

Distribution models and species discovery: the story of a new *Solanum* species from the Peruvian Andes

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Abstract

A new species of *Solanum* sect. *Solanum* from Peru is described here. *Solanum pseudoamericanum* Särkinen, Gonzáles & S.Knapp **sp. nov.** is a member of the Morelloid clade of *Solanum*, and is characterized by the combination of mostly forked inflorescences, flowers with small stamens 2.5 mm long including the filament, and strongly exerted styles with capitate stigmas. The species was first thought to be restricted to the seasonally dry tropical forests of southern Peru along the dry valleys of Río Pampas and Río Apurímac. Results from species distribution modelling (SDM) analysis with climatic predictors identified further potential suitable habitat areas in northern and central Peru. These areas were visited during field work in 2013. A total of 17 new populations across the predicted distribution were discovered using the model-based sampling method, and five further collections were identified amongst herbarium loans. Although still endemic to Peru, *S. pseudoamericanum* is now known from across northern, central and southern Peru. Our study demonstrates the usefulness of SDM for predicting new occurrences of rare plants, especially in the Andes where collection densities are still low in many areas and where many new species remain to be discovered.

Resumen

Se describe una nueva especie de *Solanum* sección *Solanum* endémica del Perú. *Solanum pseudoamericanum* Särkinen, P. Gonzáles & S.Knapp **sp. nov.**, es un miembro del clado Moreloide de *Solanum*. Se caracteriza por presentar inflorescencias bifurcadas, flores con estambres pequeños de 2.5 mm de largo incluyendo el filamento y estilos muy exertos con estigma capitado. En un principio se pensó que la

especie estaba restringida a los bosques tropicales estacionalmente secos del sur del Perú, a lo largo de los valles secos de los ríos Pampas y Apurímac. Los resultados del análisis de los modelos de distribución de especies (SDM) con predictores climáticos identificaron posibles áreas con hábitat adecuado en el norte y centro del Perú. Durante el trabajo de campo en el 2013 estas áreas fueron visitadas. Se descubrieron 17 nuevas poblaciones ubicadas dentro de la distribución predicha, y aunque sigue siendo endémica en el Perú, *S. pseudoamericanum* ahora es conocida en todo el norte, centro y sur de Perú. Nuestro estudio demuestra la utilidad de SDM para predecir nuevos registros de plantas raras, sobre todo en los Andes, donde la cantidad de colecciones sigue siendo baja en muchas áreas y donde muchas especies nuevas aún no se han descubierto.

Keywords

Tropical Andes, Solanaceae, species distribution modelling, Peru, endemism, rare species, Morelloide Clade, *Solanum* section *Solanum*

Palabras clave

Andes tropicales, Solanaceae, modelos de distribución de especie, Perú, endemismo, especies raras, Clado Morelloide, *Solanum* sección *Solanum*

Introduction

The tropical Andean hotspot is one of the most species rich but data poor areas of the world (Swenson et al. 2012). The area is estimated to contain c. 45,000 vascular plant species (Orme et al. 2005; Mittermeier et al. 2005; Olson and Dinerstein 2002), slightly more than the entire flora of Brazil catalogued thus far (<http://floradobrasil.jbrj.gov.br>, accessed on Sept 2013). At the meeting point between the northern and central Andes, Peru alone hosts 19,232 plant species, of which 5,581 (29%) are endemic (Brako and Zarucchi 1998; León et al. 2006; Jørgensen et al. 2011).

Many more species remain to be discovered, however, especially in Peru and Ecuador, where the number of new discoveries per year shows no sign of diminishing (Joppa et al. 2011). In fact, estimates based on taxonomic effort over time project that up to 6,400 species of vascular plants remain to be discovered in the area (Joppa et al. 2011). The high number of undescribed species is not surprising considering the generally low collection density of vascular plants in the Andes (Distler et al. 2009). New discoveries continue to be made even in taxonomically better-known groups such as birds (Hosner et al. 2013; Seeholzer et al. 2012), lizards (Venegas et al. 2013), and mammals (Jiménez et al. 2013; Helgen et al. 2013). It is clear that further collections are needed to completely describe the area's biodiversity and to fully understand species distributions in the Andes.

In an effort to speed up the process of cataloguing species diversity and recording accurate distributions, an approach referred to as Model-Based Sampling (MBS) has been developed (Guisan et al. 2006). MBS uses Species Distribution Models (SDM) to create maps of potentially suitable habitat areas for poorly known and/or yet undescribed species. Areas with similar environmental conditions that are identified in

the modelled maps are then targeted during field work. Although the power of MBS has been shown in previous studies across geographic regions and taxonomic groups (Raxworthy et al. 2003; Le Lay et al. 2010; Boetsch et al. 2003; Williams et al. 2009; Edwards et al. 2005; Guisan et al. 2006; Bourg et al. 2005), more case studies are needed to demonstrate that MBS analyses prior to field work can aid in species description and discovery, especially in tropical areas where collection densities remain low.

Here we present a case study of MBS from *Solanum*, one of the most species rich vascular plant genera in the Andes. In Peru alone *Solanum* includes 299 species, of which 102 are endemic (Knapp et al. 2006; Jørgensen et al. 2011), and many new species continue to be discovered (e.g., Stern and Bohs 2010; Knapp 2010a,b; Farugia and Bohs 2010). Currently we are in the process of revising the Morelloid clade, one of the largest groups of *Solanum* in the Andes lacking a taxonomic monograph. The Morelloid clade consists of five morphological sections (sections *Solanum*, *Campulisolanium*, *Parasolanum*, *Chamasarachidium*, and *Episarcophyllum*), and includes c. 68 species of which c. 58 are endemic to the tropical Andes (Bohs 2005). Several new species have been identified during the taxonomic study and are awaiting formal description. Here we describe one of these, *Solanum pseudoamericanum* sp. nov. Särkinen, Gonzáles & S.Knapp, originally known only from four collections from southern Peru. We use MBS to predict areas containing new populations and confirm the validity of the approach by locating the plants through targeted field work.

Methods

Species description

We examined 26 herbarium specimens in the herbaria listed in the text. These were combined with our field observations from Peru in the identification and description of the new taxon (see Taxonomy below). All specimens are cited in the text and full data is provided in the supplemental file and on Solanaceae Source (www.solanaceae-source.org). We included all specimens examined in the model-based analysis.

Model-based sampling (MBS)

Following the MBS approach by Guisan et al. (2006), we used a SDM method to identify potentially suitable habitat areas for *S. pseudoamericanum*. We chose the machine learning algorithm MAXENT version 3.3.3e (Phillips et al. 2006) for developing the habitat suitability maps. MAXENT uses the principle of maximum entropy to discriminate the range of environments associated with species occurrences from the range of environmental conditions present across the landscape and finds the smoothest climatic envelope that describes the presence points. MAXENT is considered one of the most reliable methods when working with a small number of potentially biased

occurrence records (Hernandez et al. 2006; Pearson et al. 2007; Wisz et al. 2008; Elith et al. 2006), and has been found to outperform other SDM methods in complex but poorly collected areas (Hernandez et al. 2008). MAXENT requires presence points only and can hence be used for modelling poorly known species for which reliable absence records cannot be derived.

Identifying potential new populations

We first ran MAXENT based on the four observed collections from 2012 from southern Peru to identify potential suitable habitat areas for the target species (Model 1). The model was run with default settings (allowing for transformations of the covariates with the default thresholds for conversion, removing duplicate presence records, maximum number of background points = 10,000, maximum number of iterations = 500; convergence threshold = 0.00001; fit regularization parameter = 1; default prevalence = 0.5). To evaluate model performance, we ran it with cross-validation, where the occurrence data is randomly split into two equal-sized groups and one of them is then used for creating the model whilst the other is used for validating the model. We chose cross-validation approach because it uses all of the data for validation, unlike a single training/test split, and is hence more suitable when working with small numbers of occurrence points across a complex landscape (Hernandez et al. 2008).

The model was run with 11 bioclimatic variables at 30 arc second spatial resolution (c. 1 km²) (Hijmans et al. 2005; <http://www.worldclim.org>). Variables used in models as predictors should optimally be independent. In order to avoid colinearity between the climatic variables, we tested for correlations between all the 19 BioClim and the digital elevation model (SRTM) using Principal Component Analyses, and excluded nine variables that were found to be highly correlated with Pearson correlations coefficients of 0.75 or higher (Table 1). The remaining 11 variables included layers describing the seasonality of the habitat (Mean Diurnal Range, Temperature Seasonality, Temperature Annual Range and Precipitation Seasonality) and precipitation and water availability (Precipitation of Wettest Quarter, Precipitation of Driest Quarter, Precipitation of Warmest Quarter, Max Temperature of Warmest Month, Mean Temperature of Driest Quarter) (Table 1). The model was trained using southern Peru alone (-76, -70, -15.2, -12), and the results of the training were then projected over the whole of Peru (-81.6, -68.0, -18.5, 0). This approach of limiting the model training extent avoids model overfitting which leads to underestimation of species' distribution areas (Barve et al. 2011).

The Model 1 output was ground-truthed with additional field work. To target areas where potential new populations of *S. pseudoamericanum* could be encountered, we chose to interpret the Model 1 cumulative output. We chose not to use a threshold approach, where the prediction is divided into a binary map of presence or absence, due to the fact that only four records were used for building the model and hence using a threshold approach would discard valuable data. The cumulative output indicates

Table 1. Principal components analysis (PCA) results of the climatic variables (<http://www.worldclim.org>) used to generate distribution models for *S. pseudoamericanum*. Variables with Pearson correlation coefficients equal or greater than 0.75 were removed.

	PC1	PC2
Cumulative variation explained	47%	70%
BIOCLIM VARIABLES USED	Eigenvectors	
Mean Diurnal Range (BIO2)	0.085	-0.117
Isothermality (BIO3)	-0.095	-0.001
Temperature Seasonality (BIO4)	0.044	0.175
Max Temperature of Warmest Month (BIO5)	-0.277	0.121
Min Temperature of Coldest Month (BIO6)	-0.304	0.160
Temperature Annual Range (BIO7)	0.097	-0.094
Mean Temperature of Driest Quarter (BIO9)	-0.300	0.148
Precipitation Seasonality (BIO15)	0.070	0.346
Precipitation of Wettest Quarter (BIO16)	-0.224	-0.254
Precipitation of Driest Quarter (BIO17)	-0.235	-0.278
Precipitation of Warmest Quarter (BIO18)	-0.109	-0.253

relative suitability, not probability, of occurrence with values ranging from 0 to 100. Grid cell values are calculated as the sum of the cells with equal or lower probability, multiplied by 100 to give a percentage (Phillips et al. 2006). All areas identified in the Model 1 with a relative suitability of more than 40% were considered as high priority areas for ground-truthing during the second field season in April-June 2013. Further occurrence records for the new species were identified through herbarium visits and loans. Local Peruvian herbaria were visited in Arequipa (HUSA), Lima (MOL, USM), Trujillo (HUT) and Cajamarca (CPUN), and loans from several international herbaria were examined (F, MO, US, S, NY).

Potential distribution map

We ran a second model after the second field season, where all new localities identified through field work and herbarium visits and loans were included. Model 2 was run using a total of 26 records, of which four were from our first field trip in 2012, 17 were from our second field trip in 2013, and five from herbarium records (Appendix, Occurrence data). The same 11 climatic predictors and MAXENT parameters were used as in Model 1 (see above). The model was trained using Peru as the study extent, and results were projected to an area that covered the whole of Ecuador and northern Bolivia (-81.0, 65.6, -19.5, 0). A final potential distribution map for *S. pseudoamericanum* was produced based on the cumulative output of Model 2, where all areas with relative suitability above 0.4 (logistic output) were considered as potential areas of occurrence for the species.

Results

We evaluated the relative success of our SDM model predictions based on the mean area under curve (AUC) values of the receiver operating characteristic (ROC) curve of the cross-validation replicates. AUC values close to 1 indicate optimal performance, whilst values close to 0.5 indicate performance equal to random. Both models yielded AUC values > 0.98 indicating good model performance (Table 2). The two most important climatic variables included in Models 1 and 2 were precipitation of the driest quarter, temperature seasonality, and minimum temperature of the coldest month based on jackknife analyses of variable importance. Other important variables included isothermality (mean diurnal range coupled with annual temperature range) and maximum temperature of warmest month.

The results of Model 1, using only the first four records from 2012, showed highly suitable climatic conditions in northern and central Peru in the Departments of Cajamarca, La Libertad, Ancash and Huánuco, as well as in northernmost Piura and Loja, El Oro and Azuay provinces of Ecuador (Fig. 1). The core suitable areas were visited in Cajamarca, La Libertad, and Ancash during the second field season, and 17 new populations were identified (Fig. 1). Five specimens were identified amongst herbarium loans from NY and MO, collected from Piura and Cusco (Fig. 1; Appendix). Surprisingly, no collections of *S. pseudoamericanum* were found in local herbaria in Peru. Model 1 also identified highly suitable habitat areas in southern Moquegua and Arequipa (Fig. 1). These areas were visited in 2012 during our first field season and whilst many *Solanum* collections were made, no specimens of *S. pseudoamericanum* were observed.

Model 2 was run with all collection data from 2012 and 2013, including all herbarium collections (Fig. 2). The Model 2 prediction was generally similar to Model 1, but Model 2 predicted a smaller range size to the species where no suitable habitat areas are predicted to occur outside Peru except in Loja, Ecuador, and only small areas of likely habitat area are found in Arequipa (Fig. 2). The smaller predicted distribution area in Model 2 was despite the fact that the results were projected over larger area covering both Ecuador and northernmost Bolivia. Areas identified in Model 2 as likely habitat areas but which remain unconfirmed include southwest San Martín, Huánuco, northern Pasco, Huancavelica, Junín, and Arequipa, as well as Loja, Ecuador (Fig. 2).

Discussion

Can SDM help in finding rare species?

Previous studies have clearly demonstrated how the use of SDM can dramatically increase detection rates of rare species in the field (Guisan et al. 2006; Raxworthy et al. 2003; Edwards et al. 2005; Boetsch et al. 2003). Our case study adds to this list of studies where records of rare species are used to locate new populations via SDM. Once

Table 2. Model performance values for the two models run to detect suitable habitat areas for *S. pseudoamericanum*.

Model	No. of records	AUC score (mean)	Standard deviation
Model 1	4	0.987	0.009
Model 2	26	0.984	0.014

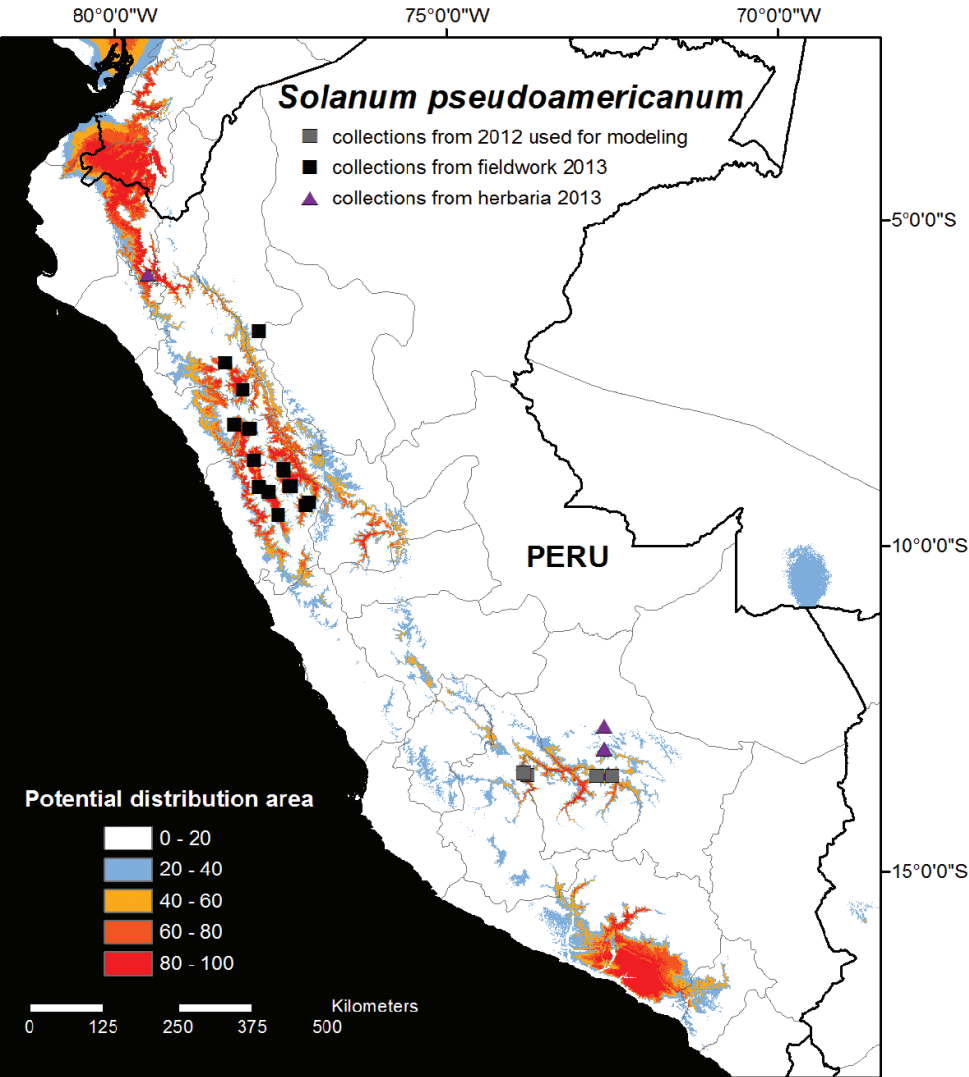


Figure 1. Potential habitat distribution map of *Solanum pseudoamericanum*. The potential habitat areas reflect the cumulative output of the MAXENT model produced using 11 climatic variables with the original four collection localities from 2012 from southern Peru shown as grey squares on the map (see Methods for details). Areas identified as highly suitable (above 40% cumulative probability) in central and northern Peru were visited in 2013 during the second field season, and 17 new collection localities were found as a result (black squares). Five additional collections were identified amongst herbarium loans (purple triangles).

new populations are found, new models are reiteratively run to enhance the distribution models (La Ley et al. 2010). Our example demonstrates that the MBS approach can be used even in more complex and poorly collected areas such as the Andes, and can greatly help in increasing our knowledge of species distribution patterns in highly diverse systems. It is clear from the continuing rates of species discovery in plants (Joppa et al. 2011) as well as in mammals and birds in the tropical Andes (Hosner et al. 2013; Seeholzer et al. 2012; Jiménez et al. 2013; Helgen et al. 2013) that tools such as SDM should be used to predict diversity patterns from the existing sparse data.

