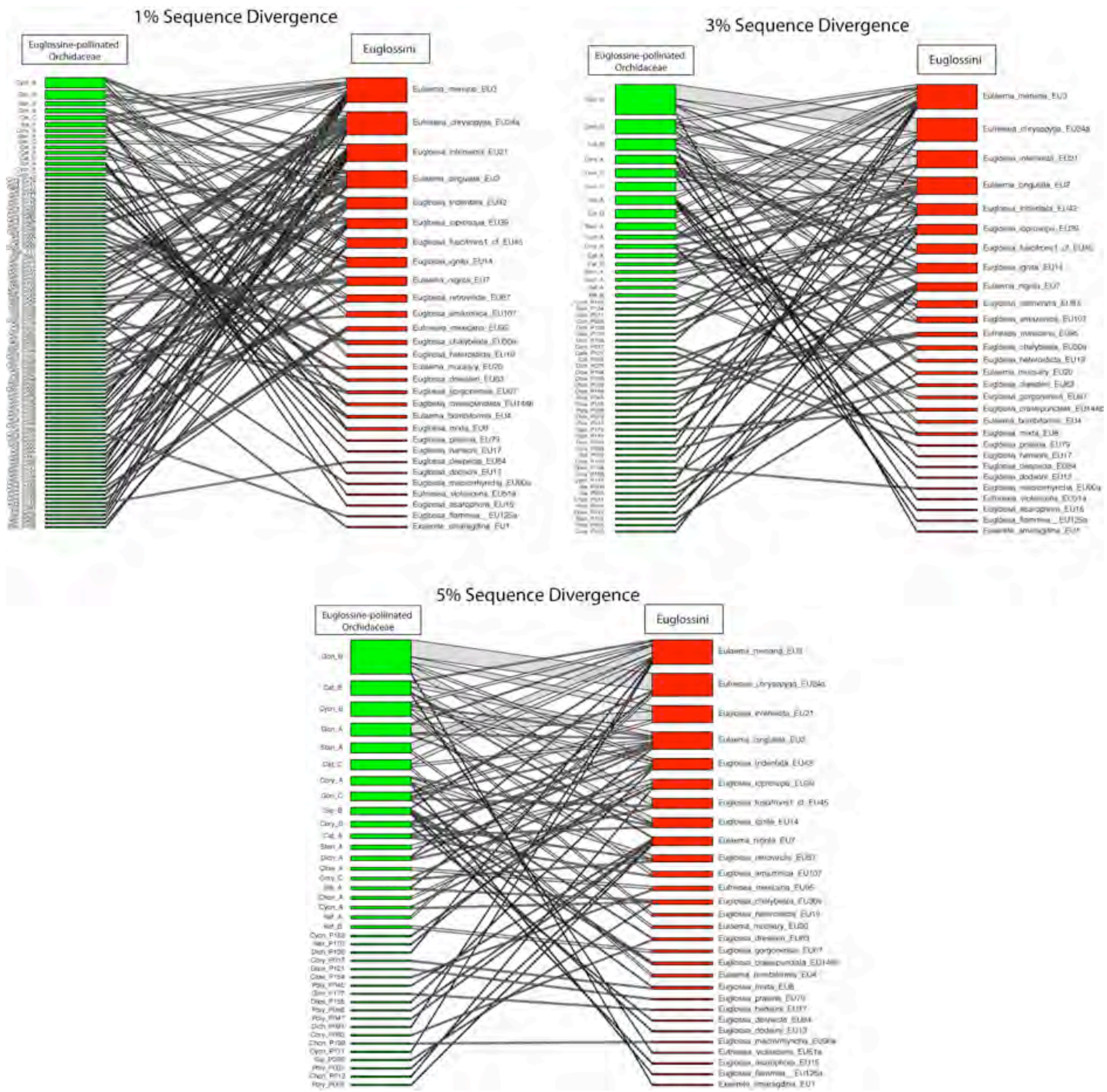

Figure S-13. Bipartite interaction network graphs of euglossine bees and euglossine-pollinated orchids based on three different cutoff levels (1%, 3%, and 5%) for defining species limits among orchid lineges. Network nodes were arranged by decreasing degree (number of interactions per species) from top to bottom.

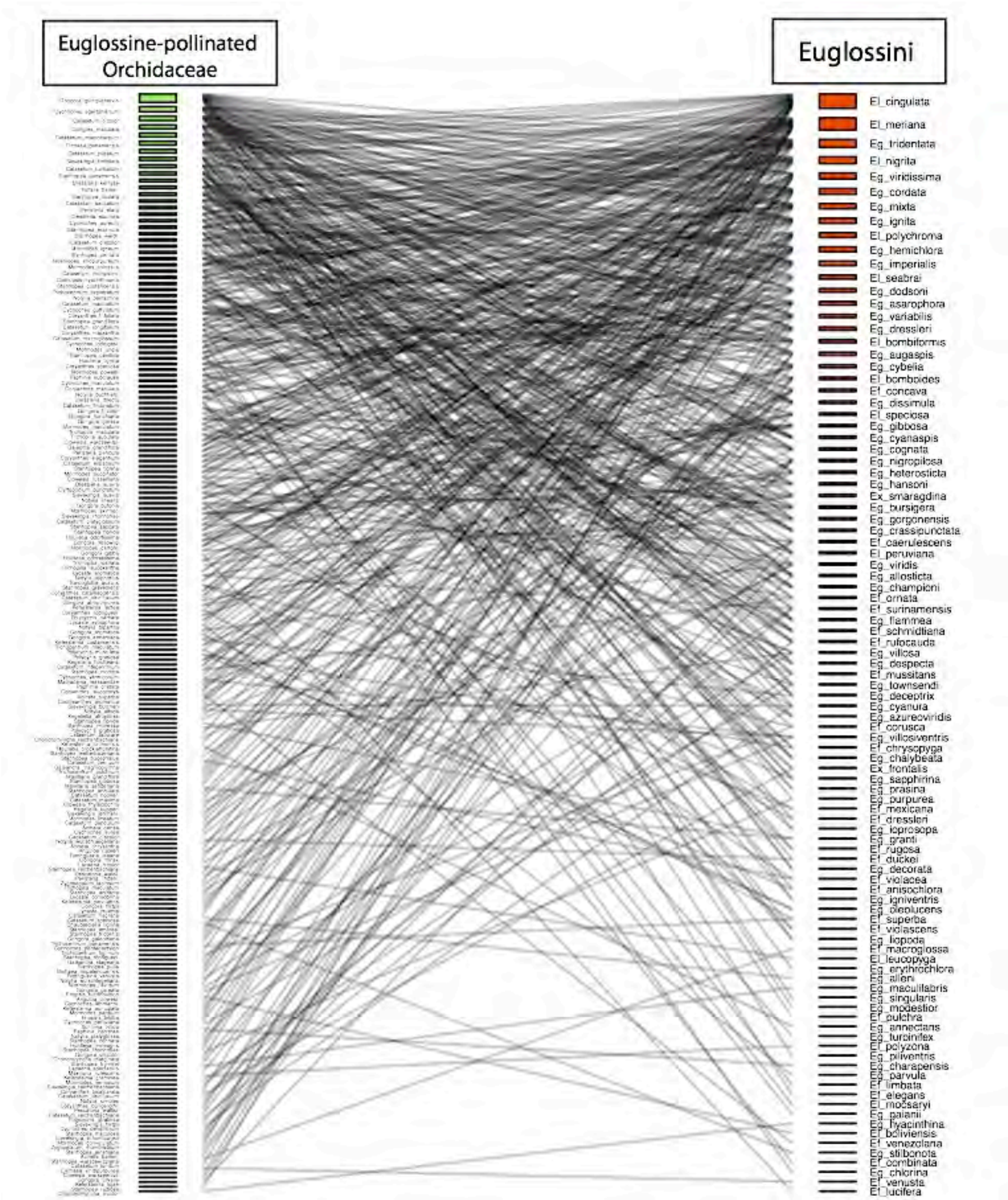

Figure S-14. Bipartite network graph of euglossine bees and euglossine-pollinated orchids based on the dataset of Ramírez *et al.* 2002 (*31*). The data set was filtered to include only those records where the bee and orchid species were known, which resulted in 583 bee-orchid interactions. The original dataset was derived from literature records, museum collections, and field notes collected between 1960 and 2002 across the neotropical region. Network interactors were sorted by degree.