Modelled versus observed distribution maps

Here we describe a new species and provide both an observed distribution map as well as a modelled distribution range for the species. With increasing ease of SDM through publicly supported online portals such as BioVel (<http://www.biovel.eu>), the tools are now available for non-specialists to analyse models prior to species publication. Generally, SDMs are still created by GIS specialists rather than taxonomic specialists, but the availability of online portals will hopefully increase the use of SDM amongst taxonomists who are best informed to run such models because of their expert knowledge of species' ecology.

Modelled distribution maps have large benefits over observed distribution maps. Modelled maps, although still incomplete, can be argued to provide a more realistic picture of the actual species' distribution area. This is because modelled maps are less biased by collection densities, and although nowhere near complete, provide a step towards representing species distributions in a more realistic manner. Such maps will also aid in targeting field collecting efforts and provide additional information for planning conservation areas compared to traditional maps.

Whilst advocating the publication of modelled distributions for new species, we fully acknowledge that species distributions are not guided by simple factors such as climate alone. Many factors govern range size, including dispersal limitation, competitive exclusion, habitat destruction, urbanisation and agriculture, as well as species interactions. These complex factors are often dismissed in simplistic SDMs where only bioclimatic predictors are included. Simple SDMs can, however, be used as a starting point for evaluating rare species (e.g., Simon et al. 2011). Firstly, SDMs can be used to establish whether species are truly restricted in their distributions by reducing sampling artefacts such as those presented here. Secondly, simple SDMs can be used as null models to examine whether bioclimatic factors restrict species' distributions or whether other factors, such as dispersal limitation or habitat destruction, are likely at play.

Against the odds?

In the case of *S. pseudoamericanum*, the MBS approach helped us to extent the range size of the newly described species, changing our view of the target taxon from a nar-

row endemic species restricted to only two river valleys in southern Peru to a relatively widespread species that is distributed across Peru. The large increase in the actual observed distribution range of the new species demonstrates not only how poorly collected the Peruvian Andes is for vascular plants, but also how MBS can work with extremely low number of collection records across a complex landscape. This extension of the observed occurrence area of the newly described species was despite the relatively large model training area that was used, where the whole of Peru was considered. The use of relatively large training areas in model training leads to model overfitting and underprediction of distribution areas (Barve et al. 2011), which in our case means that there is likely to be a bias towards underestimating the true potential habitat area of *S. pseudoamericanum*. But is our case study an exception?

Our null hypothesis was that MBS approach cannot be used in such a highly variable landscape as the Andes with as few records as we had available. Our expectations were low for two reasons. Firstly, the climate data available for the Andes through WorldClim suffers from high uncertainty because only a few weather stations were used to interpolate the data (Hijmans et al. 2005). Hence, we expected that the climatic data might not be adequate to produce good models for Andean species. Secondly, we expected poor model performance due to the low number of records used. Although some algorithms, such as MAXENT which was used here, have been found to be less sensitive to small sample sizes than other methods, they still require generally more than 30 records to obtain accurate results (Wisiz et al. 2008; Kadmon et al. 2003).

Results from our case study indicate that both assumptions might not be correct. The high AUC scores shown by our models indicate that informative models can be run with as little data as used here and with climate predictors alone. The climate data appears to be of high enough quality to reveal broad patterns that can be used to identify suitable habitats across poorly explored regions. Variation in climate, and the associated elevational gradients, seem to explain large parts of plant distribution patterns in the Andes (Killeen et al. 2007), and hence such simple bioclimatic models can perform well. This is in contrast to lowland Amazonia where climatic variation, as well as elevational gradients, are much reduced and where the importance of soil in explaining diversity patterns has been highlighted (Hoorn et al. 2010; Higgins et al. 2011; Tuomisto et al. 2003).

Another question is the minimum number of occurrence records required for building accurate distribution models. While it is well established that more data produce better, more accurate models (Wisiz et al. 2008; Kadmon et al. 2003), the question remains how little is enough to produce an informative SDM? The good news based on our case study is that the actual number of records might not be the only thing that matters. As exemplified by *S. pseudoamericanum*, a small number of records can be enough to characterize the climatic niche of a species, given that the few records available adequately describe the environment that the species occupies. In other words, it is not only the pure number of records but the information content that the locality points provide that matters (Kadmon et al. 2003). Optimally, occurrence records should be spatially spread and represent the environmental extremes

that the species occupies (Syfert et al. 2013). Because the information content of the occurrence points is often hard to know a priori, our case study demonstrates the value of running preliminary SDM analyses even when only a handful of records are available. Caution has to be given to how SDM analyses are run with limited data, and care should be especially given to interpreting AUC values which can be inflated due to small number of records (Wisniewski et al. 2008), especially when sampling bias is present (Raes and ter Steege 2006). Despite this caution, our results presented here are encouraging and we see SDMs as a tool that can offer much needed help in our efforts to describe diversity in poorly explored areas such as the Andes.

Taxonomic treatment

The new species described here belongs to *Solanum* section *Solanum* within the Morrelloid clade (sensu Bohs 2005) of *Solanum*. The section contains species that are unarmed shrubs and herbs to 2 m tall with simple or branched glandular or eglandular trichomes, simple to many times branched internodal inflorescences and small berries with multiple small seeds and usually containing stone cells.

Solanum pseudoamericanum Särkinen, P.González & S.Knapp, sp. nov.

urn:lsid:ipni.org:names:77134672-1

http://species-id.net/wiki/Solanum_pseudoamericanum

Figs 2–4

Diagnosis. Like *Solanum americanum* L. but differing in branched inflorescences with flowers spaced along the rachis (not umbellate), rounded calyx lobes that are not reflexed in fruit, style exerted beyond the anther tube for more than 1 mm, stigma globose and capitate, and fruit with the surface not markedly shiny.

Type. Peru: Cajamarca: Prov. Cajabamba, in town of Cajabamba, 7°36'43"S, 78°03'28"W, 2649 m, 9 May 2013 (fl, fr), S. Knapp, T. Särkinen, H.M. Baden, P. González & E. Perales 10575 (holotype: USM!; isotypes: BM!, HUT!, CPUN!).

Description. Herb with woody base, 20–50 cm tall, the individual stems to 1 m long and sprawling. Stems terete or somewhat angled with ridges, pubescent with simple uniseriate 1–4-celled trichomes often clustered along the stem angles; new growth densely pubescent with appressed 1–4-celled simple uniseriate trichomes 0.2–0.8 mm long. Sympodial units difoliate, not geminate. Leaves simple, 4.5–12(–15) cm long, 1.8–8 cm wide, ovate to elliptic; adaxial surface sparsely pubescent with more or less appressed 1–4-celled translucent simple uniseriate trichomes, these denser along the veins; abaxial surface more densely pubescent with simple uniseriate trichomes like those of the upper surface; primary veins 5–8 pairs; base acute and decurrent on the petiole; margins entire or occasionally with shallow lobes in the basal third; apex acute; petiole 0.5–2.5(–5) cm long, occasionally narrowly winged, sparsely pubescent with

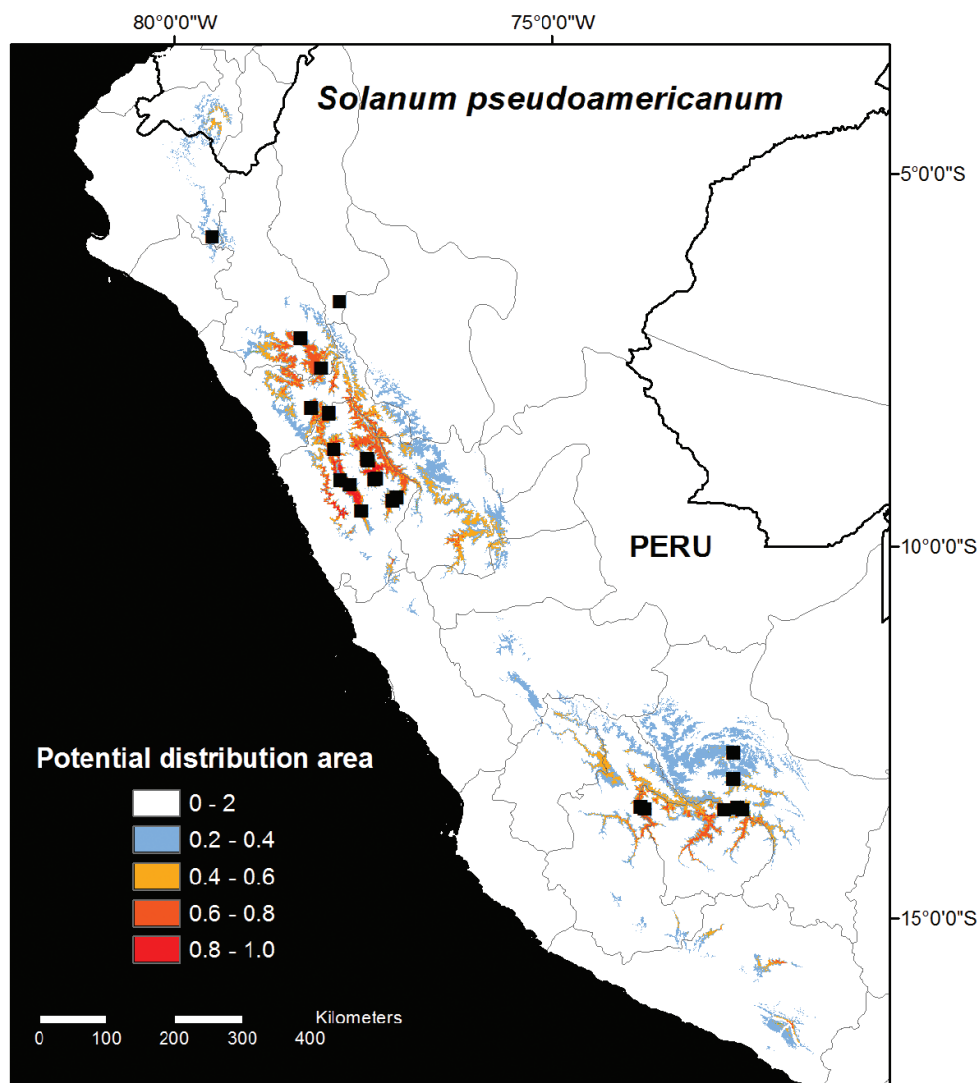


Figure 2. Distribution map of *Solanum pseudoamericanum*. The potential habitat areas reflect the logistic output of the MAXENT model produced using 11 climatic variables with all current known occurrence records (N=26; Model 2).

simple uniseriate trichomes like those of the stems and leaves. Inflorescences lateral and intermodal, 1–2.5 cm long, simple or once-branched, with 3–5(9) flowers, sparsely pubescent with appressed 1–2-celled simple uniseriate trichomes; peduncle 0.4–1.6 cm long, if the inflorescence branched then the peduncle rachis 0.4–0.6 cm long; pedicels 0.6–0.7 cm long, ca. 0.3 mm in diameter at the base and apex, straight and spreading, articulated at the base; pedicel scars spaced ca. 1 mm apart. Buds globose, the corolla only exserted from the calyx tube just before anthesis. Flowers 5-merous, all perfect; calyx tube ca. 1 mm long, the lobes 0.5–0.7 mm long with rounded apices, sparsely

pubescent with 1–4-celled translucent simple uniseriate trichomes; corolla 5–6 mm in diameter, stellate, white with a yellow central portion near the base, lobed slightly less than halfway to the base, the lobes ca. 1.5 mm long, 2 mm wide, strongly reflexed at anthesis, later spreading, densely pubescent abaxially with 1–4-celled simple uniseriate trichomes, these usually shorter than the trichomes of the stems and leaves; filament tube minute, pubescent with tangled uniseriate trichomes adaxially; free portion of the filaments ca. 1 mm long, pubescent like the tube; anthers ellipsoid, yellow, ca. 1.5 mm long, 0.7–0.8 mm wide; ovary conical, glabrous; style 3–4 mm long, exserted (0.5)1–2 mm beyond the anther cone, densely pubescent with 2–3-celled simple uniseriate trichomes at the base; stigma globose and capitate, minutely papillate, bright green in live plants. Fruit a globose berry, 4–9 mm in diameter, green at maturity or green and turning purplish black when ripe, the surface not markedly shiny, lacking stone cells aggregates; fruiting pedicels 4–7 mm long, ca. 1 mm in diameter at the base, spreading and becoming somewhat more woody in fruit, usually remaining on the plant after fruit drops; fruiting calyx lobes spreading or appressed to the berry, not reflexed. Seeds 35–45 per berry, 1.2–1.5 mm long, 0.9–1 mm wide, flattened-reniform, yellowish, the surfaces minutely pitted, the testal cells pentagonal in outline.

Distribution. Endemic to Peru in the upper zones of seasonally dry tropical forests or in mid-elevation montane forests, usually above 2,000 m elevation, with only some overlap between the closely related *S. americanum* that occurs from sea level to 2,200 m in elevation; commonly growing in sandy soils in full sun or partial shade in disturbed sites such as landslides and roadsides or cultivated areas, often in moist depressions in otherwise dry areas, associated with *Schinus molle* L., *Aspidosperma polyneuron* Müll. Arg., *Eriotheca* sp., *Vachellia macracantha* (Humb. & Bonpl.) Seigler & Ebinger, *Alnus acuminata* Kunth, *Solanum probolospermum* Bitter, and *Calceolaria* spp.; (930–)1700–3200(–3735) m in elevation. Based on field and herbarium collections *S. pseudoamericanum* occurs in the Departments of Amazonas, Ancash, Apurímac, Cajamarca, Cusco, La Libertad, and Piura, but based on the modelled habitat suitability map (Fig. 2) it is also likely to also occur in the Departments of Lambayeque, Huánuco, Huancavelica, Ayacucho, Junín, southwestern San Martín, northernmost areas of Lima, and in the Province of Loja in Ecuador.

Ecology. Flowering January–July, fruiting March–July.

Etymology. The name *Solanum pseudoamericanum* refers to the fact the new species greatly resembles *S. americanum* in general form and has been commonly identified under the name of the more common pantropical weed.

Conservation status. The IUCN threat status of *S. pseudoamericanum* is here considered of least concern (LC) based on the relatively large extent of the species occurrence (c. 159,000 km²), although the actual area of occupancy is small (96 km²). The species grows readily in disturbed sites and combined with the fact that the currently known populations are spread across Peru, it appears to have relatively low threat status despite the generally increasing human pressure and habitat destruction in the Andes.

Specimens examined. PERU. Amazonas: Chachapoyas, 8 km along road from Leimebamba to Celendín, between km 417–416, 6°42'48"S, 77°49'05"W, 2634 m,

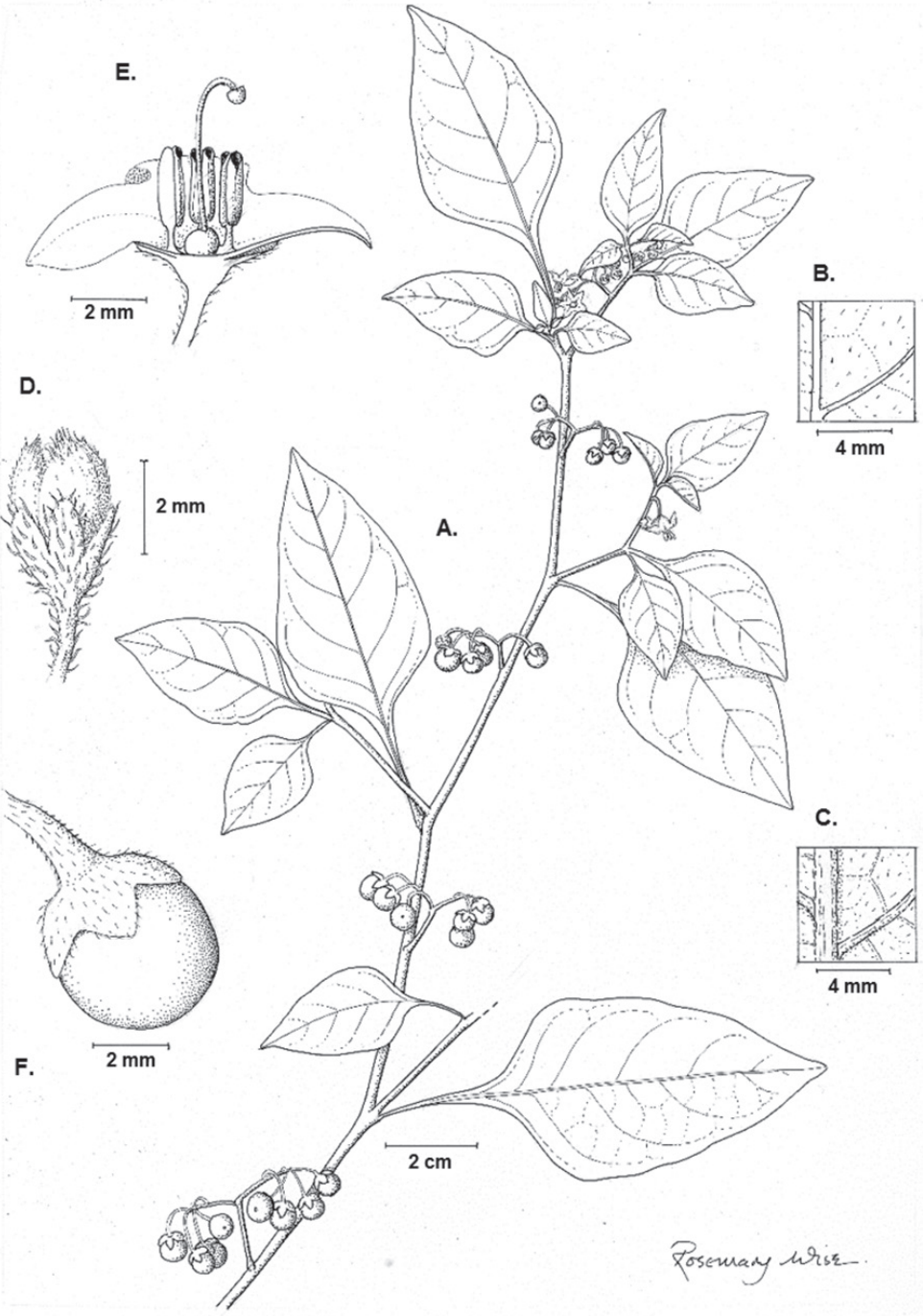


Figure 3. Illustration of *Solanum pseudoamericanum*. A Habit B Adaxial leaf surface C Abaxial leaf surface D Bud E Half flower F Fruit (A–F Knapp 10351). Illustration by Rosemary Wise.

21 Apr 2013 (fl, fr), *T. Särkinen et al.* 4624 (USM, BM). **Ancash:** Pallasca, Puente Chucusvalle over Río Tablachaca, left bank of river (other side of bridge in La Libertad), 8°12'10"S, 77°57'06"W, 2148 m, 11 May 2013 (fl, fr), *S. Knapp et al.* 10604 (USM, BM); Pallasca, ca. 10 km above Puente Chucusvalle over Río Tablachaca on rd to Pallasca, 8°13'25"S, 77°57'23"W, 2148 m, 11 May 2013 (fl, fr), *S. Knapp et al.* 10616 (USM, BM); Huaylas, Dist. Pueblo Libre, just beyond Carapampa village, a few km above bridge over Río Santa, 9°06'28"S, 77°48'42"W, 2637 m, 13 May 2013 (fl, fr), *S. Knapp et al.* 10650 (USM, BM); Huaraz, Huaraz, in city, 9°31'51"S, 77°31'27"W, 3003 m, 15 May 2013 (fl, fr), *T. Särkinen et al.* 4670 (USM, BM); Carhuaz, on rd from Mancos to Musho, before Puente Apachico, 9°10'35"S, 77°40'31"W, 2886 m, 16 May 2013 (fl, fr), *T. Särkinen et al.* 4678 (USM, BM); Corongo, km1-3 on rd to Corongo, a side road from Chimbote-Huaraz main rd, 8°41'38"S, 77°53'51"W, 2334 m, 18 May 2013 (fl, fr), *T. Särkinen et al.* 4686 (USM, BM); Pomabamba, just in the outskirts of Pomabamba on rd leading to Piscobamba, 8°49'27"S, 77°27'12"W, 3008 m, 21 May 2013 (fl, fr), *T. Särkinen et al.* 4730 (USM, BM); Pomabamba, 2-3km from Pomabamba towards Lucma, 8°51'13"S, 77°26'12"W, 2837 m, 22 May 2013 (fl, fr), *T. Särkinen et al.* 4737 (USM, BM); Yungay, ribera del Río, 20 Jul 1977, *Luna, A.*, 70 (USM); Carlos F. Fitzcarrald, on rd between Sapcha and San Luis, 9°05'50"S, 77°21'05"W, 3133 m, 24 May 2013 (fl, fr), *T. Särkinen et al.* 4778 (USM, BM); Carlos F. Fitzcarrald, in San Luis, outskirts of town, 9°05'35"S, 77°19'42"W, 3147 m, 24 May 2013 (fl, fr), *T. Särkinen et al.* 4780 (USM, BM); Huari, c. 5km from Pomachaca on road to Llamellín, 9°23'05"S, 77°06'59"W, 2605 m, 26 May 2013 (fl, fr), *T. Särkinen et al.* 4791 (USM, BM); Huari, on rd from Pomachaca to Llamellín, 9°20'24"S, 77°03'22"W, 2571 m, 26 May 2013 (fl, fr), *T. Särkinen et al.* 4794 (USM, BM). **Apurímac:** ca. 11 km from Chincheros descending to Río Pampa on Ayacucho-Andahuaylas rd (RN3), 13°31'27"S, 73°46'15"W, 2215 m, 7 Mar 2012 (fl, fr), *S. Knapp et al.* 10300 (USM, BM); Chincheros, along Río Pampa on Ayacucho-Andahuaylas rd (RN3), ca. 3-4 km from Puente Pampa on Apurímac side, 13°29'26"S, 73°49'32"W, 2028 m, 7 Mar 2012 (fl, fr), *S. Knapp et al.* 10307 (BM, USM); Abancay, village of Tambo, above Curahuasi, on rd from Abancay to Cusco, Dist. Curahuasi, 13°32'21"S, 72°43'02"W, 2673 m, 10 Mar 2012 (fl, fr), *S. Knapp et al.* 10351 (USM, BM); Abancay, at turn to Santuario Curahuasi, ca. 17 km above Puente Cunyac over Río Apurímac, road Abancay-Cusco towards Curahuasi, Dist. Curahuasi, 13°32'19"S, 72°29'28"W, 2340 m, 11 Mar 2012 (fl, fr), *S. Knapp et al.* 10357 (USM, BM). **Cajamarca:** Cajabamba, in town of Cajabamba, 7°36'43"S, 78°03'28"W, 2649 m, 9 May 2013 (fl, fr), *S. Knapp et al.* 10575 (USM, BM); Cajamarca, km1244 on rd from Cajamarca to San Marcos, just outskirts of Namora village, 7°12'04"S, 78°19'33"W, 2764 m, 24 Apr 2013 (fl, fr), *T. Särkinen et al.* 4640 (USM, BM). **Cusco:** La Convención, Dist. Echarate, Papelpata, Alto Echarate, 12°46'37"S, 72°36'39"W, 931 m, 24 May 2007 (fl, fr), *G. Calatayud et al.* 4062 (NY); Anta, Mollepata, W of Cusco, 13°30'29"S, 72°33'21"W, 3200 m, 10 Jan 1984 (fl), *A.H. Gentry et al.* 44135 (MO); La Convención, Santa Teresa, Dist. Santa Teresa, Carretera Santa Teresa-Hidroeléctrica, Bosque Seco Secundario, 13°07'21"S, 72°36'31"W, 1700 m, 20 Mar 2004 (fl, fr), *I. Huamantupa et al.* 4280 (MO); La Convención, Santa Teresa, Dist. Santa Teresa, Carretera Santa Teresa-

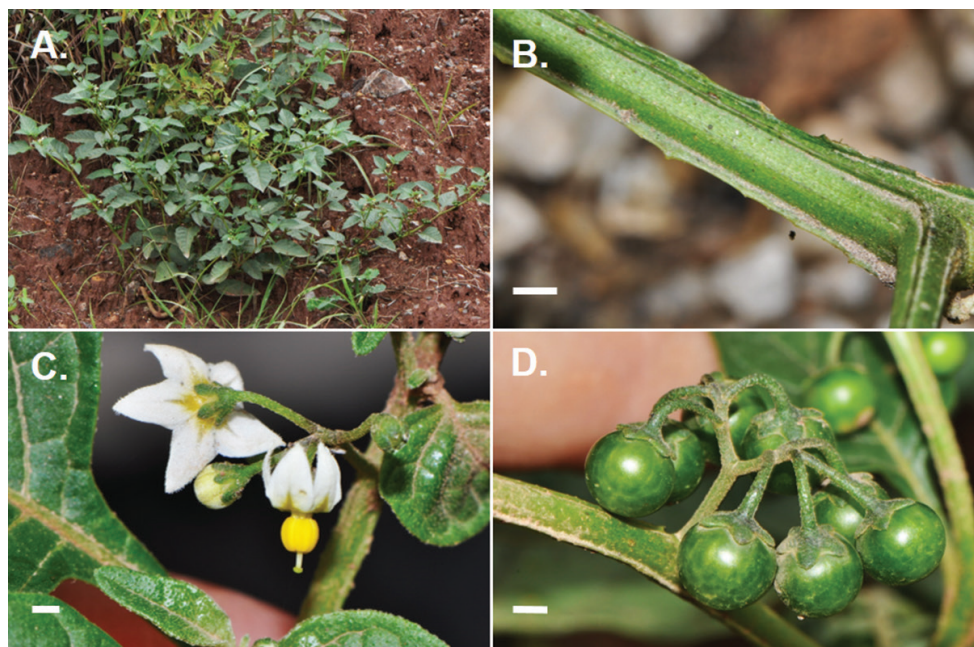


Figure 4. Photos of *Solanum pseudoamericanum*. **A** Habit **B** Ridged stem **C** Flowers with small anthers c. 1.5 mm long, strongly exserted styles and with capitate stigmas **D** Developing fruits which turn purple-black when fully ripe with calyx appressed to the fruit. (A Särkinen *et al.* 4640; B Knapp *et al.* 10357; C, D Knapp *et al.* 10300) Scale bars = 1 mm.

Hidroeléctrica, Bosque Seco Secundario, 13°07'21"S, 72°36'31"W, 1700 m, 20 Mar 2004 (fl, fr), *I. Huamantupa et al.* 4287 (MO,USM). **La Libertad:** Santiago de Chuco, ca. 1 km outside Santiago de Chuco on rd from Shorey and Shorey Chico, at stream crossing, 8°08'38"S, 78°11'08"W, 3735 m, 10 May 2013 (fl, fr), *S. Knapp et al.* 10590 (USM, BM); Santiago de Chuco, 6–8 km below Mollepata on rd to river valley of Río Tablachaca, right side of river, 8°12'03"S, 77°57'11"W, 3735 m, 11 May 2013 (fl, fr), *S. Knapp et al.* 10599 (USM, BM). **Piura:** Huancabamba, Porculla, km 38, 5°50'25"S, 79°29'38"W, 5°50'25"S, 79°29'38"W, 1800 m, 8 Apr 1989 (fl, fr), *S. Llatas Q.* 2348 (NY).

Discussion. Most of the collections of *S. pseudoamericanum* are the result of our intensive collecting of Solanaceae in Peru in the last two years. We suspect that the paucity of earlier collections may in part be due to the resemblance to the widespread and weedy *S. americanum* that has led to botanists regarding this new species as not worth collecting. Widespread species often harbour cryptic diversity (e.g., Cavers *et al.* 2013), especially in groups such as the Morelloid clade, where differences between species are relatively small.

Solanum pseudoamericanum can be distinguished from the similar *S. americanum* by the following suite of characters; berries that are matte or somewhat shiny at maturity, versus very shiny in *S. americanum*, styles that are always exserted to approximately equal to the length of the anther cone, versus styles almost included in the anther cone in *S. americanum*, and globose, bright green stigmas, versus white or pale green stigmas that

are merely a widening of the style tip in *S. americanum*. Other members of the Morelloid clade in Peru without glandular trichomes which grow sympatrically with *S. pseudoamericanum* differ from it in being larger in growth form reaching up to 2 m in height, having larger, always violet flowers and fruits that are green at maturity (*S. probolospermum* Bitter and *S. zahlbruckneri* Bitter), or being smaller herbs up to 30 cm high with similar sized flowers but fruits orange or yellow in colour (*S. corymbosum* Jacq and *S. radicans* L.f.).

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Appendix

Occurrence records of *Solanum pseudoamericanum* (doi: 10.3897/phytokeys.31.6312.app) File format: Comma Separated Values (.csv).

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A taxonomic synopsis of Altingiaceae with nine new combinations

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Abstract

A taxonomic synopsis of the Altingiaceae is presented, including the taxonomic enumeration and distribution of 15 recognized species based on studies of 1,500 specimens from 24 herbaria throughout the distributional range of the taxa. Previous phylogenetic analyses based on several molecular markers have shown that *Altingia* and *Semiliquidambar* are nested within *Liquidambar*. All *Altingia* and *Semiliquidambar* species are now formally transferred to *Liquidambar*, which has the nomenclatural priority. The following nine new combinations are herein made: *Liquidambar cambodiana* (Lecomte) Ickert-Bond & J. Wen, *L. caudata* (H. T. Chang) Ickert-Bond & J. Wen, *L. chingii* (Metcalf) Ickert-Bond & J. Wen, *L. gracilipes* (Hemsl.) Ickert-Bond & J. Wen, *L. multinervis* (Cheng) Ickert-Bond & J. Wen, *L. obovata* (Merrill & Chun) Ickert-Bond & J. Wen, *L. poilanei* (Tardieu) Ickert-Bond & J. Wen, *L. siamensis* (Craib) Ickert-Bond & J. Wen, and *L. yunnanensis* (Rehder & Wilson) Ickert-Bond & J. Wen.

Keywords

Altingia, Altingiaceae, *Liquidambar*, *Semiliquidambar*, taxonomic synopsis

Introduction

The Altingiaceae (the sweet-gum family) are a small family of trees that have been traditionally classified into members with a predominantly temperate distribution (*Liquidambar* L.) and those with a largely tropical to subtropical distribution (*Altingia* Noronha, *Semiliquidambar* H. T. Chang). The family is valued worldwide

for its timber and fragrant resin (styrax) and is locally highly prized for the roots and bark used in traditional Chinese medicine (Vink 1957; Zhang et al. 2003; Ickert-Bond et al. 2007). Most noteworthy to biologists, Altingiaceae show a fascinating intercontinental disjunction in temperate regions of North America, W Asia and some higher elevational montane areas in subtropical Asia and Mexico (Ickert-Bond and Wen 2006). Furthermore, deep molecular divergence coupled with a high level of morphological similarity suggests a conserved morphology of some species, i.e., morphological stasis, an evolutionary phenomenon that has been proposed for many animal groups as well as some plants (Ickert-Bond and Wen 2006). Other members of the Altingiaceae exhibit morphological divergence in response to habitat diversity in the subtropics of eastern Asia. One member of the sweet-gum family, *Semiliquidambar*, has puzzled scientists since its discovery in the 1960s, due to its rarity and morphological intermediacy between the other two genera (Ferguson 1989).