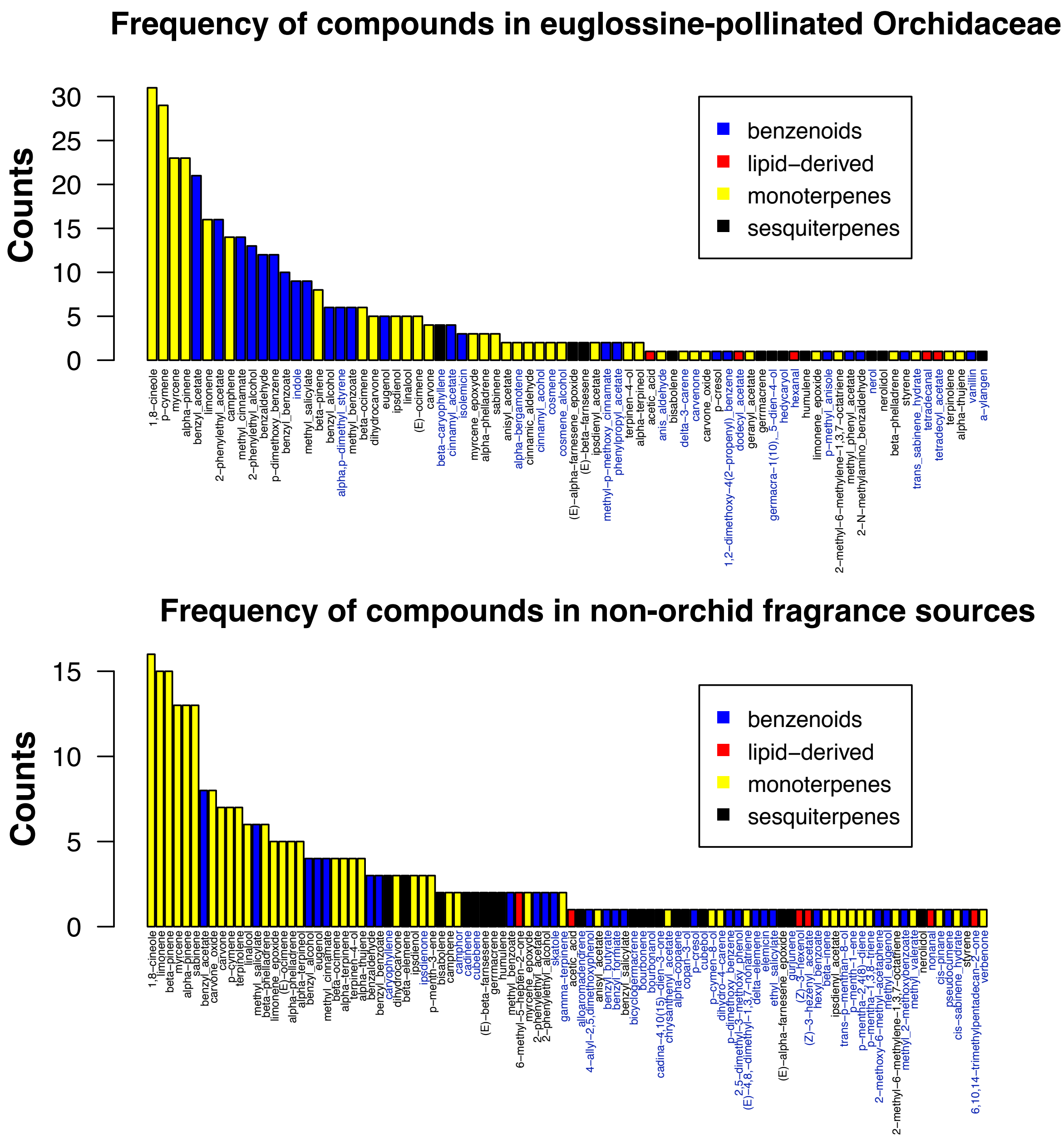

Figure S-15. Frequency histograms of chemical compounds produced by 65 species of euglossine-pollinated Orchidaceae (*top*) and 34 species of non-orchid fragrance sources (*bottom*). The names of the compounds that are unique to either group of plants are indicated in blue.

SUPPLEMMENTARY TABLES:

Table S1. Analysis of diversification with survival models. Estimated parameters and hypothesis testing for euglossine-pollinated Orchidaceae and euglossine bee lineages. Parameter values in parentheses correspond to standard errors, unless otherwise indicated.

Diversification model		**Catasetinae**	**Stanhopeinae**	**Zygopetalinae**	**Euglossini**
Model A:	log	-51.724	-203.142	-67.178	-394.358
(constant	AIC	105.448	408.284	136.355	790.716
diversification)	δ	0.107 (0.026)	0.214 (0.023)	0.110 (0.02)	0.127 (0.01)
Model B:	log	-51.533	-203.115	-67.069	**-388.23**
(Diversification changes	AIC	107.067	410.231	138.137	780.46
following Weibull law)	α	0.102 (0.022)	0.216 (0.02)	0.10 (0.02)	0.117 (0.008)
	β	1.133 (0.231)	0.980 (0.09)	1.08 (0.19)	1.267 (0.087)
Model C:	log	-51.719	-202.236	-67.124	-392.285
(abrupt diversification shift)	AIC	107.439	408.473	138.247	788.57
	δ1	0.109 (0.03)	0.252 (0.03)	0.10 (0.03)	0.108 (0.013)
	δ2	0.104 (0.037)	0.186 (0.02)	0.11 (0.03)	0.155 (0.019)
Model A vs Model B	χ^2 (p-value)	0.381 (P = 0.5372)	0.054 (P = 0.81)	0.218 (P = 0.64)	12.255 (P = 5e-04)
Model A vs Model C	χ^2 (p-value)	0.009 (P = 0.926)	1.811 (P = 0.17)	0.108 (P = 0.74)	4.145 (P = 0.04)
γ-statistic (mean)		0.438	1.680	0.6281	-2.443
Simulated critical γ (0.05 and 0.95 percentile)		-4.05 and -1.60	-4.46 and -1.77	-4.25 and -1.85	-2.79 and 0.46

Table S2. Taxonomic summary of male euglossine-pollinated Orchidaceae (tribe Cymbidieae). Number of genera and species described within each taxon are indicated in parentheses, based on Chase et al 2003 (*62*). Previous male-euglossine pollination records were based on Ramírez et al 2002 (*31*). A comprehensive list of genera were only included for the subtribes Catasetinae, Stanhopeinae and Zygopetalinae. Fd= food deception.

Tribe	Subtribe	Genus	Male-euglossine pollination observed before?	Sampled in this study?
Cymbidieae (188/3814)				
	Catasetinae (8/367)			
		Grobya (4)		
		Mormodes (78)	yes	
		Catasetum (157)	yes	yes
		Clowesia (7)	yes	yes
		Cycnoches (33)	yes	yes
		Cyrtopodium (44)	yes	
		Dressleria (10)	yes	yes
		Galeandra (34)	yes (fd)	yes
	Coeliopsidinae (3/18)			
		Coeliopsis (1)	yes	
		Lycomormium (6)	yes	
		Peristeria (11)	yes	
	Stanhopeinae (20/257)			
		Acineta (15)	yes	
		Braemia (1)		
		Cirrhaea (9)	yes	
		Coryanthes (38)	yes	yes
		Embreea (1)		
		Gongora (58)	yes	yes
		Horichia (1)		
		Houlletia (9)	yes	yes
		Kegeliella (3)	yes	
		Lacaena (2)	yes	
		Lueckelia (1)		
		Lueddemannia (1)		
		Paphinia (16)	yes	
		Polycycnis (15)	yes	yes
		Schlimmia (8)	yes	
		Sievekingia (16)	yes	yes
		Soterosanthus (1)		
		Stanhopea (55)	yes	yes
		Trevoria (6)		
		Vasqueziella (1)		
	Zygopetalinae (33/418)			
		Aganisia (3)		
		Batemannia (5)		

Tribe	Subtribe	Genus	Male-euglossine pollination observed before?	Sampled in this study?
		Benzingia (2)		
		Chaubardia (5)		
		Chaubardiella (8)	yes	
		Cheiradenia (1)		
		Chondrorhyncha (30)	yes	yes
		Chondroscaphe (12)		yes
		Cochleanthes (14)	yes	
		Cryptarrhena (4)		
		*Dichaea (*110)	yes	yes
		Dodsonia (2)		
		Galeottia (12)		
		Hoehneella (1)		
		Huntleya (13)	yes	
		Kefersteinia (61)	yes	yes
		Koellensteinia (19)		
		Macroclinium (38)	yes	yes
		Neogardneria (1)		
		Otostylis (4)		
		Pabstia (6)		
		Paradisanthus (4)		
		Pescatoria (28)	yes	
		Promenaea (19)	yes	
		Stenia (18)		yes
		Warrea (4)		
		Warreella (2)		
		Warreopsis (4)		
		Zygopetalum (14)	yes	
		Zygosepalum (8)	yes	
		Warczewiczella (12)	yes	yes
	Bromheadiinae (1/28)		no	
	Cymbidiinae (4/67)		no	
	Eriopsidinae (1/5)		no	
	Eulophiinae (13/316)		no	
		Eriopsis (5)		
	Oncidiinae (89/1589)			
		Macradenia (11)	yes	
		Notylia (58)	yes	
		Pterostemma (2)	yes	
		Rodriguezia (48)	yes	
		Trichocentrum (69)	yes	
		Trichopilia (26)	yes	
	Maxillariinae (17/749)			
		Anguloa (11)	yes	

Tribe	Subtribe	Genus	Male-euglossine pollination observed before?	Sampled in this study?
		Bifrenaria (26)	yes	
		Lycaste (50)	yes	
		Maxillaria (552)	yes	

Table S3. Collection locality, date, species of pollinator and position of attachment of pollinaria sampled in this study. ?= position unknown, 1= head (clypeus, labrum, vertex), 2 = antennae, 3= legs, 4= ventral mesosoma, 5 = scutum, 6 = scutellum, 7 = anterior face of TI (metasoma), 8 = TII (metasoma).

Sample ID	Attachment site	Bee Species	Bee voucher	Collection Locality	Date Collected	*ITS* GenBank Accession No.	*YCF1* GenBank Accession No.
P1	?	*Eulaema nigrita*	SR1100a	Tarapoto, San Martin Peru	2/28/2005	JF691905	JF692053
P2	?	*Eulaema nigrita*	SR1100b	Tarapoto, San Martin Peru	2/28/2005	JF691906	JF692054
P3	5	*Euglossa sp3*	SR1102	Tarapoto, San Martin Peru	2/26/2005	JF691907	JF692055
P4	?	*Eulaema meriana*	SR1103	Tarapoto, San Martin Peru	2/28/2005	JF691908	JF692151
P5	8	*Euglossa chalybeata*	SR1106	Tarapoto, San Martin Peru	2/27/2005	JF691909	JF692056
P6	3	*Euglossa chalybeata*	SR1111	Tarapoto, San Martin Peru	2/27/2005	JF691910	JF692057
P7	3	*Euglossa chalybeata*	SR1111	Tarapoto, San Martin Peru	2/27/2005	JF691911	JF692058
P8	?	*Euglossa ioprosopa*	SR1139a	Tarapoto, San Martin Peru	2/28/2005	JF691912	JF692059
P9	?	*Euglossa ioprosopa*	SR1139b	Tarapoto, San Martin Peru	2/28/2005	JF691913	JF692060
P10	5	*Euglossa magnipes*	SR1153	Tarapoto, San Martin Peru	2/28/2005	JF691914	JF692061
P11	?	*Euglossa ioprosopa*	SR1165	Tarapoto, San Martin Peru	2/28/2005	JF691915	JF692062
P12	?	*Euglossa ioprosopa*	SR1165	Tarapoto, San Martin Peru	2/28/2005	JF691916	n/a
P13	5	Euglossa ignita	SR1175	Lagunas, Loreto Peru	3/4/2005	JF691917	n/a
P14	5	*n/a*	SR1175	Lagunas, Loreto Peru	3/4/2005	JF691918	n/a
P15	1	*Euglossa sp3*	SR1179	Lagunas, Loreto Peru	3/4/2005	JF691919	JF692063
P16	7	Euglossa ignita	SR1188	Lagunas, Loreto Peru	3/5/2005	JF691920	JF692064
P17	5	*Euglossa mixta*	SR1199	Iquitos, Loreto Peru	5/11/2005	JF691921	n/a
P18	6	*Eulaema cingulata*	SR1202	Iquitos, Loreto Peru	3/11/2005	JF691922	JF692065
P19	5	Euglossa ignita	SR1203	Iquitos, Loreto Peru	3/11/2005	JF691923	JF692066
P20	5	Euglossa ignita	SR1204	Iquitos, Loreto Peru	3/11/2005	JF691924	n/a
P21	5	*Eulaema meriana*	SR1213	Cumaceba Lodge Iquitos, Loreto Peru	3/13/2005	JF691925	JF692067
P23	4	Euglossa ignita	SR1218b	Cumaceba Lodge Iquitos, Loreto Peru	5/13/2005	JF691926	n/a
P24	6	*Euglossa intersecta*	SR1220	Cumaceba Lodge Iquitos, Loreto Peru	3/13/2005	JF691927	JF692068
P25	5	*Eulaema meriana*	SR1243	Bombonaje lodge Iquitos, Loreto Peru	3/14/2005	JF691928	n/a
P26	5	Euglossa ignita	SR1247	Bombonaje lodge Iquitos, Loreto Peru	3/15/2005	JF691929	n/a
P27	2	*Euglossa sp3*	SR1248	Bombonaje lodge Iquitos, Loreto Peru	3/15/2005	JF691930	JF692069
P28	6	*Euglossa ignita*	SR1249	Bombonaje lodge Iquitos, Loreto Peru	3/15/2005	JF691931	JF692070
P29	?	*n/a*	SR1252	n/a	n/a	JF691932	JF692071
P30	4	*Eulaema meriana*	SR1253	Tarapoto, San Martin Peru	3/18/2005	JF691933	JF692072
P31	4	*n/a*	SR1273	Tarapoto, San Martin Peru	3/18/2005	JF691934	JF692073
P32	6	*Eulaema meriana*	SR1274	Tarapoto, San Martin Peru	3/18/2005	JF691935	JF692074
P33	8	*Euglossa magnipes*	SR1289	Tarapoto, San Martin Peru	3/19/2005	JF691936	n/a
P34	8	*Euglossa hetersosticta*	SR1293	Tarapoto, San Martin Peru	3/19/2005	JF691937	n/a
P35	8	*Euglossa hetersosticta*	SR1294	Tarapoto, San Martin Peru	3/19/2005	JF691938	n/a

Sample ID	Attachm ent site	Bee Species	Bee voucher	Collection Locality	Date Collected	*ITS* GenBank Accession No.	*YCF1* GenBank Accession No.
P36	8	*Euglossa magnipes*	SR1297	Tarapoto, San Martin Peru	3/19/2005	JF691939	n/a
P37	8	*Eulaema cingulata*	SR1306	Tarapoto, San Martin Peru	3/19/2005	JF691940	JF692075
P38	4	*Eulaema meriana*	SR1307	Tarapoto, San Martin Peru	3/19/2005	JF691941	JF692076
P39	8	*Euglossa ioprosopa*	SR1309	Tarapoto, San Martin Peru	3/19/2005	JF691942	JF692077
P40	6	*Eulaema meriana*	SR1319	Tarapoto, San Martin Peru	3/19/2005	JF691943	JF692078
P41	?	*Euglossa magnipes*	SR1321	Tarapoto, San Martin Peru	3/19/2005	JF691944	n/a
P42	6	*Eulaema meriana*	SR1325	Tarapoto, San Martin Peru	3/21/2005	JF691945	JF692152
P43	8	*Eulaema nigrita*	SR1327	Tarapoto, San Martin Peru	3/21/2005	JF691946	n/a
P44	8	*Euglossa ioprosopa*	SR1331	Tarapoto, San Martin Peru	3/21/2005	JF691947	JF692080
P45	6	*Eulaema nigrita*	SR1335a	Tarapoto, San Martin Peru	3/12/2005	JF691948	n/a
P46	6	*Eulaema nigrita*	SR1335b	Tarapoto, San Martin Peru	3/21/2005	JF691949	JF692081
P47	6	*Eulaema nigrita*	SR1335c	Tarapoto, San Martin Peru	3/21/2005	JF691950	JF692082
P48	6	*Euglossa fuscifrons*	SR1342	Tiputini River, Orellana Province Ecuador	3/26/2005	JF691951	JF692083
P49	6	*Euglossa fuscifrons*	SR1344	Tiputini River, Orellana Province Ecuador	3/26/2005	JF691952	JF692084
P50	6	*Euglossa intersecta*	SR1353	Tiputini River, Orellana Province Ecuador	3/27/2005	JF691953	JF692085
P51	6	*Euglossa fuscifrons*	SR1356	Tiputini River, Orellana Province Ecuador	3/27/2005	JF691954	JF692086
P52	1	*n/a*	SR1359	Tiputini River, Orellana Province Ecuador	3/27/2005	JF691955	JF692087
P55	6	*Euglossa fuscifrons*	SR1397	Tiputini River, Orellana Province Ecuador	3/29/2005	JF691956	n/a
P56	6	*Eulaema mocsaryi*	SR1398a	Tiputini River, Orellana Province Ecuador	3/29/2005	JF691957	JF692088
P58	6	*Euglossa fuscifrons*	SR1412	Tiputini River, Orellana Province Ecuador	3/30/2005	JF691958	JF692089
P59	4	*Eulaema bombiformis*	SR1430	Tiputini River, Orellana Province Ecuador	3/29/2005	JF691959	JF692090
P60	4	*Eulaema bombiformis*	SR1463	Tiputini River, Orellana Province Ecuador	4/3/2005	JF691960	JF692150
P61	6	*Euglossa fuscifrons*	SR1471	Tiputini River, Orellana Province Ecuador	4/3/2005	JF691961	JF692091
P62	?	*n/a*	na	n/a	n/a	JF691962	JF692092
P63	7	*Euglossa tridentata*	SR1477	Bilsa, Esmeraldas Ecuador	4/8/2005	JF691963	JF692093
P64	6	*Eufriesea chrysopyga*	SR1478a	Bilsa, Esmeraldas Ecuador	4/8/2005	JF691964	JF692094
P65	6	*Eufriesea chrysopyga*	SR1478b	Bilsa, Esmeraldas Ecuador	4/8/2005	JF691965	JF692095
P66	6	*Eufriesea chrysopyga*	SR1478c	Bilsa, Esmeraldas Ecuador	4/8/2005	JF691966	JF692096
P67	6	*Eufriesea chrysopyga*	SR1480a	Bilsa, Esmeraldas Ecuador	4/8/2005	JF691967	JF692097
P68	6	*Eufriesea chrysopyga*	SR1480b	Bilsa, Esmeraldas Ecuador	4/8/2005	JF691968	JF692098
P69	3	*Eufriesea chrysopyga*	SR1481a	Bilsa, Esmeraldas Ecuador	4/8/2005	JF691969	JF692159
P70	6	*Eufriesea chrysopyga*	SR1481b	Bilsa, Esmeraldas Ecuador	4/8/2005	JF691970	JF692099
P71	6	*Eufriesea chrysopyga*	SR1481c	Bilsa, Esmeraldas Ecuador	4/8/2005	JF691971	JF692100
P72	6	*Eufriesea chrysopyga*	SR1481d	Bilsa, Esmeraldas Ecuador	4/8/2005	JF691972	JF692101
P73	7	*n/a*	SR1482	Bilsa, Esmeraldas Ecuador	4/8/2005	JF691973	JF692102
P74	8	*Eufriesea chrysopyga*	SR1483	Bilsa, Esmeraldas Ecuador	4/8/2005	JF691974	JF692103
P75	1	Euglossa fuscifrons	SR1487	Bilsa, Esmeraldas Ecuador	4/8/2005	JF691975	n/a
P76	6	*Eufriesea chrysopyga*	SR1488	Bilsa, Esmeraldas Ecuador	4/8/2005	JF691976	JF692104