Generally, the Altingiaceae were considered closely related to the Hamamelidaceae (see below). The family is recognized by the solitary capitate woody infructescences with many bicarpellate fruits, and male inflorescences in heads aggregating into racemes. Other systematic characters that differentiate the two families are less well known and understood. It is now generally agreed that the Altingiaceae are a distinct family (Magallón et al. 1999); for detailed comparisons see our other contributions (APG II 2003; Pigg et al. 2004; Ickert-Bond et al. 2005, 2007; Ickert-Bond and Wen 2006; APG III 2009).

The family name Altingiaceae is based on *Altingia*, first named by Noronha (1790) in honor of the former General Governor Alting of the East Indian colonies of the Netherlands (Hayne 1830). The family was formally designated in 1843 by Horaninow (Hoogland and Reveal 2005). The scientific name for *Liquidambar* L. is a combination of the Latin and Arabic words *Liquidus* and *Amber* meaning fragrant liquid or balsam (Yaltrik and Efe 2000). Most authors have recognized *Altingia* and *Liquidambar* to be members of the Hamamelidaceae s.l., most often at the subfamily level, while Endlicher in his *Genera Plantarum* (1840) segregated the Altingiaceae [s. Balsamifluae] from the Hamamelidaceae s. str and placed Altingiaceae in *Juliflorae*, between Platanaceae and Salicaceae, while the Hamamelidaceae were placed in *Discanthae*, between Loranthaceae and Bruniaceae. Subfamily Altingioideae was recognized by J. Williams in his revision of Balfour's Manual of Botany in 1855. Bentham and Hooker (1883) treated *Liquidambar* and *Altingia* as distinct genera alongside other typical genera of Hamamelidaceae, without mention of subfamilies, but they recognized two categories (Abteilungen): (1) with the ovary containing 2- many ovaries, and (2) with the ovary containing a single ovary. Reinsch (1890) retained the traditional one family concept, but departed from the general consensus by splitting the Hamamelidaceae based on morphological and anatomical characters, that he considered to be more fundamental than the fruit, into three subfamilies: (1) Altingioideae including *Altingia* and *Liquidambar* and (2) Bucklandioideae including *Exbucklandia* R.W. Brown and *Rhodoleia* Champ. ex Hook., and (3) Hamamelidoideae including *Corylopsis* Siebold & Zucc., *Dicoryphe* Thouars, *Distylium* Siebold & Zucc., *Eustigma* Gardner & Champ., *Fothergilla* L., *Hamamelis*

L., *Loropetalum* R. Br., *Parrotia* C.A. Mey., *Sycopsis* Oliv. and *Trichocladus* Pers., (*Semiliquidambar* was not known at the time).

Baillon (1871) explicitly excluded *Liquidambar* and *Altingia* from the Hamamelidaceae, contrary to Benthams and Hooker, who included these two genera in the family. Baillon placed them in an intermediate position between Hamamelidaceae and Platanaceae. Traditionally, the Hamamelidaceae s.l. (including Altingiaceae) have been considered as a member of the Hamamelididae Takht. (Cronquist 1981; Takhtajan 1997). Recent molecular studies have shown this assemblage to be polyphyletic and support Altingiaceae and Hamamelidaceae s. str. as members of the saxifragoid clade within a larger rosoid clade (Chase et al. 1993; Magallón et al. 1999; Soltis et al. 2000; APG II 2003; Fishbein and Soltis 2004; Soltis et al. 2007; APG III 2009; Soltis et al. 2011). Furthermore, relationships among some Saxifragales, and the remaining families (Altingiaceae, Cercidiphyllaceae, Daphniphyllaceae, Hamamelidaceae, and Paeoniaceae) also remain unclear (Feng et al. 1998; Qiu et al. 1998; Hoot et al. 1999; Savolainen et al. 2000; Fishbein et al. 2001; Soltis et al. 2000). In maximum likelihood analyses of a five-gene data set, Fishbein et al. (2001) recovered an optimal topology with Daphniphyllaceae and Hamamelidaceae sister to the remaining members of the clade; however, the precise branching order of these two early-diverging members of Saxifragales was unclear. Following Daphniphyllaceae and Hamamelidaceae, Altingiaceae, Cercidiphyllaceae, and Paeoniaceae appeared as successive sisters to a core clade of Saxifragaceae, Haloragaceae and Crassulaceae. Fishbein et al. (2001) also showed that the poor resolution obtained in Saxifragales is not due to violations of assumptions or to combining data partitions having conflicting histories or processes. Rather, their analyses suggest instead that the initial diversification of Saxifragales was indeed rapid. Within Saxifragales molecular phylogenetic results have rarely supported a sister relationship between Altingiaceae and Hamamelidaceae s. str. (e.g., Hoot et al. 1999; Fishbein et al. 2001, but see Fishbein and Soltis 2004). Most recently, based on over 50,000 bp Jian et al. (2008) have found strong support for a clade composed of the Paeoniaceae + woody clade (Cercidiphyllaceae, Daphniphyllaceae, and Hamamelidaceae) Altingiaceae) to be sister to the rest of the Saxifragales. The sister group relationship of Altingiaceae with Hamamelidaceae plus Cercidiphyllaceae and Daphniphyllaceae was also strongly supported in a supermatrix approach by Soltis et al. (2013).

Altingia and *Liquidambar* are each defined by several morphological characters and have been maintained as separate genera in modern taxonomic treatments (Vink 1957; Tardieu-Blot 1965; Zhang et al. 2003). Analyses based on several molecular markers suggest that *Altingia* is nested within *Liquidambar* (Shi et al. 1998; Shi et al. 2001; Ickert-Bond et al. 2005; Ickert-Bond and Wen 2006; Ickert-Bond et al. 2007; Wu et al. 2010) and that *Semiliquidambar* is of intergeneric hybrid origin between *L. formosana*–*L. acalycina* and *A. obovata* or *A. chinensis*. Yet our morphological analysis supports *Altingia* and *Liquidambar* as mutually exclusive sister clades (Ickert-Bond et al. 2005, 2007). The apparent incongruence of these phylogenies appears to be due to morphological convergence.

Characters that distinguish *Liquidambar* from *Altingia* are related to an open wind pollination syndrome and may represent convergences to temperate habitats, particu-

larly, the presence of anthers borne on long filaments and the loss of stomium bifurcations would facilitate the wind dispersal of pollen (Hufford and Endress 1989), while long narrow styles on exserted fruits (Fig. 2D) may aid in the capture of pollen on the broad stigmatic surfaces in open habitats of temperate *Liquidambar*. Furthermore, additional synapomorphies for *Liquidambar* may also represent adaptations for a temperate distribution. These characters (elongate and tapered carpel shape, seeds with distal wings, and more tightly constructed infructescences) are related to seed rather than pollen dispersal. Several other families (e.g., Platanaceae) show a similar convergence among temperate members (Tiffney 1986; Crane 1989).

Character-state changes in *Altingia* seem to correlate with tropical and subtropical environments in eastern Asia and Indochina, whereas changes in *Liquidambar* correlate with temperate sites, where the genus is found today. Of the eight characters defining *Altingia* (Fig. 2A, B), four are reversals (characters 2–5: ratio of leaf length to width, leaf division, venation, and stipule size) (see fig. 86 of Ickert-Bond et al. 2007). The availability of diverse habitats in tropical and subtropical eastern Asia and Indochina facilitated the diversification of *Altingia* species in response to recent active uplifts of mountains in eastern Asia since the Tertiary (Morley 1999; Wen 1999, 2001; Ickert-Bond and Wen 2006).

To maintain the monophyly of the group in question (Potter and Freudenstein 2005), we place all taxa of Altingiaceae in *Liquidambar* (the earliest available name), and maintain the conserved name Altingiaceae for the family. Appropriate new combinations are provided below.

Methods

We evaluated all currently recognized taxa within *Altingia*, *Liquidambar*, and *Semiliquidambar*. Our study is based on: (1) field observations from throughout the distributional range of the taxa, with field visits to sites in Mexico (Veracruz), Vietnam, Cambodia, Indonesia and Guangdong, Hainan, Hong Kong, Hubei, Jiangxi, and Zhejiang provinces in China, and (2) the analysis of specimens in 24 herbaria (including available types): A, BK, BM, C, E, F, FI, FN, FUS, GH, HGAS, HN, IBSC, ISTO, K, LINN, LU, N, NFU, NY, P, PE, SYS, US. We previously provided detailed examination of the fruit anatomy and morphology (Pigg et al. 2004; Ickert-Bond et al. 2005; Ickert-Bond et al. 2006, 2007) and here provide an overview of some of the features that have been used to characterize the genera both for ovulate and staminate infructescences. Measurements were made with an electronic caliper (Mitutoyo mod. CD-6"CS).

Pollen of selected species from all three genera were studied to assess the taxonomic utility in this group. Pollen samples were obtained from herbarium material deposited at F unless otherwise noted (*L. chinensis* [S. Ickert-Bond 1319]; *L. excelsa* [Widjaja s.n.], *L. gracilipes* [S. Ickert-Bond 1344], *L. obovata* [Wang 36153], *L. poilanei* [S. Ickert-Bond 1296], *L. siamensis* [S. Ickert-Bond 1281], *L. acalycina* [Chui 3191 (MO)], *L. formosana* [C. Tan 93025 (2 sheets, MO)], *L. styraciflua* [Vazquez T. 153], *L. chingii*

[*S. Ickert-Bond 1330, S. Ickert-Bond 1320*], and acetolyzed (Erdtman 1960), OTOTO coated (Kelley et al. 1973; Chisoe et al. 1994, 1995), freeze fractured (Skvarla et al. 1988), dried with HMDS (Nation 1983; Chisoe et al. 1994), mounted on stubs with double-sided tape, coated with approximately 200 Å of gold in a Denton Vacuum Desk II vacuum evaporator or sputter coated with a gold/palladium target (60/40) in a Hummer VI Sputter Coating System (Chisoe and Skvarla 1996), and viewed with a JEOL JSM-880 scanning electron microscope (SEM) at 10–15 kV.

Data resources

The data underpinning the analyses reported in this paper are deposited at GBIF, the Global Biodiversity Information Facility, http://ipt.pensoft.net/ipt/resource.do?r=altingiaceae_synopsis.

Taxonomic treatment

Altingiaceae Horan., Osnov. Bot.: 271. 1841, nom. conserv. TYPE: *Altingia* Noronha, 1790. – Validated by a reference to an effectively, but not validly published Blume & J. Fischer (Fl. Javae 17-18: 3. 1829, as *Balsamifluae*) family name with a description in Latin and proposed as an alternative name. – Isonyms: Horaninov, Tetracytys: 25. 1843 (“Altingiaceae (s. *Balsamifluae*)”), validated by a reference to Blume & J. Fischer (1829); see also Lindley, Veg. Kingdom: 253. 14–28 Mar 1846, validated by a description in English). The earlier Hayne (Flora 13: 172. 1830) name is a nom. nud.

Trees, deciduous or evergreen; terminal buds perulate, narrowly ovoid. Leaves petiolate; stipules usually present, linear, ± adnate to base of petioles, caducous, leaving small scars; leaf blade palmately 3–7(or more)-lobed, or if entire lanceolate to ovate or obovate, leathery, discolorous, margin usually crenate-serrate, occasionally entire, venation pinnate or leaf blade palmately 3–7(or more)-lobed, venation actinodromous. Plants monoecious. Male inflorescence a globose to shortly cylindrical, pedunculate, many-flowered head, grouped in terminal or subterminal, compound racemes or panicles; each flower with 1–4 basal bracts. Female inflorescences capitate, subterminal or in lower part of male inflorescence, long-pedunculate, 5–30-flowered. Flowers unisexual. Sepals and petals absent. Male flowers: stamens (4–) many; filaments very short or absent; anthers obovate-ovoid, thecae 2-sporangiate, each dehiscing by a longitudinal slit or rudimentary valve, apex truncate; pollen spheroidal, polyporate. Female flowers: staminodes (also interpreted as carpelloses) absent or needlelike; ovary semi-inferior; ovules ca. 30–50 per locule, axile; styles subulate, divergent, often strongly recurved; stigmas papillose, basal parts or whole styles persistent in fruit. Infructescences globose, base truncate. Capsules woody, dehiscing loculicidally by two 2-lobed valves, also septicidally; staminode teeth and styles not persistent. Seeds many, upper ones sterile, one

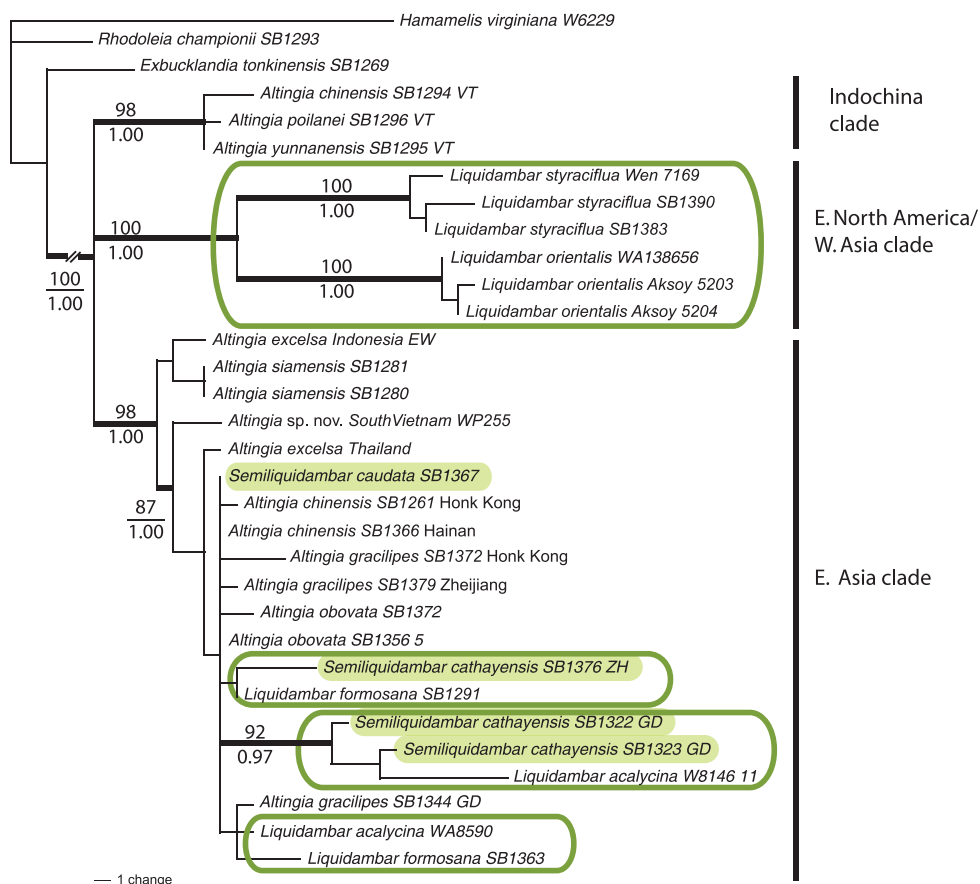


Figure 1. Phylogenetic relationships of Altingiaceae based on maximum likelihood analyses of combined cpDNA data. Phylogram is one of 14 trees ($-\ln L = 9927.72$) derived from maximum likelihood analyses showing rates of substitution under K81uf+I model of substitution evolution (Modified from Ickert-Bond and Wen 2006). Note: Break in branch lengths for the OG at left, and *Semiliquidambar* taxa with green shaded boxes, clades that include *Liquidambar* taxa have green outline boxes.

or a few lower ones fertile, flattened, narrowly winged along margin or only at apex; seed coat thick and hard; endosperm thin. $2n = 32$.

One genus and ca. 15 species: E, W, and SE Asia, Central, and North America.