Sample ID	Attachment site	Bee Species	Bee voucher	Collection Locality	Date Collected	*ITS* GenBank Accession No.	*YCF1* GenBank Accession No.
P77	3	*Eufriesea chrysopyga*	SR1489a	Bilsa, Esmeraldas Ecuador	4/8/2005	JF691977	JF692105
P78	2	*Eufriesea chrysopyga*	SR1489b	Bilsa, Esmeraldas Ecuador	4/8/2005	JF691978	JF692106
P79	1	*Eulaema meriana*	SR1490a	Bilsa, Esmeraldas Ecuador	4/8/2005	JF691979	n/a
P81	6	*Eufriesea chrysopyga*	SR1491	Bilsa, Esmeraldas Ecuador	4/8/2005	JF691980	JF692107
P82	6	*Eufriesea chrysopyga*	SR1496	Bilsa, Esmeraldas Ecuador	4/8/2005	JF691981	JF692108
P83	7	*Euglossa dressleri*	SR1498	Bilsa, Esmeraldas Ecuador	4/8/2005	JF691982	JF692109
P84	6	*Exarete smaragdina*	SR1501	Bilsa, Esmeraldas Ecuador	4/8/2005	JF691983	JF692110
P85	2	*n/a*	SR1510	Bilsa, Esmeraldas Ecuador	4/8/2005	JF691984	JF692111
P86	7	*Euglossa dressleri*	SR1511	Bilsa, Esmeraldas Ecuador	4/8/2005	JF691985	JF692112
P87	5	*Eulaema meriana*	SR1512	Bilsa, Esmeraldas Ecuador	4/8/2005	JF691986	JF692113
P88	6	*Eulaema meriana*	SR1513	Bilsa, Esmeraldas Ecuador	4/8/2005	JF691987	JF692114
P90	2	*Eulaema meriana*	SR1519a	Bilsa, Esmeraldas Ecuador	4/8/2005	JF691988	n/a
P91	1	*Eulaema meriana*	SR1519b	Bilsa, Esmeraldas Ecuador	4/8/2005	JF691989	JF692115
P92	6	*Eulaema meriana*	SR1523	Bilsa, Esmeraldas Ecuador	4/9/2005	JF691990	JF692116
P93	6	*Euglossa tridentata*	SR1524	Bilsa, Esmeraldas Ecuador	4/9/2005	JF691991	JF692117
P94	6	*Eufriesea chrysopyga*	SR1525	Bilsa, Esmeraldas Ecuador	4/9/2005	JF691992	JF692118
P97	2	*Euglossa gorgonensis*	SR1531	Bilsa, Esmeraldas Ecuador	4/10/2005	JF691993	JF692119
P98	6	*Euglossa tridentata*	SR1532	Bilsa, Esmeraldas Ecuador	4/10/2005	JF691994	JF692120
P99	5	*Eulaema cingulata*	SR1533	Bilsa, Esmeraldas Ecuador	4/10/2005	JF691995	JF692121
P100	1	*Eulaema cingulata*	SR1536	Bilsa, Esmeraldas Ecuador	4/10/2005	JF691996	n/a
P104	8	*Eulaema cingulata*	SR1539	Bilsa, Esmeraldas Ecuador	4/10/2005	JF691997	n/a
P105	7	*Euglossa flammea*	SR1544	Bilsa, Esmeraldas Ecuador	4/10/2005	JF691998	JF692122
P106	1	*Eulaema meriana*	SR1546	Bilsa, Esmeraldas Ecuador	4/10/2005	JF691999	JF692123
P107	6	*Euglossa sp.*	SR1561	Camacan, Bahia Brasil	5/8/2005	JF692000	JF692133
P108	6	*Euglossa macrorhyncha*	TA127	Anori, Antioquia Colombia	3/30/2003	JF692001	JF692134
P109	5	*Eulaema meriana*	n/a	n/a	n/a	JF692002	JF692135
P110	7	*n/a*	SC01	San Cipriano, Choco Colombia	2006	JF692003	JF692136
P111	7	*n/a*	SC02a	San Cipriano, Choco Colombia	2006	JF692004	n/a
P112	7	*n/a*	SC02d	San Cipriano, Choco Colombia	2006	JF692005	n/a
P113	3	*Euglossa mixta*	CR.129	Tarapoto-Yurimaguas road km20 San Martin, Tarapoto Peru	4/3/2003	JF692006	n/a
P114	3	*Euglossa dodsoni*	JCN.207	Mun. Lloro, Choco Colombia	3/18/2003	JF692007	n/a
P115	?	*Euglossa asarophora*	JCN.238	Lloro, Chocó Colombia	n/a	JF692008	n/a
P118	7	*Euglossa despecta*	ML044	Villavicencio, Meta Colombia	2/8/2003	JF692009	JF692137
P120	8	*Eulaema cingulata*	ML086	Leticia, Amazonas Colombia	4/15/2003	JF692010	JF692138
P121	6	*Euglossa prasina*	ML092	Leticia, Amazonas Colombia	4/15/2003	JF692011	JF692079
P122	7	*Euglossa retroviridis*	ML197	Puerto Nariño, Amazonas Colombia	4/17/2003	JF692012	JF692139

Sample ID	Attachment site	Bee Species	Bee voucher	Collection Locality	Date Collected	*ITS* GenBank Accession No.	*YCF1* GenBank Accession No.
P123	6	*Eulaema mocsaryi*	ML200	Puerto Nariño, Amazonas Colombia	4/17/2003	JF692013	JF692158
P124	8	*Eulaema meriana*	ML212	Puerto Nariño, Amazonas Colombia	4/18/2003	JF692014	n/a
P125	8	*Eulaema cingulata*	ML219	Puerto Nariño, Amazonas Colombia	4/18/2003	JF692015	n/a
P127	8	*Eulaema cingulata*	ML271	Puerto Nariño, Amazonas Colombia	4/18/2003	JF692016	n/a
P129	8	*Eulaema cingulata*	ML301	Leticia, Amazonas Colombia	4/21/2003	JF692017	n/a
P130	7	*Eulaema cingulata*	ML302	Leticia, Amazonas Colombia	4/21/2003	JF692018	JF692140
P131	8	*Eulaema meriana*	ML368	Leticia, Amazonas Colombia	6/19/2003	JF692019	JF692141
P132	7	*Euglossa retroviridis*	ML377	Leticia, Amazonas Colombia	6/23/2003	JF692020	JF692142
P133	7	*Euglossa retroviridis*	ML386	Leticia, Amazonas Colombia	6/25/2003	JF692021	JF692143
P134	1	*Euglossa ioprosopa*	ML409	Leticia, Amazonas Colombia	7/10/2003	JF692022	JF692144
P140	5	*Eufriesea auriceps*	SK112	Santa Cruz, Prov. Cordillera Bolivia	3/20/2003	JF692023	n/a
P143	6	*Euglossa intersecta*	SR0180	Mocoa, Putumayo Colombia	1/8/2003	JF692024	JF692145
P145	6	*Euglossa intersecta*	SR0205a	Mocoa, Putumayo Colombia	1/8/2003	JF692025	n/a
P146	6	*Euglossa intersecta*	SR0205b	Mocoa, Putumayo Colombia	1/8/2003	JF692026	JF692132
P147	6	*Euglossa intersecta*	SR0205c	Mocoa, Putumayo Colombia	1/8/2003	JF692027	JF692146
P148	6	*Euglossa intersecta*	SR0215	Mocoa, Putumayo Colombia	1/8/2003	JF692028	n/a
P149	6	*Euglossa intersecta*	SR0255a	Mocoa, Putumayo Colombia	1/9/2003	JF692029	JF692160
P150	6	*Euglossa intersecta*	SR0255b	Mocoa, Putumayo Colombia	1/9/2003	JF692030	JF692147
P151	6	*Euglossa intersecta*	SR0338	Mocoa, Putumayo Colombia	1/10/2003	JF692031	JF692148
P152	6	*Euglossa intersecta*	SR0352	Mocoa, Putumayo Colombia	1/10/2003	JF692032	JF692149
P153	6	*Euglossa intersecta*	SR0386	Mocoa, Putumayo Colombia	1/10/2003	JF692033	JF692153
P154	2	*Euglossa gorgonensis*	SR0530	Area de Conservación Guanacaste Costa Rica	6/28/2003	JF692034	JF692124
P155	4	*Euglossa tridentata*	SR0551	Area de Conservación Guanacaste Costa Rica	7/1/2003	JF692035	JF692125
P157	7	*Euglossa tridentata*	SR0642	Tikal Sta. Elena, Peten Guatemala	7/9/2003	JF692036	JF692128
P160	8	*Euglossa tridentata*	SR0682	Escuintla, Chiapas Mexico	7/15/2003	JF692037	n/a
P162	8	*Euglossa tridentata*	SR0688	Escuintla, Chiapas Mexico	7/15/2003	JF692038	n/a
P163	?	*Euglossa tridentata*	SR0697	Escuintla, Chiapas Mexico	7/15/2003	JF692039	JF692130
P164	6	*Eufriesea mexicana*	SR0703	Cañon del Sumidero Tuxtla, Chiapas Mexico	6/17/2003	JF692040	JF692131
P165	6	*Eufriesea mexicana*	SR0716	Cañon del Sumidero Tuxtla, Chiapas Mexico	6/17/2003	JF692041	JF692154
P166	6	*Eufriesea mexicana*	SR0726	Cañon del Sumidero Tuxtla, Chiapas Mexico	6/17/2003	JF692042	JF692155
P168	7	*Euglossa retroviridis*	SR0836	Reserva Palmarí Río Javarí,Amazonas Brazil	8/9/2003	JF692043	JF692129
P169	7	*Euglossa retroviridis*	SR0882	Reserva Palmarí Río Javarí,Amazonas Brazil	8/9/2003	JF692044	JF692156
P170	1	*Eulaema cingulata*	SR1065	Viterbo, Caldas Colombia	1/7/2004	JF692045	JF692157
P171	5	*Eulaema meriana*	SR1495	Bilsa, Naranja trail 1100 Esmeraldas Ecuador	4/8/2005	JF692046	JF692127
P177	6	*Euglossa hansoni*	TA164	Bahia Solano, Choco Colombia	4/12/2003	JF692047	JF692126
P178	6	*Eulaema cingulata*	TA251	Bahia Solano, Choco Colombia	4/14/2003	JF692048	n/a
P179	6	*Euglossa crassipunctata*	TA255	Bahia Solano, Choco Colombia	3/14/2003	JF692049	n/a

Sample ID	Attachment site	Bee Species	Bee voucher	Collection Locality	Date Collected	*ITS* GenBank Accession No.	*YCF1* GenBank Accession No.
P182	3	*Euglossa crassipunctata*	TA306a	Bahia Solano, Choco Colombia	4/15/2003	JF692050	n/a
P186	6	Euglossa sp	ML473	Villlavicencio Colombia	n/a	JF692051	n/a
P188	6	Euglossa sp	TA270	Bahia Solano, Choco Colombia	4/14/2003	JF692052	n/a

Table S4. *Genbank* BLAST search results of pollinaria-derived *ITS* sequences and morphology-based identification at the genus and below genus level. Most genera of euglossine-pollinated Orchidaceae are represented (by *ITS* sequence data) on GenBank, except those in the subtribe Catasetinae.

Sample ID	Genbank Accession ID	Orchid Species with Highest Affinity	Bit Score	Genus ID (morphology)	Subgeneric ID (species groups)
P1	AF239373.1	*Polycycnis gratiosa*	1132	*Polycycnis*	
P2	AF239373.1	*Polycycnis gratiosa*	1431	*Polycycnis*	
P3	AF470487.1	*Grobya galeata*	999	*Catasetum*	Isoceras
P4	AF521079.1	*Glomera pulchra*	347	*Vanilla*	
P5	AF470487.1	*Grobya galeata*	799	*Cycnoches*	
P6	AF239357.1	*Sievekingia herrenhusana*	1505	*Sievekingia*	
P7	AF239357.1	*Sievekingia herrenhusana*	1588	*Sievekingia*	
P8	AF470487.1	*Grobya galeata*	787	*Cycnoches*	
P9	AY870028.1	*Benzingia hajekii*	1187	*Chondrorhyncha*	
P10	AF470487.1	*Grobya galeata*	1007	*Catasetum*	Isoceras
P11	AY870029.1	*Benzingia estradae*	1304	*Chondrorhyncha*	
P11	AF239325.1	*Chondrorhyncha reichenbachiana*	1304	*Chondrorhyncha*	
P12	AF239325.1	*Chondrorhyncha reichenbachiana*	1354	*Chondrorhyncha*	
P13	AF470487.1	*Grobya galeata*	1023	*Catasetum*	Isoceras
P14	AF470487.1	*Grobya galeata*	989	*Catasetum*	Isoceras
P15	AF350550.1	*Macroclinium bicolor*	995	***NA***	
P16	AF239359.1	*Coryanthes macrantha*	1352	*Coryanthes*	
P17	AF239359.1	*Coryanthes macrantha*	1170	*Coryanthes*	
P18	AF239387.1	*Gongora tridentate*	1199	*Gongora*	
P19	AF470487.1	*Grobya galeata*	1023	*Catasetum*	Isoceras
P20	AF470487.1	*Grobya galeata*	991	*Catasetum*	Isoceras
P21	AF470487.1	*Grobya galeata*	1037	*Catasetum*	anisoceras
P23	AF470487.1	*Grobya galeata*	902	*Catasetum*	Isoceras
P24	AF239382.1	*Gongora gratulabunda*	1172	*Gongora*	
P24	AF239387.1	*Gongora tridentate*	1172	*Gongora*	
P25	AF470487.1	*Grobya galeata*	1049	*Catasetum*	anisoceras
P26	AF470487.1	*Grobya galeata*	1001	*Catasetum*	Isoceras
P27	AY870038.1	*Kefersteinia expansa*	1447	*Kefersteinia*	
P27	AY870036.1	*Kefersteinia microcharis*	1447	*Kefersteinia*	
P28	AF239387.1	*Gongora tridentate*	1148	*Gongora*	
P29	AF239382.1	*Gongora gratulabunda*	1207	*Gongora*	
P30	AF470487.1	*Grobya galeata*	963	*Catasetum*	Pseudocatasetum
P31	AF470487.1	*Grobya galeata*	946	*Catasetum*	Isoceras
P32	AF239387.1	*Gongora tridentate*	1138	*Gongora*	
P33	AF470487.1	*Grobya galeata*	827	*Cycnoches*	
P34	AF470487.1	*Grobya galeata*	833	*Cycnoches*	
P35	AF470487.1	*Grobya galeata*	827	*Cycnoches*	
P36	AF470487.1	*Grobya galeata*	839	*Cycnoches*	
P37	AF470487.1	*Grobya galeata*	1037	*Catasetum*	anisoceras
P39	AF239325.1	*Chondrorhyncha reichenbachiana*	1352	*Chondrorhyncha*	
P40	AF239349.1	*Stanhopea ecornuta*	1528	*Stanhopea*	
P41	AF470487.1	*Grobya galeata*	833	*Cycnoches*	
P42	AF521079.1	*Glomera pulchra*	347	*Vanilla*	
P43	AF470487.1	*Grobya galeata*	1037	*Catasetum*	anisoceras
P44	AF239325.1	*Chondrorhyncha reichenbachiana*	1358	*Chondrorhyncha*	
P45	AF239373.1	*Polycycnis gratiosa*	1340	*Polycycnis*	
P46	AF239373.1	*Polycycnis gratiosa*	789	*Polycycnis*	
P47	AF239373.1	*Polycycnis gratiosa*	1053	*Polycycnis*	
P48	AF239382.1	*Gongora gratulabunda*	1229	*Gongora*	