Pollen morphology appears uniform throughout the family with spherical, pentaporate grains (Fig. 3A, E, I), that show scabrae and irregularly shaped perforations on the tectum (Fig. 3B–C, F–G, J–K) and a tectate-columellate exine (Fig. 3D, H, L; Ferguson 1989). Zavada and Dilcher (1989) found slight differences in the breadth of the columellae between *Liquidambar styraciflua* and *Altingia obovata* based on TEM imagery. Our analysis of the exine using freeze-fracturing and SEM shows slight difference of this characters between *Liquidambar excelsa* (= *Altingia excelsa*, Fig. 3D)

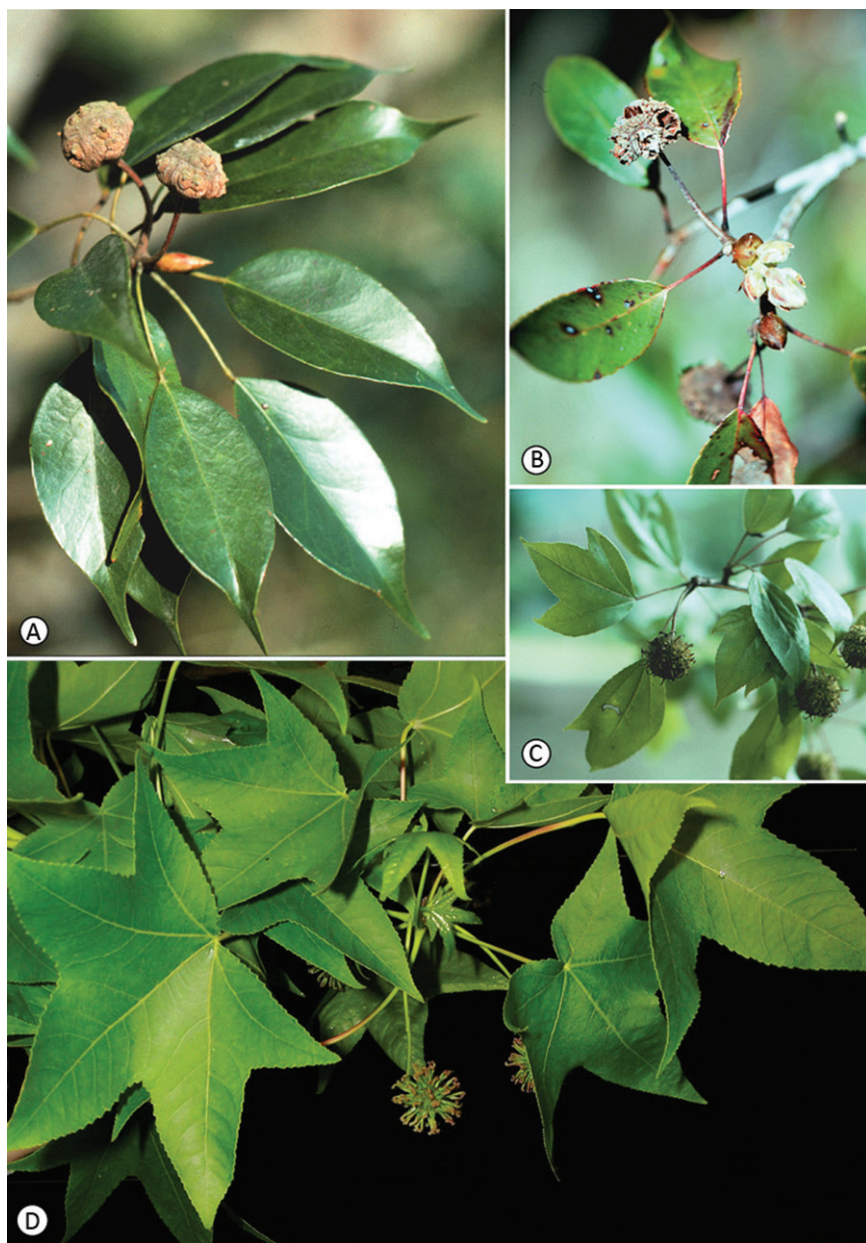


Figure 2. Morphological variation in Altingiaceae. **A** *Liquidambar gracilipes* with obconical flattened infructescences and short styles. Leaves are simple, entire, choriaceous, and show a characteristic drip tip at the apex **B** *Liquidambar siamensis* also shows obconical flattened infructescences with simple leaves that have a serrate margin and lack of a drip tip **C** *Liquidambar chingii* showing variation in leaf morphology from palmately three-lobed leaves at left, to two-lobed leaves and simple leaves on the same branch. Infructescences are globose with long styles **D** *Liquidambar styraciflua* showing palmately five-lobed, chartaceous leaves, and globose infructescences with long styles.

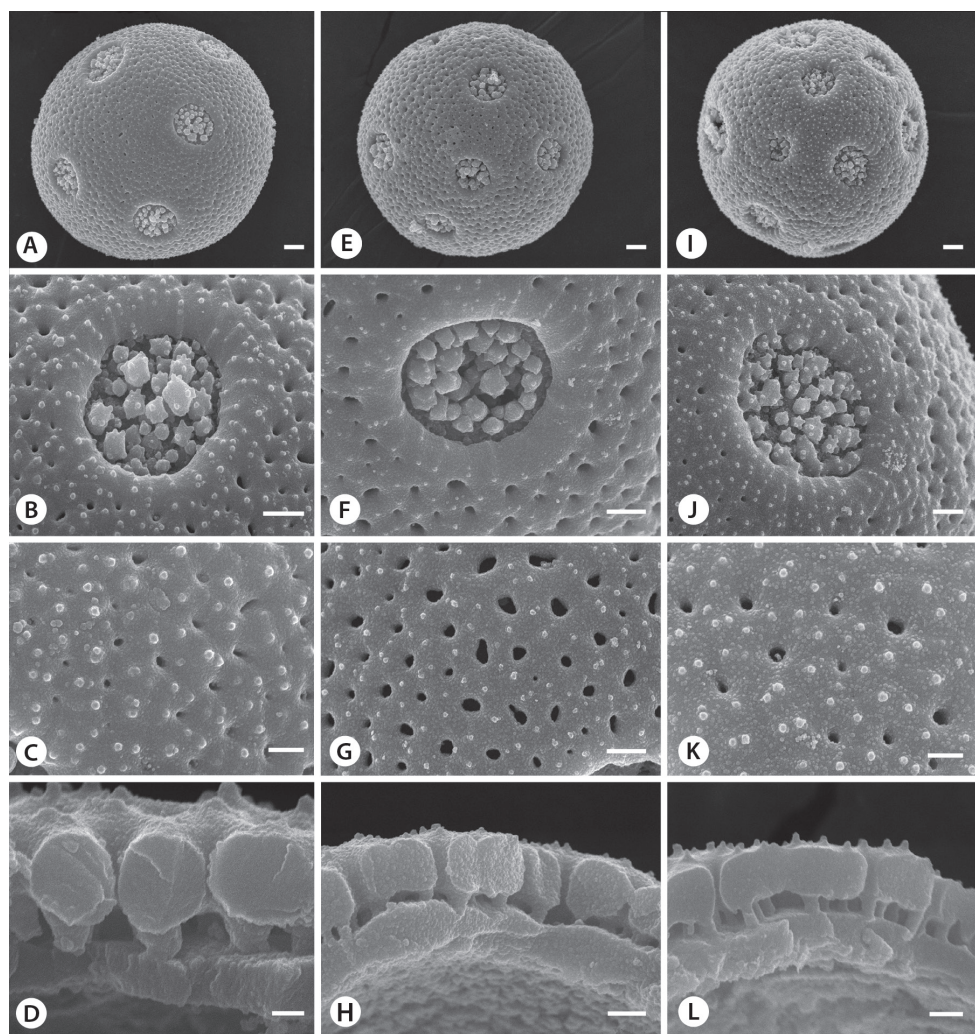


Figure 3. Pollen diversity in Altingiaceae. **A–D** *Liquidambar excelsa* **E–H** *Liquidambar gracilipes* **I–L** *Liquidambar styraciflua* **A** Pentaporate, spheroidal pollen grain **B** Details of pore showing the characteristic disintegration of the tectum **C** Details of the tectal surface displaying scabrae and irregularly-shaped perforations **D** Details of tectate-columellate exine, note columellae slightly thicker than those of comparable magnification in **H** and **E** Pentaporate, spheroidal pollen grain **F** Details of pore showing the characteristic disintegration of the tectum **G** Details of the tectal surface displaying scabrae and irregularly-shaped perforations **H** Details of tectate-columellate exine with thinner columellae than in **D** of *Liquidambar excelsa* **I** Pentaporate, spherical pollen grain **J** Details of circular pore showing eroded tectum in the pore proper **K** Details of tectal surface with irregularly-shaped perforations and scabrae **L** Details of the tectate-columellate exine with thin columellae as compared to *Liquidambar excelsa* in **D**. Scale bars: **A**, **E**, **I** = 2 μ m, scale bars: **B**, **F**, **G**, **J** = 1 μ m, scale bars: **C**, **H**, **K**, **L** = 500 nm, scale bar: **D** = 200 nm.

and *L. styraciflua* (Fig. 3L), but the columellae in *Liquidambar gracilipes* (= *A. gracilipes*, Fig. 3H) appear to be of equal width to those in the ones examined from *L. styraciflua* (Fig. 3L).

Key to the species of *Liquidambar* s.l.*

- 1 Leaves consistently palmately-lobed
- 2 Leaves of mature trees with three lobes, sometimes 5 in juvenile condition
- 3 Infructescence subglobose, with stout styles 4–6 mm long, curved; seeds with circular flange 1. *L. acalycina*
- 3' Infructescences globose, with fine styles 7–10 mm long, coiled; seeds with a terminal wing 7. *L. formosana*
- 2' Leaves of mature trees with more than 3, mostly 5 lobes, sometimes more than 5 lobes present
- 4 Infructescences with narrow style bases (up to 18 mm wide); areas between fruits appearing as a smooth rim 11. *L. orientalis*
- 4' Infructescences with broad style bases (up to 30 mm wide); areas between adjacent fruits appearing braided 14. *L. styraciflua*
- 1' Leaves variable, mostly unlobed or varying to lobed within a single branch
- 5 Leaves tri-nerved, mostly palmately-lobed, seldom unlobed 5. *L. chingii*
- 5' Leaves penninerved, strictly unlobed
- 6 Infructescences obconical with 5–8 fruits, base of the infructescence with a prominent “skirt”
- 7 Leaves coriaceous, 2–3 cm wide, glossy above; margin entire, less often serrate; fruits up to 2 cm broad 8. *L. gracilipes*
- 7' Leaves chartaceous, 3–4 cm wide, dull above; margin serrate; fruits broader than 3 cm 13. *L. siamensis*
- 6' Infructescences mostly subglobose, with 10–30 fruits, base of the infructescence lacking a “skirt”
- 8 Leaves glossy above, margins distinctly revolute upon drying; endemic to Cambodia 2. *L. cambodiana*
- 8' Leaves dull above, margins not curled; of broader distribution in southeast Asia
- 9 Petioles 0.5–1.2 cm long
- 10 Leaves elliptical 4. *L. chinensis*
- 10' Leaves obovate
- 11 Leaf base acute, apex obtuse, lateral veins 8–10, conspicuous beneath 10. *L. obovata*
- 11' Leaf base subcordate to rounded, base acute, lateral veins 5–6, not prominent beneath 12. *L. poilanei*

- 9' Petioles 2–5 cm long
 12 Leaves chartaceous6. *L. excelsa*
 12' Leaves coriaceous
 13 Leaves 4–7 cm long, apex caudate, petioles slender, 1–1.5 mm thick; infructescences 1–2 cm broad3. *L. caudata*
 13' Leaves 8–13 cm long, apex acute, petioles stout, 2–3 mm thick; infructescences 2–3 cm broad.....15. *L. yunnanensis*

* *Liquidambar multinervis* is poorly understood at present and is not included in the key.

***Liquidambar* L., in *Sp. Pl.* 2:999. 1753.**

<http://species-id.net/wiki/Liquidambar>

Altingia Noronha, in Verh. Bal. Gen. v. (1785) Art. ii. 9; ed. II. 41, nom. cons., syn. nov.
Semiliquidambar H. T. Chang, in Acta Sct. Nat. Sunyatseni: 35, 1962, syn. nov.

Type. *Liquidambar styraciflua* L.

1. *Liquidambar acalycina* H. T. Chang, Acta Sci. Nat. Univ. Sunyatseni, 1959 (2): 33. 1959. TYPE. CHINA: Hunan: Wugang, H. T. Chang 4701 (holotype: IBSC 001053!).
http://species-id.net/wiki/Liquidambar_acalycina

Distribution. China (Anhui, Guangdong, Guangxi, Guizhou, Hubei, Hunan, Jiangsu, Jiangxi, Sichuan, and Zhejiang). **Representative specimens examined. CHINA:** **Fujian:** Wuyi Mountain, *Wuyi Shan Team* 80-225 (MO); Wuyishan, Hengkeng, *H.-Y. Zou* 1984 (MO); **Guangdong:** Ruyuan Xian, *C. Wang* 44102 (MO); **Guangxi:** Damiashan, Shanfang Qu, Cidong Xian, Jiuwanshan, *S.-Q. Chen* 14715 (MO); **Guizhou:** Yinjiang Xian, along the trail between Zhangjiaba and Huguoshi on the west side of the Fanjing Shan mountain range, *B. Bartholomew* 1660 (GH); Yinjiang Xian, vicinity of Xiapingsho on the west side of the Fanjing Shan mountain range, *B. Bartholomew* 1758 (GH, MO); **Hubei:** Lichuan, *Metasequoia* Region of Lichuan Xian (Hsien), vicinity of Lojiaba on the W side of the valley, *B. Bartholomew* 1950 (GH); no locality, *E.H. Wilson* 513 (GH); vicinity of Shui-sa-pa, *J.L. Gressitt* 2415 (GH); **Hunan:** Hengshan, Goulowshan, *J.B. Zuo* 356 (MO); Hengshan, Nanyue, Longci, *S.-Q. Chen* 3346 (2 sheets, MO); Yizhang, Mangshan, Datangken, *L.-H. Liu* 542 (MO); **Jiangxi:** De-Xin, De-xin county, *K. Yao* 11486 (GH); Lushan, *M.L. Nie* 91192 (MO); **Sichuan:** S. Wushan, *A. Henry* 52181 (GH); **Zhejiang:** Linan Xian, Changhua, Bailongtanshan, *P.L. Chiu* 961 (MO).

Cultivated. Arnold Arboretum, grown from seeds collected from Hubei province during the Sino-American Botanical Expedition (*SABE* 1950 [GH]) near Lojiaba in the *Metasequoia* Valley of Lichuan Xian in October 1980.

2. *Liquidambar cambodiana* (Lecomte) Ickert-Bond & J. Wen, comb. nov. Basionym: *Altingia cambodiana* Lecomte, Bull. Mus. Hist. Nat. Paris 30: 391 (1924). TYPE. CAMBODIA: Mont d'Éléphant, Se mean phnom, *Poilane* 263 (holotype: P [P00749065!]; isotype: P [P003173561!]).

urn:lsid:ipni.org:names:77134706-1

http://species-id.net/wiki/Liquidambar_cambodiana

Note. A unique species with only three specimens from one locality in Cambodia known. The protologue does not include reference to where *Poilane* 263 is deposited. Furthermore, the two specimens at P are the only ones that include both “*Poilane* 263” and the locality information on the sheet (agreeing with the type description). The other two sheets, one at the Smithsonian (US 150518!) and one at the Edinburgh Botanic Gardens Herbarium (E 00181744!) include only labels that state *Herb. Mus. Paris, Altingia cambodiana* H. Lec. *Institute Scientifique de Saigon – M. Poilane Reçu le 20 May 1921*. These two later sheets (US 150518! And E 00181744!) most likely were part of the original material that Lecomte saw when he described *A. cambodiana*.

Distribution. SW Cambodia. **Representative specimens examined.** CAMBODIA. *M. Poilane* s.n. (US 150518!), (E 00181744!).

3. *Liquidambar caudata* (H. T. Chang) Ickert-Bond & J. Wen, comb. nov. Basionym: *Semiliquidambar caudata* H. T. Chang, Acta Sci. Nat. Univ. Sunyatseni, 1962: 39. 1962. TYPE. CHINA: Fujian: Shaxian County, *FUS expedition 53260* (holotype; FUS 47396- seen as photo!).

urn:lsid:ipni.org:names:77134707-1

http://species-id.net/wiki/Liquidambar_caudata

Semiliquidambar cuspidata H. T. Chang, Acta Sci. Nat. Univ. Sunyatseni, 1962: 39, 1962. TYPE. CHINA: Zhejiang: Ningning, *Hangzhou Botanical Garden* 7303 (holotype: PE [PE1392499!]; isotype: MO [MO4525923!]).

Note. This taxon is similar to *A. gracilipes*, but its leaves are not strongly 3-nerved at the base.

Distribution. Fujian and Zhejiang provinces of China. **Representative specimens cited.** CHINA: **Zhejiang:** Ye Ling, Tai Shun County, *Z.G. Mao* 10237 (MO 4491051); Ying Chuan, Jing Ning county, *S.Y. Chang* 4837 (MO 4491052, MO 4536933).

4. *Liquidambar chinensis* Champ., Kew Journ. Bot. 4: 164, 1852. TYPE. CHINA: Hong Kong, *Champion* 325 (lectotype here designated: K [H2007/01764!]).

http://species-id.net/wiki/Liquidambar_chinensis

Altingia chinensis (Champ.) Oliver ex Hance, in J. Linn. Soc. 13: 103, 1873.

Altingia chinensis f. *pubescens* X.H. Song, in J. Nanjing Inst. Forest 4: 49, 1984. TYPE: CHINA: Guizhou: Libo, X.H. Song 1348 (holotype: NFU!).