Sample ID	Genbank Accession ID	Orchid Species with Highest Affinity	Bit Score	Genus ID (morphology)	Subgeneric ID (species groups)
P49	AF239382.1	*Gongora gratulabunda*	1114	*Gongora*	
P50	AF239387.1	*Gongora tridentate*	1072	*Gongora*	
P51	AF239387.1	*Gongora tridentate*	1189	*Gongora*	
P52	AF350550.1	*Macroclinium bicolor*	1023	***NA***	
P55	AF239387.1	*Gongora tridentata*	1199	*Gongora*	
P56	AF239349.1	*Stanhopea ecornuta*	1491	*Stanhopea*	
P58	AF239382.1	*Gongora gratulabunda*	1227	*Gongora*	
P59	AF470487.1	*Grobya galeata*	971	*Catasetum*	Pseudocatasetum
P60	AF470487.1	*Grobya galeata*	961	*Catasetum*	Pseudocatasetum
P61	AF239382.1	*Gongora gratulabunda*	1281	*Gongora*	
P62	AF239387.1	*Gongora tridentata*	1243	*Gongora*	
P63	AF239360.1	*Coryanthes elegantium*	1582	*Coryanthes*	
P64	AF239386.1	*Gongora armeniaca*	989	*Gongora*	
P65	AF239382.1	*Gongora gratulabunda*	1124	*Gongora*	
P66	AF239382.1	*Gongora gratulabunda*	1116	*Gongora*	
P67	AF239387.1	*Gongora tridentata*	1074	*Gongora*	
P68	AF239387.1	*Gongora tridentata*	1185	*Gongora*	
P69	AF239357.1	*Sievekingia herrenhusana*	1394	*Sievekingia*	
P70	AF239387.1	*Gongora tridentata*	1126	*Gongora*	
P71	AF239386.1	*Gongora armeniaca*	985	*Gongora*	
P71	AF239388.1	*Gongora sphaerica*	985	*Gongora*	
P72	AF239382.1	*Gongora gratulabunda*	1211	*Gongora*	
P73	AF239359.1	*Coryanthes macrantha*	1380	*Coryanthes*	
P74	AF239387.1	*Gongora tridentata*	1051	*Gongora*	
P75	AY870078.1	*Dichaea aff. morrisii Pupulin 1189*	959	***NA***	
P76	AF239382.1	*Gongora gratulabunda*	1080	*Gongora*	
P77	AY870035.1	*Kefersteinia trullata*	1586	*Kefersteinia*	
P78	AY870035.1	*Kefersteinia trullata*	1499	*Kefersteinia*	
P79	AF239320.1	*Dichaea neglecta*	950	***NA***	
P81	AF239382.1	*Gongora gratulabunda*	1201	*Gongora*	
P82	AF239387.1	*Gongora tridentata*	1170	*Gongora*	
P83	AF239359.1	*Coryanthes macrantha*	1439	*Coryanthes*	
P84	AF239386.1	*Gongora armeniaca*	963	*Gongora*	
P85	AY870034.1	*Kefersteinia guacamayoana*	1245	*Kefersteinia*	
P85	AY870035.1	*Kefersteinia trullata*	1245	*Kefersteinia*	
P86	AF239359.1	*Coryanthes macrantha*	1402	*Coryanthes*	
P87	AF239349.1	*Stanhopea ecornuta*	1556	*Stanhopea*	
P88	AF239349.1	*Stanhopea ecornuta*	1538	*Stanhopea*	
P90	AF239357.1	*Sievekingia herrenhusana*	1518	***NA***	
P91	AF239319.1	*Dichaea muricata*	1174	***NA***	
P92	AF239349.1	*Stanhopea ecornuta*	1550	*Stanhopea*	
P93	AF239387.1	*Gongora tridentata*	1162	*Gongora*	
P94	AF239387.1	*Gongora tridentata*	1086	*Gongora*	
P97	AY870038.1	*Kefersteinia expansa*	1566	*Kefersteinia*	
P98	AF239382.1	*Gongora gratulabunda*	1267	*Gongora*	
P99	AF470487.1	*Grobya galeata*	1031	*Catasetum*	anisoceras
P100	AY870078.1	*Dichaea aff. morrisii Pupulin 1189*	991	*Dichaea*	
P104	AF470487.1	*Grobya galeata*	862	*Cycnoches*	
P105	AF239359.1	*Coryanthes macrantha*	1342	*Coryanthes*	
P106	AF239319.1	*Dichaea muricata*	1326	*Dichaea*	
P107	AY870023.1	*Stenia aff. wendiae Whitten s.n.*	1507	***NA***	
P108	AY870066.1	*Chondroscaphe escobariana*	1572	***NA***	
P109	AF239349.1	*Stanhopea ecornuta*	1550	*Stanhopea*	
P110	AF239359.1	*Coryanthes macrantha*	1360	*Coryanthes*	
P111	AF239359.1	*Coryanthes macrantha*	1263	*Coryanthes*	
P112	AF239388.1	*Gongora sphaerica*	954	*Gongora*	

Sample ID	Genbank Accession ID	Orchid Species with Highest Affinity	Bit Score	Genus ID (morphology)	Subgeneric ID (species groups)
.	AF239357.1	*Sievekingia herrenhusana*	1600	*Sievekingia*	
P114	AF239357.1	*Sievekingia herrenhusana*	1350	*Sievekingia*	
P115	AF239357.1	*Sievekingia herrenhusana*	1366	*Sievekingia*	
P118	AF239359.1	*Coryanthes macrantha*	1398	*Coryanthes*	
P120	AF470487.1	*Grobya galeata*	1033	*Catasetum*	anisoceras
P121	AF470487.1	*Grobya galeata*	819	*Galeandra*	
P122	AF239359.1	*Coryanthes macrantha*	1467	*Coryanthes*	
P123	AF239349.1	*Stanhopea ecornuta*	1528	*Stanhopea*	
P124	AF470487.1	*Grobya galeata*	831	*Cycnoches*	
P125	AF470487.1	*Grobya galeata*	1051	*Catasetum*	anisoceras
P127	AF470487.1	*Grobya galeata*	955	*Catasetum*	anisoceras
P129	AF470487.1	*Grobya galeata*	1025	*Catasetum*	anisoceras
P130	AF239359.1	*Coryanthes macrantha*	1479	*Coryanthes*	
P131	AF470487.1	*Grobya galeata*	831	*Cycnoches*	
P132	AF239359.1	*Coryanthes macrantha*	1451	*Coryanthes*	
P133	AF239359.1	*Coryanthes macrantha*	1437	*Coryanthes*	
P134	AY870021.1	*Stenia pallida*	1455	***NA***	
P140	AF470487.1	*Grobya galeata*	1025	*Catasetum*	anisoceras
P143	AF239387.1	*Gongora tridentata*	1235	*Gongora*	
P145	AF239387.1	*Gongora tridentata*	948	*Gongora*	
P146	AF239382.1	*Gongora gratulabunda*	1215	*Gongora*	
P147	AF239387.1	*Gongora tridentata*	1253	*Gongora*	
P148	AF239387.1	*Gongora tridentata*	985	*Gongora*	
P149	AF239382.1	*Gongora gratulabunda*	1197	*Gongora*	
P150	AF239387.1	*Gongora tridentata*	1253	*Gongora*	
P151	AF239387.1	*Gongora tridentata*	1191	*Gongora*	
P152	AF239382.1	*Gongora gratulabunda*	1275	*Gongora*	
P153	AF239387.1	*Gongora tridentata*	1148	*Gongora*	
P154	AY870037.1	*Kefersteinia maculosa*	1586	***NA***	
P155	AF239411.1	*Dressleria dilecta*	1037	*Cycnoches*	
P157	AF239359.1	*Coryanthes macrantha*	1465	***NA***	
P160	AF470487.1	*Grobya galeata*	737	*Cycnoches*	
P162	AF470487.1	*Grobya galeata*	842	*Cycnoches*	
P163	AF470487.1	*Grobya galeata*	125	*Cycnoches*	
P164	AF470487.1	*Grobya galeata*	682	*Clowesia*	
P165	AF470487.1	*Grobya galeata*	835	*Clowesia*	
P166	AF470487.1	*Grobya galeata*	1017	*Clowesia*	
P168	AF239359.1	*Coryanthes macrantha*	1380	*Coryanthes*	
P169	AF239359.1	*Coryanthes macrantha*	1296	*Coryanthes*	
P170	AY870055.1	*Warczewiczella guianensis*	1477	***NA***	
P171	AF470487.1	*Grobya galeata*	482	*Cycnoches*	
P177	AF239387.1	*Gongora tridentata*	896	*Gongora*	
P178	AF239387.1	*Gongora tridentata*	1035	*Gongora*	
P179	AF239388.1	*Gongora sphaerica*	1065	*Gongora*	
P182	AF239357.1	*Sievekingia herrenhusana*	1507	*Sievekingia*	
P186	AF470487.1	*Grobya galeata*	674	*Galeandra*	
P188	AF239387.1	*Gongora tridentata*	957	*Gongora*	

Table S5. Fragrance sources used to assemble chemical data matrices of volatile compounds. The literature references, or the GC-MS instrument used, are indicated for each plant species. The corresponding full details of the literature sources are listed in the reference section: Armbruster et al 1989 (*63*); Eltz et al 1999 (*64*); Kaiser 1993 (*59*); Knudsen et al 1999 (*65*); Hentrich et al 2007 (*66*); Hentrich et al 2009 (*67*); Machado et al 2003 (*68*); Marques et al 2010 (*69*); Ramos et al 2000 (*70*); Sazima et al 1993 (*71*); Schwerdtfeger et al 2002 (*72*); Williams & Whitten 1983 (*73*); Williams & Whitten 1999 (*74*).

Family	Subtribe	Species	Reference	Parts
Orchidaceae	Maxillarieae	*Anguloa clowesi*	Kaiser 1993	flower
Orchidaceae	Maxillarieae	*Anguloa dubia*	Kaiser & Gerlach, unpublished	flower
Orchidaceae	Maxillarieae	*Anguloa cliftonii*	Kaiser & Gerlach, unpublished	flower
Orchidaceae	Maxillarieae	*Anguloa ruckeri*	Kaiser & Gerlach, unpublished	flower
Orchidaceae	Maxillarieae	*Anguloa tognettiae*	Kaiser & Gerlach, unpublished	flower
Orchidaceae	Oncidiinae	*Aspasia epidendroides*	Williams & Whitten 1983	flower
Orchidaceae	Oncidiinae	*Aspasia principissa*	Williams & Whitten 1983	flower
Orchidaceae	Oncidiinae	*Aspasia variegata*	Williams & Whitten 1983	flower
Orchidaceae	Catasetinae	*Catasetum expansum*	Williams & Whitten 1983	flower
Orchidaceae	Catasetinae	*Catasetum integerrimum*	Williams & Whitten 1983	flower
Orchidaceae	Catasetinae	*Catasetum longifolium*	Williams & Whitten 1983	flower
Orchidaceae	Catasetinae	*Catasetum macroglossum*	Williams & Whitten 1983	flower
Orchidaceae	Catasetinae	*Catasetum maculatum*	Williams & Whitten 1983	flower
Orchidaceae	Catasetinae	*Catasetum pileatum*	Kaiser 1993	flower
Orchidaceae	Catasetinae	*Catasetum viridiflavum*	Williams & Whitten 1983	flower
Orchidaceae	Catasetinae	*Coryanthes leucocorys*	Kaiser 1993	flower
Orchidaceae	Catasetinae	*Coryanthes mastersiana*	Kaiser 1993	flower
Orchidaceae	Catasetinae	*Coryanthes picturata*	Kaiser 1993	flower
Orchidaceae	Catasetinae	*Coryantehes vieirae*	Kaiser 1993	flower
Orchidaceae	Catasetinae	*Clowesia thylaciochila*	Williams & Whitten 1983	flower
Orchidaceae	Catasetinae	*Clowesia russelliana*	Williams & Whitten 1983	flower
Orchidaceae	Catasetinae	*Clowesia warczewitzii*	Williams & Whitten 1983	flower
Orchidaceae	Catasetinae	*Cycnoches loddigesii*	Williams & Whitten 1983	flower
Orchidaceae	Catasetinae	*Cycnoches sp.*	Williams & Whitten 1983	flower
Orchidaceae	Stanhopeinae	*Embreea rodigasiana*	Williams & Whitten 1983	flower
Orchidaceae	Stanhopeinae	*Gongora aceras*	Williams & Whitten 1983	flower
Orchidaceae	Stanhopeinae	*Gongora atropurpurea*	Williams & Whitten 1983	flower
Orchidaceae	Stanhopeinae	*Gongora armeniaca*	Williams & Whitten 1983	flower
Orchidaceae	Stanhopeinae	*Gongora bufonia*	Williams & Whitten 1983	flower
Orchidaceae	Stanhopeinae	*Gongora cassidea*	Williams & Whitten 1983	flower
Orchidaceae	Stanhopeinae	*Gongora gibba*	Williams & Whitten 1983	flower
Orchidaceae	Stanhopeinae	*Gongora quinquenervis*	Williams & Whitten 1983	flower
Orchidaceae	Stanhopeinae	*Gongora tricolor*	Williams & Whitten 1983	flower
Orchidaceae	Stanhopeinae	*Gongora superflua*	Williams & Whitten 1983	flower
Orchidaceae	Stanhopeinae	*Gongora truncata*	Williams & Whitten 1983	flower
Orchidaceae	Stanhopeinae	*Gongora unicolor*	Williams & Whitten 1983	flower
Orchidaceae	Maxillarieae	*Lycaste aromatica*	Kaiser 1993	flower

Orchidaceae	Maxillarieae	*Lycaste cruenta*	Kaiser 1993	flower
Orchidaceae	Catasetinae	*Mormodes hookeri*	Williams & Whitten 1983	flower
Orchidaceae	Catasetinae	*Mormodes sinuatum*	Williams & Whitten 1983	flower
Orchidaceae	Oncidiinae	*Notylia sp 36020*	Kaiser & Gerlach, unpublished	flower
Orchidaceae	Oncidiinae	*Notylia guatemala*	Kaiser & Gerlach, unpublished	flower
Orchidaceae	Oncidiinae	*Notylia sp 01*	Kaiser & Gerlach, unpublished	flower
Orchidaceae	Stanhopeinae	*Stanhopea anfracta*	Williams & Whitten 1999	flower
Orchidaceae	Stanhopeinae	*Stanhopea annulata*	Williams & Whitten 1983	flower
Orchidaceae	Stanhopeinae	*Stanhopea candida*	Williams & Whitten 1983	flower
Orchidaceae	Stanhopeinae	*Stanhopea costaricensis*	Williams & Whitten 1983	flower
Orchidaceae	Stanhopeinae	*Staanhopea ecornuta*	Williams & Whitten 1983	flower
Orchidaceae	Stanhopeinae	*Stanhopea embreei*	Williams & Whitten 1983	flower
Orchidaceae	Stanhopeinae	*Stanhopea florida*	Williams & Whitten 1993	flower
Orchidaceae	Stanhopeinae	*Stanhopea frymerei*	Williams & Whitten 1993	flower
Orchidaceae	Stanhopeinae	*Staanhopea gibbosa*	Williams & Whitten 1983	flower
Orchidaceae	Stanhopeinae	*Staanhopea grandiflora*	Williams & Whitten 1993	flower
Orchidaceae	Stanhopeinae	*Stanhopea impressa*	Williams & Whitten 1983	flower
Orchidaceae	Stanhopeinae	*Stanhopea jenischiana*	Kaiser 1993	flower
Orchidaceae	Stanhopeinae	*Stanhopea oculata*	Williams & Whitten 1983	flower
Orchidaceae	Stanhopeinae	*Stanhopea panamensis*	Williams & Whitten 1983	flower
Orchidaceae	Stanhopeinae	*Stanhopea pulla*	Williams & Whitten 1983	flower
Orchidaceae	Stanhopeinae	*Stanhopea ruckeri*	Williams & Whitten 1983	flower
Orchidaceae	Stanhopeinae	*Stanhopea saccata*	Williams & Whitten 1999	flower
Orchidaceae	Stanhopeinae	*Stanhopea tigrina*	Williams & Whitten 1983	flower
Orchidaceae	Stanhopeinae	*Stanhopea tricornis*	Williams & Whitten 1999	flower
Orchidaceae	Stanhopeinae	*Stanhopea wardii*	Williams & Whitten 1983	flower
Orchidaceae	Stanhopeinae	*Stanhopea warscewicziana*	Williams & Whitten 1999	flower
Araceae		*Anthurium antioquense*	Schwerdtfeger et al 2002	inflorescence
Araceae		*Anthurium apaporanum*	Schwerdtfeger et al 2002	inflorescence
Araceae		*Anthurium armeniense*	Schwerdtfeger et al 2002	inflorescence
Araceae		*Anthurium huixtlense*	Schwerdtfeger et al 2002	inflorescence
Araceae		*Anthurium nymphaeifolium*	Schwerdtfeger et al 2002	inflorescence
Araceae		*Anthurium sp96082438*	Schwerdtfeger et al 2002	inflorescence
Araceae		*Anthurium rubrinervium*	Hentrich et al 2007	inflorescence
Araceae		*Anthurium sagittatum*	Hentrich et al 2009	inflorescence
Araceae		*Anthurium thrinax*	Hentrich et al 2009	inflorescence
Solanaceae		*Cyphomandra sciadostylis*	Sazima et al 1993	flower
Solanaceae		*Cyphomandra diploconos*	Sazima et al 1993	flower
Solanaceae		*Cyphomandra divaricata*	Kaiser & Gerlach, unpublished	flower
Solanaceae		*Cyphomandra diversifolia*	Kaiser & Gerlach, unpublished	flower
Solanaceae		*Cyphomandra hartwegii*	Sazima et al 1993	flower
Euphorbiaceae		*Dalechampia aristolochifolia*	Kaiser & Gerlach, unpublished	flower
Euphorbiaceae		*Dalechampia brownsbergensis*	Kaiser & Gerlach, unpublished	flower
Euphorbiaceae		*Dalechampia magnoliifolia*	Armbruster et al 1989	flower
Euphorbiaceae		*Dalechampia spathulatha*	Armbruster et al 1989	flower
Arecaceae		*Geonoma macrostachys*	Knudsen et al 1999	inflorescence