Note. No specimen was mentioned in the type description. *Champion* 325 (K) is the only *Champion* specimen of *Altingia* found by us so far. It bears a label with a handwritten identification *Liquidambar* sp. nov. by *Champion* (based on comparison with other holotype material described by *Champion* at K). This specimen is thus designated as the lectotype for *Liquidambar chinensis* Champ.

Distribution. China (Guangdong, Guangxi, Guizhou, Hainan, Hong Kong), Vietnam. **Representative specimens examined.** **CHINA: Guangdong:** Kwai Shan, Tsing-lo-kong village, Ho-yuen district., W.T. Tsang 28544 (A); Lin Fa Shan, Sam Hang Shek T'au Village, Hwei-yang District, W.T. Tsang 25942 (A, E); Naam Kwan Shan, Tsengshing District, W.T. Tsang 20218 (E, MO); Poon Yue district, C.O. Levine 3158 (MO); Xinyi Xian, C. Wang 31828 (MO); **Guangxi:** Chen Pien District, S.P. Ko 56024 (A); Foo Lung, Sup Man Ta Shan, H.Y. Liang 69714 (A); Pingnan Xian, C. Wang 39334 (MO); Shap Man Taai Shan, near Hoh Lung village, SE of Shang-ze, Guangdong border (Shang-ze district), W.T. Tsang 22577 (A); Shap Man Taai Shan, near Iu Shan village, SE of Shang-ze, Guangdong border, Shangze district, W.T. Tsang 22189 (F); She-Feng Dar Shan, S. Nanning, R.-C. Ching 7937 (A); Tong Shan (along Guangdong border), near Sap-luk Po village (Waitsap district), W.T. Tsang 22788 (A); **Hong Kong:** Aberdeen Rd., H.C. Tang 590 (HK), Y.S. Lau 206 (HK); Jardin Botanique, E. Bodinier 1042 (E); Hong Kong Botanical Garden, S. Ickert-Bond 1274 (F); Lokchong, C.L. Tso 21049 (F); Luk Keng, Shek Pan Tam, P.-S. Choi s.n. (HK); Ma On Shan, K.E. Wong s.n. (HK); Shing Mun Country Park, Shing Mun Arboretum, S. Ickert-Bond 1261 (F); **Zhejiang:** Feng Yang Mtn., H.-Y. Zou 307 (A), H.-Y. Zou 761 (MO). **VIETNAM: Lao Cai:** SaPa, A. Petelot 2332 (MO); M. Brillet 19 (P, 2 sheets).

5. *Liquidambar chingii* (Metcalf) Ickert-Bond & J. Wen, comb. nov. Basionym: *Altingia chingii* Metcalf, Lingnan Sc. Journ. 10: 413, 1931. TYPE. CHINA: Fujian: near Zhejiang border, 2800 ft., R.-C. Ching 2244 (holotype: SYS [SYS53818!]; isotypes: A [A 00043389!], IBSC [IBSC 001070!], NY [NY 00356121!], PE [PE 217977!]), SYS [SYS000957151!]).

urn:lsid:ipni.org:names:77134708-1

http://species-id.net/wiki/Liquidambar_chingii

Altingia chingii Metcalf var. *parvifolia* Chun, Sunyatsenia 1: 241, 1934. *Semiliquidambar cathayensis* H. T. Chang var. *parvifolia* (Chun) H. T. Chang, in Acta Sc. Nat. Sunyatseni: 38, 1962. TYPE: CHINA: Guangdong, Ying Tak, Wentong Shan, in mixed woods, H.Y. Liang 61283 (holotype: IBSC [IBSC001069!]; isotype: PE [PE 512712!]).

Semiliquidambar cathayensis H. T. Chang, Acta Sunyatseni: 37, 1962. TYPE. CHINA: Guangdong: Ruyuan, S.P. Ko 53448 (holotype: IBSC [IBSC001068!]; isotype: PE [PE 509073!]).

Semiliquidambar cathayensis H. T. Chang var. *fukienensis* H. T. Chang, in Acta Sct. Nat. Sunyatseni: 38, 1962. TYPE. CHINA: Fujian: Zhangping, *Y. Ling* 4522 (holotype: PE [PE419004!]; isotype: PE [PE83570!]).

Semiliquidambar chingii (Metcalfe) H. T. Chang, in Acta Sct. Nat. Sunyatseni: 38, 1962.

Semiliquidambar chingii (Metcalfe) H. T. Chang var. *longipes* Y. K. Li & X. M. Wang, in Acta Botanica Yunnanica 8: 275, 1962. TYPE. CHINA: Guizhou: Lipo Xian, Wujiahe, *Exped. of Guizhou Academy of Science* 76536 (holotype: HGAS!; isotype: SYS [SYS00072758!]).

Semiliquidambar coriacea H. T. Chang, in Acta Sct. Nat. Sunyatseni: 39, 1962. TYPE. CHINA: Guangdong: Ruyuan, *C. Wang et C.Y. Li* 44074 (holotype: SYS [SYS123416!]; isotype: IBSC [IBSC001071!], PE [PE723787!]).

Distribution. China (Fujian, Guangdong, Guangxi, Guizhou, Jiangxi) and Vietnam (Ha Giang, Lao Cai). **Representative specimens examined.** **CHINA: Guangdong:** Da Ling Tan, Shan Shuai, Li Shan, *Peixiang Tan* 58681 (A); Hua Nan Agriculture University, specimen plant garden, Guangzhou, *Zhiming Wu* 85062 (MO); Nanling National Forest Park, *S. Ickert-Bond* 1307 (F), 1308 (F), 1310 (F), 1311 (F); Zhong Ba Shui, Zhong Ba, Yao Zu county, *L. Deng* 6681 (MO); **Hainan:** Bai Shui Ling, Dali County, Dali Mountains, Chengpo district, Qiungzhou County, *L. Deng* 3549 (MO); Qiongshong, Ying Ge Ling, eastern slope, *National Geographic Society Hainan Expedition* 46 (MO). **VIETNAM: Ha Giang:** Vi-Xuyen District, Minh-Tan community, *H. Ngoc Kinh* 169 (HN).

6. *Liquidambar excelsa* (Noronha) Oken, Allg. Naturgesch. iii. (3) 1539, 1841. Basionym: *Altingia excelsa* Noronha, Verh. Batav. Genootsch. Kunsten. 5(2): 9, 1790. http://species-id.net/wiki/Liquidambar_excelsa

Altingia caerulea Poir., Encycl. [J. Lamarck & al.] Suppl. 5: 545, 1819.

Liquidambar rasamala Blume, Cat. Gew. Buitenz. 6, 1823.

Liquidambar altingiana Blume, in Flora Javae 17: 8, tt. 1,2, 1829.

Liquidambar cerasifolia (Wall. & Griff.) Voigt, Hort. Suburb. Calcutt. 301. 1845.

Distribution. China, Bhutan, India, Indonesia (Java, Bali, Sumatra), Malaya, Myanmar, and Thailand. **Representative specimens examined.** **BHUTAN.** Sarbhang district: above Noonpani, 16 km along Sarbhang-Chirang road, *A. Grieson* 3581 (E). **CHINA. Yunnan:** between Muang Hing and Szemao and the Szemao hills proper, Southern Yunnan, *J.F. Rock* 2768 (GH); between Tengyueh and Lungling, *J.F. Rock* 7174 (GH); no locality, *G. Forrest* 18414 (GH); Ping-pien Hsien, *H.T. Tsai* 61528 (GH); Shweli valley, *G. Forrest* 8763 (E, GH). **INDIA.** East Bengal, *Griffith* 3380 (A, GH, P); Jingale Bam near Nagahill, *Prain* 769 (GH); Kachin Hills, Saden, Upper Burma, Mokim, *Shaik s.n.*; Ind. Or., *Griffith* 286 (GH); Ceylon, Royal Botanic Gardens, Peradeniya, sect. C 276, *D.M.A. Jayaweera* 1617 (GH). **INDONESIA.** Bali, Dedugul, *Dumat* 414 (MO), Bali Timur, Tabana. 2 km W of Candi Kuning, in natural areas of Kebun Raya, beyond introduced *Altingia* forest,

McDonald & Ismail 4966 (E, GH); Dutch West Indies, *van de Koppel* 3299 (MO); East Timor, Koepang, *De Voogd* 1772 (A); Java, *Field Museum* 373260 (A); Java, Ijoboshan, *C.S. Sargen s.n.*; W. Java, Nirmala Estate, gu Halimum area, Blukar and remnant of forest, *M.J. v. Balgooy* 2912 (GH); West-Java, Res. Batavia. Pasir Tjarewed, Land Boland, west of Bogor (Buitenzorg), elev. 600 m., *Bakhuizen* 6372 (MO); West Java, relict tree tp Tjibodas Mt. Garden, Gunung Gedeh (Mt.), *Willem Meijer s.n.* (MO); N. Sumatra, Karo plateau, Kaban Djahe, *J.A. Loerzing* 17368 (A); South East Java, *H. O. Forbes* 1201 (GH); Sumatra, Res. Benkaelen and Afd. Redjang, *T.H. Endert* 1068 (A); Sumatra, Sumatra's Westk. *Moera-Laboch For. Serv, Neth. Ind.* 18066 (A). **MYANMAR.** East of Paungdaw Power Station, west bank of the Paungdaw chaung river, *J. Keenan* 1407 (E), 1528 (MO); Patkai Mts., *G. Schaap* 13 (A); gorge of the Hkrang Hka, North Triangle (Hkinhum), *F. Kingdon-Ward* 20761 (A); south of Hpuginhku village, *J. Keenan* 3679 (E); Tenasserim Division, Tavoy District, *J. Keenan* 1940 (A). **THAILAND.** Nakhon Nayok, Khao Yai National Park, *T. Smitinand* 10848 (E); NE Kjonkaen, Phu Khieo, Game Reserve, ca. 80 km E of Phetchabun, *Kyoto University* 41655 (A).

7. *Liquidambar formosana* Hance, Ann. Sc. Nat. Ser. V. v. 215, 1866. TYPE. CHINA: Taiwan: Martio 1864, *R. Oldham* s.n. (lectotype here designated, P [P00749063!]; isolectotypes: NY [NY00356137!], P [P00749064!]).

http://species-id.net/wiki/Liquidambar_formosana

Liquidambar acerifolia Maxim., in Bull. Acad. Petersb. x. 486, 1866.

Liquidambar edentata Merrill, in Journ. Arnold Arb. viii. 6, 1927. (TYPE. CHINA: Fujian [Fukien]: probably near Foochow, *F.T. Metcalf & T.C. Chang* 877, fruit only (Lectotype here designated: UC [UC 288168!]).

Liquidambar maximowiczii Miq., Ann. Mus. Bot. Lugd. Bat. 3: 200, 1867.

Liquidambar rosthornii Diels, Bot. Jahrb. Syst. 29(3-4): 380, 1900.

Liquidambar tonkinensis A. Cheval. in Bull. Econ. Indochine, n. s. 10: 839, 1918.

Note. A few specimens from Hunan and Guangdong exhibit pubescent stems, leaf surfaces and lobing attributable to young plants, previously annotated by Merrill (1934) as “*L. formosana* var. *heterolobata*”: *Tsang* 20927 (MO, SYS), *B. Xiong* 8845, 9492, 10032 (MO), Hupeh Prov.: *Wilson* 513 (GH-2 sheets). This variety has never been formally published. These specimens are here referred to *L. formosana*.

The type of *Liquidambar edentata* Merrill is a mixture of a) *L. formosana* Hance [UC288168] as a single fruit mounted on the sheet, and b) a large branch of *Acer tutcheri* Duthie. Thus, lectotypification is required. One of the duplicates of *F.T. Metcalf and T.C. Chang* 877 at UC [UC258487] bears a label with the original handwriting of Merrill: “*Liquidambar edentata* Merr.”, but the reference to the original publication (“Journ. Arnold Arbor. 8:6. 1927. Type in US Natl. Herb.”) is not Merrill’s own handwriting and was probably later added (as determined by John Boggan [US] from comparison with other holotype material at US described by Merrill). All duplicates of

Metcalf & Chang 877 [A 258487!, SYS 00072571!, UC 258487!] consist only of the branch of *Acer tutcheri*, without the *Liquidambar* fruit.

Distribution. China (Anhui, Chongqing, Fujian, Gansu, Guangdong, Guangxi, Guizhou, Hainan, Hong Kong, Hunan, Hubei, Jiangsu, Jiangxi, Shanxi, Sichuan, Taiwan, and Zhejiang), Laos, and Vietnam. **Representative specimens examined.** **CHINA:** **Anhui:** *K. Ping* 1597 (MO); Chien Shan Hsien, Tien Chu Shan, Chien Shan Hsien, *C. S. Fan* 280 (GH); Chiuhwashan, *S.C. Sun* 1302 (GH); Wang Shilong, Hefei Shi, Zushan, east slope, *H.L. Yin* 2031 (MO); Hwa Shan, *C.S. Fan* 75 (E); **Chongqing** (formerly in Sichuan Prov.): Chengkou Shi, *T.L. Dai* 103616 (MO); Nanchuan Hsien, *W.P. Fang* 811 (A); **Fujian:** Fan Hsioh Niao, Shaowu and vicinity, *F.P. Metcalfe* 9360 (GH); Hinghwa Dist., *H.H. Chung* 1006 (GH); Nanping Shi, Mangdanshan, *G.-S. He* 6179 (MO); Nanping Shi, 3800 Kan, *G.-S. He* 5677 (MO); Minhow Hsien: Pehling, near village dwellings, *H.H. Chung* 2132 (GH); Sing-Shan, Foochow and vicinity, *C.C. Tang* 4655 (MO); Yenping: Buong Kang, *H.H. Chung* 3589 (GH); Yenping: Cha-ping, on slope, *H.H. Chung* 2901 (GH); **Gansu:** Wan Xian, Bikou, *Z.-Y. Zhang* 14271 (MO); Wan Xian, Motianling Shan, Baishui Jiang Nature Reserve, ENE of city of Bikou, *D.E. Boufford et al.* 37528 (MO); **Guangdong:** Chong Uen Shan near Kau Fung, Loh Ch'ang District, *W. Tsang* 20927 (A, MO); Guangdong, Canton and vicinity, *C.O. Levine* 1731 (MO); Lok F'au Mt., *C.O. Levine* 1572 (MO); Lung T'au Shan, Iu village and Yeung uk village, *Lignan Team* 12347 (MO); Nanling National Forest Park, *S. Ickert-Bond* 1305 (F); Nanling National Forest Park, *S. Ickert-Bond* 1305 (F), *S. Ickert-Bond* 1309 (F); Nanxiong, *L. Deng* 6602 (MO); Near Ninling city, on hill side, *S. Ickert-Bond* 1321 (F); Road to Jiangxi, along river, ca. 5 km S of Shitang city, *S. Ickert-Bond* 1326 (F); Road to Hunan from Nine Peaks, ca. 7 km outside of town, *S. Ickert-Bond* 1324 (F); Wan Tong Shan, Ying Tak district, *T.M. Tsui* 417 (MO); Yang Shan, and vicinity, South of Linchow, Yang Shan district, *T.M. Tsui* 516 (MO); *T.M. Tsui* 660 (2 sheets, MO); Xinyi Xian, *C. Wang* 31824 (MO); Guangchow, White Cloud Hill on the way to the Temple, *H.H. Chung* 866 (GH); **Guangxi:** *A.N. Steward* 442 (GH); Chuen Yuen, *T.S. Tsoong* 81972 (GH); Longjing, Dagingshan, *P.X. Tan* 57605 (MO); Loh Hoh Tsuen, Ling Yun Hsien, *A.N. Steward* 29 (GH); Mts. Surrounding Pa Lau village, near Sui-Luk, SW of Nanning (Sui-luk village), *W.T. Tsang* 21817 (GH); San-min village and vicinity, P'an-ku-shan and Ch'ao- t'ien-shan, Kwei-lin district, *W.T. Tsang* 28068 (GH); Ta Tseh Tsuen, *A.N. Steward* 1075 (GH); **Guizhou:** Jiangkou Xian, Baishuidong (white water cave) above the Minxiao River, SW of Jiangkou, *B. Bartholomew* 773 (GH); Lungli, *H. Handel-Manzetti* 185 (GH); **Hainan:** Bak Sa, *S. K. Lau* 25962 (GH). Bawangshanling, *Z.-X. Li* 3841 (MO); Chim Shan, Maan Ts'uen and vicinity, Ling Shui (Ling- tui) district, *H. Fung* 20245 (MO); Ka Chik Shan, Ka Chik Shan and vicinity, *S.K. Lau* 1645 (GH); Kam Kong, Yik Tsok Mau, *Canton Christian College Herbarium* 7700 (MO); Lingshui Xian, Nanqui, *L. Deng* 3116 (MO); Pak Shik Ling, Pak Shik Ling and vicinity, Ku Tung Village (Ching Mai district), *C.I. Lei* 355 (GH); Yangxin Xian, Longgang Zhen, *C.-L. Ye* 9689 (MO); Ya Xian, *X.-R. Liang* 62343 (MO); Yonlin, Yaichow, *F.C. How* 20124 (MO); **Hong Kong:** Chung Chi College, *S.Y. Hu & K.H. Yung* 46 (MO); Chinese University of Hong Kong campus, *S.Y. Hu* 20064 (MO); *S.Y. Hu* 20953 (GH),

MO); Hau T'ong Shan, Fuk Lung Monastery, Sin-Fung District, Fung Shue, *Y.M. Taam* 779 (GH); Hong Kong University campus, *H.C. Tang* 1473 (GH); Shing Mun Country Park, at the crossroads of Lead Mine Pass and Main Dam, *S. Ickert-Bond* 1260 (F); **Hubei**: Changchow, White Cloud Hill on the way to the Temple, *H.H. Chung* 866 (GH); Chikungshan, border of the provinces of Hupeh and Honan, on the divide between the Yang-Tze and the Hwai-ho rivers, *L.H. Bailey s.n.* (GH); Hinghwa Dist., *H.H. Chung* 1006 (GH); Hupeh (W) Arnold Arboretum Expedition, *E.H. Wilson* 795 (E); Lin District, *C.O. Levine* 3302 (GH); *A. Henry* 5218 (GH); *A. Henry* 7630 (GH); Lung T'au Shan, Iu village and Yeung uk village, *Lignan* 12347 (MO); Western Hupeh, Feng Heang, *E.H. Wilson* 513 (GH); W. Hupeh, *E.H. Wilson* 218 (GH); Xinyi Xian, *C. Wang* 31824 (MO); Yang Shan and vicinity, South of Linchow, Yang Shan district, *T.M. Tsui* 660 (MO); Yenping, Cha-ping, *H. H. Chung* 2901 (GH); **Hunan**: Henyuang, Goulowshan, *J.B. Zuo* 356 (MO); Liuyuang Xian, Longfa Zhen, Shizhu Feng, *B. Xiong* 2922 (MO); P'ing T'ou Shan, T'ang Wan village, Yi Chang district, *W.T. Tsang* 23613 (GH); Yushun Xian, Zhengxi, *X-G. Li* 204950 (MO); **Jiangsu**: Changsu, *T.Y. Cheo* 1149 (MO); Haichow village, *J. Hers* 2264 (GH); Hua Shan, Nanking, *W.R. Carles s.n.* (E); Kinling, *E.H. Wilson* 1639 (GH); Liu Liu Shan, near Haichow, *J. Hers* 608 (GH); Mao Shan, Tanjang, *Tso* 1803 (GH); Nanking, *S.S. Chien* 1019 (GH); Yun-Tai-Shan, northern headland of Liuhe, extending into Kou Linhong, Lianyungong Bay, *SAYTBET* 45208 (GH); Yun-Tai-Shan, Lian-yun-gang, NE of Jiangsu prov., *K. Yao* 8505 (MO); Yuntai, Zikiang Shan (Purple Mountain), N extension of Mao Shan; NE of Sun Yat-Sen Memorial and Tomb, *SAYTBET* 45272 (GH); **Jiangxi**: Chuen Yuen, *T.S. Tsoong* 81972 (GH); De-Xin county, *K. Yao* 11561 (GH); Gangmaiping Xiang Huangyangjie, *B. Xiong* 5706 (MO);); 3 km from Julianshan Nature Preserve entrance, *S. Ickert-Bond* 1327 (F); Kinkiang, *E.H. Wilson* 1628 (GH); Oo Chi Shan, near Lam Uk Village, Lungan district, *S.K. Lau* 4809 (GH); San-min village and vicinity, P'an-kushan and Ch'ao-t'ien-shan, Kwei-lin district, *W.T. Tsang* 28068 (GH); Sang-su-ling, near Sih-cha-chieh Kan River, about 60 mi south of Nanchang, Kinagsi, *H.H. Chung* 40 (GH); **Shanxi**: Yuyang Xian, Xiaoguojiaba, *K.-J. Fu* 5799 (MO); **Sichuan**: *T. T. Yu* 229 (GH, MO); **Taiwan**: Chiayi Hsien, Fanlu Hsiang, area nearby Pantienyen, *Y.-R. Lin* 516 (MO); Formosana Hokuto, *A. Faurie* 279 (GH); Hsinchu Hsien, Wufengm Wushishan, *S. Saito* 8371 (MO); Kelung, *O. Warburg* 9810 (GH); Nanto, Province Nanto, *E.H. Wilson* 10031 (GH) Wu Tsau street, *T. Sozan* 13490 (GH), *L.L. Liu et al. s.n.* (MO); Taipei, University campus, *Y.R. Cheun s.n.* (GH, MO); Tamsui, *A. Henry* 425 (GH); Taitum, *U. Faurie* 45 (GH); **Zhejiang**: Feng Yang Mountains, *H.-Y. Zou* 140 (GH); Kwangsi, Yung Hsien, Ta Tseh Tsuen, *A.N. Steward* 1075 (GH); Langquan, Taishui, *R.C. Ching* 4823 (GH); Lishui, Dagantou, *S. Chang* 6242 (MO); Sang-su-ling, near Sih-cha-chieh Kan River, about 60 li south of Nanchang, Kinagsi, *H.H. Chung* 40 (GH); Taichow, *R.-C. Ching* 1578 (GH), *R.-C. Ching* 4823 (GH); Tien Tai Shan, Kwohchingze, *C.Y. Chiao* 14238 (GH). **LAOS**: Bolikhamxay, Khamheut district, Ban Namphao, ca. 5 km east of town proper, *D.D. Soejarto* 11399 (GH); haut plateau, bassin d'atopen, *Harmand* 13007 (P). **VIETNAM**: **Cao Bang**: Ha Lang, municipality Thang Loi, vicinity of Thang Loi village, *P.K. Loc et al.* 1704 (MO); **De Quang**: Quang Tri,

Lao Bao, *M. Poilane* 1317 (P); **Bac Giang**: Sau (Annam), Tonkin, foret de Pho-ve, *A. Chevalier* 2964 (P); **Ha Tay**: Da Chong, *A. Petelot* 5747 (A); Mt. Bavi National Park, close to Park headquarters, roadside, *S. Ickert-Bond* 1290 (F), Mt. Bavi National Park, roadside, *S. Ickert-Bond* 1291 (F); **Hoa Binh**: Kim Boi, *T. Tien Phuong* 2539 (HN); **Lang Son**: Dong Dang, *B. Balansa* 1156 (P); Huu Lien District, Huu Lien Municipality, Huu Lien Protected Area, near village of Lan Cau, *D.K. Harder et al.* 4180 (MO); Lai moi sau cuoi, Savanne cay go, Chi lang, *N. Tang Khoi* 420, 421 (HN); **Nghe An**: Ke hhe, *Donnat* 38180 (P); Reserve forestier de Co - Ba (Vie-Nhe), *F. Fleury* 30170 (P); **Ninh Binh**: Cuc Phuong National Park, headquarters, east of helipad, *N.M. Cuong* 93 (GH, MO); **Phu Tho**: Foret de Dao gia, pres de Phu Tho, *A. Chevalier* 37471 (P); **Than Hoa**: Phong Y, *M. Poilane* 1610 (P); **Tuyen Quang**: Reserve forestiere de Niu-La, *F. Fleury* 37961 (F); **Vinh Phuc**: Ngoc Thanh, Me Linh, *Phuong* 4647 (2 sheets, HN).

8. *Liquidambar gracilipes* (Hemsl.) Ickert-Bond & J. Wen, comb. nov. Basionym: *Altingia gracilipes* Hemsl., in Hook. Ic. Pl. t. 2837, 1907. TYPE. CHINA: Fujian, S.T. Dunn Hb. Hongk. 2682. (Lectotype here designated HK [HK 10948!]; islectotypes: A [A 00043390!], IBSC [IBSC 001001!])
 urn:lsid:ipni.org:names:77134709-1
http://species-id.net/wiki/Liquidambar_gracilipes

Altingi gracilipes Hemsl. var. *serrulata* Tutcher, Hong Kong Administrative Report 1914: M31. TYPE. CHINA, Hong Kong, Ukautang, *W.J. Tutcher* Herb. Hongkong No. 10947) (holotype: HK [HK 10949!, collected 25/5/1914]; isotypes: HK [Garden Department Hong Kong 1711!, collected 25/5/1914], HK [HK10950!])

Altinga gracilipes Hemsl. f. *uniflora* H. T. Chang, Sunyatsenia 7: 74: 1948. TYPE. CHINA, Fujian, *Y. Ling* 2295 (holotype: IBSC 001003!)

Distribution. China (Fujian, Guangdong, Hong Kong, and Zhejiang). **Representative specimens examined.** CHINA: **Fujian**: Jian Ou, Wang Mu Lin, *Fujian Forestry Coll.* 41 (MO); Long Yan, Jiang Shan, Shuang Che, *H. Chen* 1272 (F, MO); Nan Ping, Mang Tang Mountains, *G. He* 4690 (MO), *G. He* 5479 (MO), *G. He* 6155 (MO); Yong An, Hong Tian, *Fujian Team* 5567 (MO); Yungyung Mts., Fujian, central, *S.T. Dunn* 2682 (GH); **Guangdong**: Chaochow district, *N.K. Chun* 42718 (MO); Da Pu, Yan Shang, Min Ying, *L. Deng* 5438 (MO); Da Pu, Feng Xi, *X. Wang* 153 (MO); Da Pu, Ying Jian, *Z. Li* 963 (MO); Da Pu, Pu Cheng, *X. Li* 202545 (MO); Feng Xun, Da Tian, Bei Xi, *X. Li* 200921 (MO); He Yuan, Xin Feng Jian, *B. Yu* 103106 (MO); He Ping, Qing Zhou, *Z. Wei* 120579 (MO); Jiu Lian Xiang, Xiao Shui, *Z. Wei* 120217 (MO); Lian Ping, Zhong xin, Da Shui, *Y. Liu* 242 (MO); Ping Yuan, *L. Dong* 4331 (MO); Qiao Lin, Shi Hu, *L. Dong* 4685 (MO); Raoping Xian, *N.K. Chun* 42718 (2 sheets, MO); Rao Ping, Feng Huang, *X. Li* 200701 (MO); Rao Ping, Feng Huang Yu, *H. Zeng* 72101 (MO); Tung Koo Shan, Tapu district, Tan Shue, *W.T. Tsang* 21697 (GH, HK, P); Wu Hua, Shuang

Hua, *Z. Li* 1162 (MO); Wu Hua, Qi Mu Zhang, *Y.-J. Wang* 56484 (MO); Xin Yi, Da Wu Lin, *Z. Feng* 36293 (MO); Yam Na Shan [Yit Nga Shan] Mei [Kaying] District, *W.T. Tsang* 21514 (GH), Yunfu Xian, *C. Wang* 37057 (MO); **Hong Kong:** *M.T. Sin & W.K. Woo s.n.* (HK); Pat Sin Leng Country Park, Nam Chung trail, *S. Ickert-Bond* 1272 (F); Nam Chung, *D. Lau* 43 (GH, MO), *T.W. Lau* 98 (GH, MO), *Y.-W. Lam* 1429 (HK), *K.-L. Yip* 4082 (MO); Pat Sin Leng, Plover Cove Country Park, Plover Cove Reservoir, *S. Ickert-Bond* 1266 (F); Pat Sing Leng Nature Trails, *L.T. Lo* 629 (HK); Sha Tau Kok-luk Keng, *S.Y. Hu* 9984 (GH); Wu Kau Tan N.T., *S.Y. Hu & Y.C. Kong* 175 (MO), *Y.S. Lau* 2634 (HK); **Zhejiang:** Between Ping Yung and Tai Suan, *R.-C. Ching* 2199 (E); Feng Yang Mtn., *H.-Y. Zou* 79 (MO), *H.-Y. Zou* 151 (GH), *H.-Y. Zou* 762 (GH); Long Qian, Ju Shui, *P.L. Chiu* 1072 (MO); Qing Yuan, Wu Du Mountain, *Z.G. Mao* 10231 (MO); Shui Chang, Pu Nang, *P.L. Chiu* 1470 (MO); Taishun Hsien, *Y.L. Keng* 316 (GH).

9. *Liquidambar multinervis* (Cheng) Ickert-Bond & J. Wen, comb. nov. Basionym: *Altingia multinervis* Cheng, in Notes For. Inst. Nat. Centr. Univ. Nanking, Dendrol. Ser., No. 1, 3 1947. TYPE. CHINA: Guizhou: Chishui, Tiantaishan, 29 Oct 1938, *P.C. Tsoong* 256 (holotype, N seen as photo!; isotype, SYS 72729!).

urn:lsid:ipni.org:names:77134710-1

http://species-id.net/wiki/Liquidambar_multinervis

Note. Specimens of *L. multinervis* show long-petioled papery leaves, with 10 lateral veins, and serrate margin, closely resembling *L. siamensis* or *L. excelsa*. Broken infructescences of the specimen at N suggest few fruits per infructescence, thus underscoring the closeness to *L. siamensis*, while Cheng (1947) described its close affinity with *L. yunnanensis*. This species is poorly understood, we have only seen the type collection that consists of a branch with multiple leaves and a crushed infructescence. The distributional discontinuity of *L. multinervis* in N Guizhou from those of *L. siamensis* and *L. excelsa* much further south may warrant specific status, but more material is needed. N Guizhou is not well explored botanically and with more exploration of this area, we might be able to better characterize this taxon in the future.

Distribution. China, N Guizhou.

10. *Liquidambar obovata* (Merrill & Chun) Ickert-Bond & J. Wen, comb. nov. Basionym: *Altingia obovata* Merrill & Chun, in Sunyatsenia, 2: 238, 1935. TYPE. CHINA: Hainan: Yaichow, Ngai Yen, *F.C. How* 70369 (holotype: NY [NY 00356124!]; isotypes: A [A00043391!], HK [HK1713!], SYS [SYS 00095710!]).

urn:lsid:ipni.org:names:77134711-1

http://species-id.net/wiki/Liquidambar_obovata

Distribution. China, Hainan. **Representative specimens examined.** CHINA: Hainan: no locality, *H.Y. Liang* 64371 (E), *H.Y. Liang* 64734 (GH), *H.Y. Liang* 62594 (P);

C. Wang 35691 (MO); *C. Wang* 35897 (GH); Ding'an Xian, *C. Wang* 36153 (MO); Lingshui Xian, *C. Wang* 36638 (MO); Mo San Leng, *N.K. Chun* 44321 (GH); Qiong Zhong county, Cheng Po district, Da Li village (up?), Baishui Ling, Deng, *Liang* 3685 (MO); Waning County, Liulian Mts., *Y. Zhong* 4321 (MO); Waning county, Wumie district, Tongtie mountain (Ling), *Z. Li* 4972 (MO).

11. *Liquidambar orientalis* Mill., Gard. Dict. ed. 8, n. 2, 1768.

http://species-id.net/wiki/Liquidambar_orientalis

Liquidambar imberbis Ait., Hortus Kew. (W. Aiton) 3: 365, 1789.

Liquidambar orientalis Mill. var. *integriloba* Fiori, Ann. R. Inst. Sup. Agr. For. Naz. 9: 153, 1924.

Note. *Liquidambar orientalis* still needs lectotypification. The prologue states as follows: ‘The seeds were sent by Mr. Peyssonel from the Levant, to the French king’s garden at Marli, a few of which were sent to me by Mr. Richard, the king’s gardener, which succeeded in the Chelsea [Physic] garden.’

When examining type material from FI of var. *integriloba* and the typical *L. orientalis* no clear distinction of lobing was observed. The FI specimens were identified as *L. orientalis* var. *integriloba* (*A. Fiori* 230 – 2 sheets, *A. Fiori* 231 – 2 sheets, *G. Jannone* s.n. – 1 sheet, *A. Fiori* s.n. – 1 sheet). When comparing material from Turkey (ISTO), the specimens collected by *Aksoy* 5202 (2 sheets) have margins that are sometime lobed beyond the typical 5 – lobing, also observed in *Aksoy* 5201 (ISTO-1 sheet), and *Aksoy* 5203 (ISTO - 4 sheets), while specimens identified as *L. orientalis* var. *integriloba* lack such lobing, as seen in *Aksoy* 5204 (ISTO-3 sheets) also from Turkey. This specimen (*Murray* 1020 – GH, MO) lacks the typical lobing of var. *orientalis* and could thus be considered var. *integrifolia*.