Gesneriaceae	*Gloxinia perennis*	Kaiser & Gerlach, unpublished	flower
Burseraceae	*Protium altsonii*	Ramos et al 2000	bark
Burseraceae	*Protium hebetatum*	Ramos et al 2000	bark
Burseraceae	*Protium heptaphyllum*	Marques et al 2010	bark
Burseraceae	*Protium nitidifolium*	Ramos et al 2000	bark
Burseraceae	*Protium paniculatum*	Ramos et al 2000	bark
Burseraceae	*Protium spruceanum*	Machado et al 2003	bark
Burseraceae	*Protium strumosum*	Ramos et al 2000	bark
Araceae	*Spathiphyllum floribundum*	Williams & Whitten 1983	inflorescence
Araceae	*Spathiphyllum humboldtii*	Hentrich et al 2009	inflorescence
Lauraceae	*Ocotea* log 1	Whitten et al 1993	bark
NA	rotten log 2	Whitten et al 1993	bark
NA	rotten log 3	Whitten et al 1993	bark
NA	rotten log 4	Eltz et al 1999	bark
Fabaceae	*Dalbergia* log	Whitten et al 1993	bark

Table S6. Species of euglossine bees used for chemical analyses. The GC-MS instruments and literature sources used are indicated. The total number of individuals analyzed (*n*) per species are indicated.

Species	*n*	Data Source	Sampling locality
Eufriesea surinamensis	3	GC-MS at UC Berkeley	Ometepe, Nicaragua
Euglossa allosticta	13	GC-MS at Bochum	BCI, Panamá
Euglossa azureoviridis	4	GC-MS at Bochum	BCI, Panamá
Euglossa bursigera	11	GC-MS at Bochum	BCI, Panamá
Euglossa cognata	14	GC-MS at Bochum	BCI, Panamá
Euglossa crassipunctata	9	GC-MS at Bochum	BCI, Panamá
Euglossa cyanaspis	5	GC-MS at Bochum	BCI, Panamá
Euglossa deceptrix	11	GC-MS at Bochum	BCI, Panamá
Euglossa despecta	25	GC-MS at Bochum	BCI, Panamá
Euglossa dilemma	30	GC-MS at Bochum	Yucatán, Mexico
Euglossa dissimula	14	GC-MS at Bochum	BCI, Panamá
Euglossa dodsoni	3	GC-MS at Bochum	BCI, Panamá
Euglossa hemichlora	15	GC-MS at Bochum	BCI, Panamá
Euglossa heterosticta	11	GC-MS at Bochum	BCI, Panamá
Euglossa ignivetnris	6	GC-MS at Bochum	BCI, Panamá
Euglossa imperialis	13	GC-MS at Bochum	BCI, Panamá
Euglossa mixta	11	GC-MS at Bochum	BCI, Panamá
Euglossa purpurea	1	Whitten et al 1993	Heredia, Costa Rica
Euglossa tridentata	16	GC-MS at Bochum	BCI, Panamá
Euglossa viridissima	33	GC-MS at Bochum	Yucatán, Mexico
Eulaema bombiformis	7	GC-MS at Bochum	Panamá, French Guiana
Eulaema meriana	41	GC-MS at Bochum	Panamá, French Guiana
Exaerete smaragdina	1	GC-MS at UC Berkeley	Ometepe, Nicaragua

SUPPLEMENTARY REFERENCES:

31. S. Ramírez, R. L. Dressler, M. Ospina, *Biota Colombiana* **3**, 7 (2002).
32. K. M. Kay, J. B. Whittall, S. A. Hodges, *BMC Evol. Biol.* **6**, 1 (2006).
33. Syncroscopy, (2002).
34. K. M. Neubig *et al.*, *Plant Syst. Evol.* **277**, 75 (2009).
35. MacClade v.4.06 [computer program]. Sunderland, MA: Sinauer Associates.
36. *Paup** v4b. [computer program] Sunderland, MA: Sinauer Associates.
37. F. Ronquist, J. P. Huelsenbeck, *Bioinformatics* **19**, 1572 (2003).
38. D. R. Maddison, W. P. Maddison. (2007).
39. A. J. Drummond, S. Y. W. Ho, M. J. Phillips, A. Rambaut, *PLoS Biol.* **4**, 699 (2006).
40. S. R. Ramírez, R. B. Singer, B. Gravendeel, C. R. Marshall, N. P. Pierce, *Nature* **448**, 1042 (2007).
41. J. G. Conran, J. M. Bannister, D. E. Lee, *Am. J. Bot.* **96**, 466 (2009).
42. A. L. S. Gustafsson, C. F. Verola, A. Antonelli, *BMC Evol. Biol.* **10**, (2010).
43. B. Bytebier, A. Antonelli, D. U. Bellstedt, H. P. Linder, *P R Soc B* **278**, 188 (2011).
44. A. Antonelli, C. F. Verola, C. Parisod, A. L. S. Gustafsson, *Biol. J. Linn. Soc.* **100**, 597 (2010).
45. S. R. Ramírez, D. W. Roubik, C. Skov, N. E. Pierce, *Biol. J. Linn. Soc.* **100**, 552 (2010).
46. M. S. Engel, *Am. Mus. Novit.* **3272**, 1 (1999).
47. M. S. Engel, *Am. Mus. Novit.*, 1 (2006).
48. J. M. F. Camargo, D. Grimaldi, S. R. M. Pedro, *Am. Mus. Novit.* **3293**, 1 (2000).
49. S. Cardinal, J. Straka, B. N. Danforth, *Proc. Natl. Acad. Sci. U. S. A.* **107**, 16207 (2010).
50. S. R. Ramirez *et al.*, *Mol. Phylogenet. Evol.* **56**, 519 (2010).
51. O. G. Pybus, P. H. Harvey, *Proc. R. Soc. Lond. B Biol. Sci.* **267**, 2267 (2000).
52. E. Paradis, *P Roy Soc Lond B Bio* **264**, 1141 (1997).
53. E. Paradis, J. Claude, K. Strimmer, *Bioinformatics* **20**, 289 (2004).
54. L. J. Harmon, J. T. Weir, C. D. Brock, R. E. Glor, W. Challenger, *Bioinformatics* **24**, 129 (2008).
55. E. L. Rezende, J. E. Lavabre, P. R. Guimarães, P. Jordano, J. Bascompte, *Nature* **448**, 925 (2007).
56. C. F. Dormann, J. Frund, N. Bluthgen, B. Gruber, *The Open Ecology Journal* **2**, 7 (2009).
57. C. F. Dormann, B. Gruber, J. Frund, *R news* **8**, 8 (2008).
58. S. W. Kembel *et al.*, *Bioinformatics* **26**, 1463 (2010).
59. R. Kaiser, *The Scent of Orchids - Olfactory and Chemical Investigations*. (Givaudan-Roure, Elsevier, Amsterdam, 1993), pp. 676-677.
60. R. P. Adams. (Allured Publishing Corporation, Carol Stream, IL, 2001).
61. Y. Zimmermann, S. R. Ramirez, T. Eltz, *Ecology* **90**, 2994 (2009).
62. M. W. Chase, K. M. Cameron, R. L. Barrett, J. V. Freudenstein, in *Orchid Conservation,* K. W. Dixon, S. P. Kell, R. L. Barrett, P. J. Cribb, Eds. (Natural History Publications, Kota Kinabalu, Sabah, 2003), pp. 69-89.

63. W. S. Armbruster, S. Keller, M. Matsuki, T. P. Clausen, *Am. J. Bot.* **76**, 1279 (1989).
64. T. W. Eltz, W. M. Whitten, D. W. Roubik, K. E. Linsenmair, *J. Chem. Ecol.* **25**, 157 (1999).
65. J. T. Knudsen, S. Andersson, P. Bergman, *Oikos* **85**, 409 (1999).
66. H. Hentrich, R. Kaiser, G. Gottsberger, *Ecotropica (Bonn.)* **13**, 149 (2007).
67. H. Hentrich, R. Kaiser, G. Gottsberger, *Plant Biology* **12**, 587 (2010).
68. L. B. Machado, M. D. Zoghbi, E. H. A. Andrade, *Flavour Fragr. J.* **18**, 338 (2003).
69. D. D. Marques *et al.*, *Acta Amazonica* **40**, 227 (2010).
70. M. F. S. Ramos, A. C. Siani, M. R. R. Tappin, A. C. Guimaraes, J. E. L. D. Ribeiro, *Flavour Fragr. J.* **15**, 383 (2000).
71. M. Sazima, S. Vogel, A. Cocucci, G. Hausner, *Plant Syst. Evol.* **187**, 51 (1993).
72. M. Schwerdtfeger, G. Gerlach, R. Kaiser, *Selbyana* **23**, 258 (2002).
73. N. H. Williams, W. M. Whitten, *Biological Bulletin* **164**, 355 (1983).
74. N. H. Williams, W. M. Whitten, *Plant Species Biol.* **14**, 129 (1999).