Distribution. Southwestern Turkey and on the Greek island of Rhodes. **Representative specimens examined.** **TURKEY:** C₂ Mugla: Kaycepra, *Goner* 9145 (MO); C₂ Mugla: Kargi, 10 km N of Fethiye, *G. Polunin* 14923 (E); Mughla near Dogusbelen, *Danish Bot. Trans-Asia Expedition III, No. 2081* (E); Mugla, between Köycefiz and Kavak *Aksoy* 5203 (ISTO); Mugla: Distr. Marmaris, Er. Koezcegiz, *Khan* 45 (E); Isparta, Sütçüler, Karacaören *Aksoy* 5204 (ISTO); Koezcegiz, *J.S. Andersen* 2081 (E); near Severagno, *Khan et al.* 45 (E); Paludal place (marsh), 1 km NE of Marmaris, *E. Murray* 1020 (A, E, MO); Vil. Mughla near Dogus belen, *P.H. Davis* 13474 (E). **GREECE:** collini a sud di Severagno, *G. Jannone* s.n. (FI); Peveragno, secus rivulum “Pelicano”, *K.H. Rechinger* 8550 (E); convento d’Iskiati, *A. Fiori* 130 (FI), *A. Fiori* 230 (FI); era Alaeruna ed Apallaua, lengo il flemme Saduras, *A. Fiori* 231 (FI); Rhodes Island, between Malona and Archangelos, *K. Boratynska et al.* 15 (K); between Malona and Archangelos, old trees along small stream, very frequent, *K. Boratynska* 164 (K); Salakos, hedges near stream, *Davis* 40317 (K); SE of Salakos, along stream, below orchard, *K. Boratynska* 15 (K). **Cultivated:** Italy: Rome, *Martinetto* s.n. (ASU). USA: Washington, University of Washington Arboretum, *A.L. Bogle* 1561 (ASU).

12. *Liquidambar poilanei* (Tardieu) Ickert-Bond & J. Wen, comb. nov. Basionym: *Altingia poilanei* Tardieu, Fl. Camb., Laos & Vietn., Fasc. 4, 95 (1965), in adnot. TYPE. VIETNAM: SaPa, *M. Poilane* 12844 (holotype, P 00317366!).

urn:lsid:ipni.org:names:77134712-1

http://species-id.net/wiki/Liquidambar_poilanei

Distribution. Vietnam. **Representative specimens examined:** VIETNAM. Lao Cai: Sa Pa, *China-Vietnam Team* 8462 (HN); Ta Pinh Hmong village, some of the last remaining forest by small river across from rice paddies, *S. Ickert-Bond* 1296 (F).

13. *Liquidambar siamensis* (Craib) Ickert-Bond & J. Wen, comb. nov. Basionym: *Altingia siamensis* Craib, in Kew Bull. 1928, 68. TYPE. THAILAND: Mŭang Pan, 700 m, evergreen forest, Doi Duan, *Kerr* 5110 (holotype: BK257949!).

urn:lsid:ipni.org:names:77134713-1

http://species-id.net/wiki/Liquidambar_siamensis

Altingia tenuifolia Chun ex H.T. Chang, in Acta Sci. Nat. Univ. Sunyatseni, 1959(2): 34, 1959. TYPE. CHINA: Guizhou [Kweichow], Dushan, *Y. Tsiang* 6677 (holotype, IBSC!, isotypes: A [A00043392!], E [E00181734!], NY [00356122!]).

Altingia angustifolia H.T. Chang, Acta Sci. Nat. Univ. Sunyatseni, 1961 (4): 52, 1961. TYPE. CHINA: Guangdong, Dapu, in dense forests, 10 Jun 1957, *L. Deng* 5031 (holotype: IBSC (IBSC 001000!); isotype: PE (PE00029853!)).

Altingia takhtajanii Thai, Bot. J., URSS, l. 996, 1965. TYPE. VIETNAM: Chieng-ve, Moc-chan, alt. 770 m, 13-III-1963, *Thai Van Trung* 108 (holotype: LE!)

Distribution. China (Guangdong, Yunnan), Cambodia, Laos, N Thailand, and Vietnam. **Representative specimens examined.** CAMBODIA. Forêt de Phnom Penh, Komnhan, *M. Bejaud* 877 (P). **Kampot:** Bokor National Park, Pokopvil waterfall, near the head, *S. Ickert-Bond* 1280 (F), 1281 (F); Kampot, Bokor National Park, upper Popovill waterfall head, *M. Monyrak* 10 (A); **INDONESIA.** Java, Preanger Takoka, *Koordes* 15754 (P). **LAOS:** Fam Neva et M. Ham, *M. Poilane* 2000 (A, P); haut cours de la Zehépone entre A Chieng et Klem Zalo, *M. Poilane* 13500 (P); Pak Song, Sedone Prov., Sedone, *J.E. Vidal* 4461 (P). **THAILAND.** **Nakorn Nayo:** Khao Yai, *Hardial* 601 (A), *J.F. Maxwell* s.n. (MO); Nakhon Nayok, Khao Yai National Park, *T. Smitinand* 10848 (E); Nam Phnom, Prov. E., District Chaiyaphum, *C.F. van Beusekom* 4102 (MO). **UNION OF MYANMAR:** Tenasserim division, Tavoy district, east of Paungdaw Power Station, west bank of the Paungdae chaung, *J. Keenan* 1407 (E, MO). **VIETNAM:** semi flumen Da one in foret Bieu Loa, *L. Pierre* s.n. (P); **Da Nang:** Tourane, 100 km S of Hue, the later being Loureiro's type locality for the majority of the Cochinchina species, *J. Clemens* 3388 (A, MO, P); **Gialai-Kontum:** Dac Long, Dac Glai, Kontum, *N. Kin Dao* 182 (HN); Kbang, Kong Ha Nung, So Nglang, Xa Dong, Dac Glay, va mot so tinh Khac, *no collector* 745 (HN); So Rang, An Khe, *V. Xuan Phuong* 586 (HN);

Khánh Hòa: Cay to hop, Nhatrang, *M. Poilane* 3228 (P); Hon Ba Mtns., Suoi Cat Village, *D.D. Soejarto DDS 13561* (MO); Nui Chua National Park, Ninh Hai Distr., Vinh Hai Municipality, *J.C. Regalado et al. HLF4449* (MO); **Lam Dong:** en peu au sud de la Mation agu cole de Blao pres du Haut Donai, *M. Poilane 22153* (P); Loc Tan, Bao Lac, *N. Tien Ban 469* (HN), *H. Tue 523* (HN). **Ninh Thuan:** Ka Rom pro: Phanrang, *M. Poilane 9938* (2 sheets, P); **Son La:** Song Ma, *N. Tien Ban 110* (HN).

14. *Liquidambar styraciflua* L., Sp. Pl. 999, 1753. TYPE: *Kalm*, Herb. Linn. No. 1134.1 (LINN), (lectotype designated by Wijnands in Bot. Commelins: 109. 1983, [LINN HL1134.1, seen as image!]).

http://species-id.net/wiki/Liquidambar_styraciflua

Liquidambar barbata Stokes, Bot. Mat. Med. iv. 332, 1812.

Liquidambar gummifera Salisb., Prod. 393, 1796.

Liquidambar macrophylla Oerst., Am. Centr. 16 t. 10, 11, 1863. TYPE. NICARAGUA: Monte Pantasma. *A.S. Oersted 3050* (lectotype designated by Sosa in Flora Veracruz 1:2. 1978 [C], as photo at MEXU; isolectotype [F!]).

Liquidambar styraciflua var. *macrophylla* (Oerst.) Nied. in Engl. & Prantl, Nat. Pflanzenfam. 3, Abt. 2a: 124, fig. 69H, 1891.

Liquidambar styraciflua var. *mexicana* Oerst., Amer. Centr. 16, t. 11. 1863. TYPE. MEXICO: Veracruz: H. Bartholomé, *F.M. Liebmann 3052* (lectotype designated by Sosa in Flora Veracruz 1:2. 1978 [C], as photo at ALA! and XAL).

Representative specimens examined. BELIZE: Cayo: Chiquibul, Ceibo Grande to Main Divide, *A.K. Monro 2626* (MO), Ceibo Grande to drill sites track, *M. Pena 1046* (MO); Chalate, Vicinity of La Palma, Dept. of Chalatenango, *P.H. Allen 7265* (F). **EL SALVADOR:** Dept. Chalatenango: Along trails from San Ignacio to Las Pilas, west slope, *J.M. Tucker 1209* (F); Chalate, El Jute, *S. Calderon 1928* (F); Hacienda San Miguel near Metapan, *M.C. Carlson 757*, (F); On the road between San Salvador and La Palma, *M.C. Carlson 608* (F); Salvador, Ana, forested slopes between Rio San Miguel and summit of Cerro El Pinal, Pine-aok zone, mountains near Finca San Jose, 10 km, *N.C. Fassett 28302*, (F, GH, MO); San Ignacio, La Palma, *M. Hernandez 558* (MO); San Jose Igenio, P.N. Montecristo, *V.M. Martinez 142, 454*, (MO); 20 kms al SO de Montecristo, *R.A. Molina 12578* (F). **GUATEMALA:** Cerro Negro, *J.A. Steyermark 51726* (A); Chicoyonito, Dept. Alta Verapaz, *J.D. Smith 1855* (GH); Cocola, Reion de Cocola, northeast of Carcha, Dept. Alta, *P.C. Standley 70309* (A); Dept. Alta Verapaz, Coban, *H. Tuerckheim 1804* (E, GH, MO); Dept. Huehuetenango: Cerro Victoria, *J.A. Steyermark 49713*, (A); Dept. Zacapa: pine-covered slopes, Sierra de las Minas, *J.A. Steyermark 29732* (A); Dept. Zacapa: along Rillito del Volcan de Monos, *J.A. Steyermark 42409*, (A); Huehne, Yalambohoch, *E. Seler 3024* (GH); Nebaj, Dept. Quiche, *A.F. Skutch 1739* (A); Sierra de las Minas, near San Geronimo, *W.A. Kellerman 6412* (MO); Valley of Rio de las Violetas, north of Nebaj, *G.R. Proctor 25212* (F, MO); Verapaz, Baja Verapaz. Mun. Chilasco, 6km al SW de Chilasco,

L.P. Tenorio 14900 (MO). **HONDURAS:** Aldea El Carmelo, 1 km SE of Valle de Angeles, *G. Amador* 172 (F); Floresta de pino-liquidambar de la Monatana Zanquin, *R.A. Molina* 2834 (F, GH); Lempira, Celaque National Park, ca. 7 km of Gracias, *T.F. Daniel* 9628 (MO); Rio Pijol Valley, 6–7 km south of Nueva Eperanza, *R.L. Liesner* 26609 (MO); Trencheras, 20 km N of Siguatepeque, *R. Howard* 627 (A); Valle Encantado, slopes of Mt. Uyuca, *P.H. Allen* 11181 (A); **Dept. Morazan:** entre Pena Blany, Lo de Ponce, *L.O. Williams* 17113 (GH); slopes of Cerro de Uyuca, *P.C. Standley* 887 (F); **Dept. Atlantida:** vicinity of La Ceiba, near Danto river, *T.G. Yuncker* 8776 (GH); **Dept. of Comayagua:** edge of ravine near El Achote, *T.G. Yuncker* 5830 (F, GH); El Achote, near Siguatepeque, *P.C. Standley* 56158 (A); **Comaya:** bosque mixto y humedo de Barranco Trincheras, *R.A. Molina* 10807 (F); R. Selan, *V.J. Rodriguez* 2840 (F); vicinity of Siquatepeque, *P.C. Standley* 6497 (F); **Cortes:** Montana de Cusuco, Cordillera de Idalfonso, *R.A. Molina* 7254 (F); Montaña San Cristobal, sur de Agua Fria, *R.A. Molina* 7614 (F); Montaña Agua Fria, *R.A. Molina* 11342 (F); Montana San Idalfonso entre Banaderos y Cusuco, *R.A. Molina* 11454 (F). **El Paraíso:** Guinope, *V.J. Rodriguez* 1883 (F); Montaña Teupasenti, entre Junquillo y Teupasenti, *R.A. Molina* 11940, (F); Mt. Volcan, *L. Williams* 12190 (F); Paraíso; **Lempira:** Montana de Celaque, SE portion of massif, *G. Davidse* 34570 (MO); Mount Elaque National Park, *J. Renfrow* 16 (MO); **Moraza:** 20 km de Tegucigalpa, Montaña La Tigra, *A. Rubio* 63 (MO); Bosques del Volcan de Guaimaca, Cordillera Misoco, *R.A. Molina* 6127 (F); Campamento de Las Flores, *P.C. Standley* 13708 (F); Cerca de Montaña La Tigra, *R.A. Molina* 13755 (F); Faldas de Uyuca, *R.A. Molina* 983 (F); Los Planes. 25 km al N.E. de Tegucigalpa, *S. Y. Chevez* 119 (MO); Pinares entre La Piramide y Zambrano, *R.A. Molina* 11034 (F); Region of El Quebracho, *P.C. Standley* 23747 (F); Valle Encantado, slopes of Mt. Uyuca, *P.H. Allen* 11181 (F); **Ocotep:** Cordillera Merendon 10 km from Nueva Ocotepique, *R.A. Molina* 22235 (F); **Olancho:** Montaña La Bellota en Cordillera Almenares, *R.A. Molina* 8430 (F); **Siguat:** 7.5 km SW of Gracias, Lempira. Celaque National Park, *T. Hawkins* 176 (MO); Alrededor del Centro de Visitantes, *D. Mejia* 357 (MO); Guamil alrededor de Los Planes, *D. Mejia* 402 (MO). **MEXICO:** **Chiapas:** A 500 m al N de Rayon, camino de Pichucalco, *S.E. Martinez* 24118 (MO); 3 km northwest of Pueblo Nuevo Solistahuacan, *R.F. Thorne* 40034 (MO); at Rincon Chamula, 12 km northwest of Pueblo Nuevo, *P.H. Raven* 19784 (F); Colegio Linda Vista (Yerba Buena), *G.L. Webster* 17747 (MO); Colonia Kokijaz, *A. Mendez Ton* 6087 (MO); Mpio. De Bochil, Puliupul, *C.H. Perino* 3262 (MO); Ridge with Montane Rain Forest- Pine Oak, *D.E. Breedlove* 21762 (MO); San Andres Larrainzar, *L.G. Gonzalez* 233 (MO); Steep slope with montane rain forest, *D.E. Breedlove* 34365 (MO); West of Tenejapa Center, *D.E. Breedlove* 6886 (F); **Hidalgo:** 5 kms al oeste de Tianguistengo, *M. Hernandez* 5630 (MO), *M. Hernandez* 6912 (MO); 5 kms al oeste de Tianguistengo, district Zacualtipan, *H.E. Moore* 1925 (GH); 4 kms al oeste de Tianguistengo, (*styraciflua*) (MO); along Highway 85, *D.H. Norris*, 17397 (MO); district Jacala, municipality Chapulhuacan, *H.E. Moore* 2176 (GH); district Molango, municipality Molango, *H.E. Moore* 1995 (GH); **Nuevo Leon:** Dulces Nombres, *F.G. Meyer* 2799 (MO); **Oaxaca:** 12 km al N de Guevea de Humboldt, distr. De Juchitan, *R. Torres* 2541 (F); Distrito Mixe: Municipio de Totontepec: Totontepec, *Reyes Rivera*, *J.* 257 (MO); Loma del Guayabo, Huautla de Jimenez, *M. Hernandez* 448 (MO);

Municipio de Santiago Comaltepec: La Esperanza, *R. Lopez Luna* 27 (MO); Municipio de Totontepec: Totontepec, *R.J. Rivera* 907 (MO); Municipio de Totontepec, Chinantequilla, *E. Vargaz Ruiz* 44, 124 (MO); **Puebla**: Region Orizaba (second label states Xalapa), *M. Bourgeau* 2412 (GH); **Tamaulipas**: Rancho del Cielo (property of Frank Harrison), ca. 7 km WNW of Gomez Farias, *W. Burger* 26 (F); En el Rancho El Julilo, *S.E. Martinez* 3872 (F); **Veracruz**: 1 km above and NW of San Andres Tlalnehuayocan, *M. Nee* 26198 (F); 1 km al norte de Banderilla, Mun. Banderilla, *J.I. Calzada* 5246 (F); 1 km NW of Elotepec along (impassable), *M. Nee* 28898 (F); 2 km al NE de Banderilla, Rancho La Mesa, Banderilla, *M.G. Zola* 500 (F, MO); 3 km SSW of Zongolica along gravel road to Chichiquila, Mun. Huatusco, *M. Nee* 29442, 29444 (F); 6 km (by road) ESE of Ixhuacan de Los Reyes, Mun. Ixhuacan de Los Reyes, *M. Nee* 22484 (F, GH); 10 km north of Huatusco in typical *Liquidambar* forest, *G.K. Arp* 4186 (F); 18 mi North of Jacala on Highway 85, *D. Seigler* 3601 (F); along Huayacocotla--Zontecomatlan rd., between Barro, La Calabaza and 5 km by road SE of Zilacatipan, Mun. Huayacocotla, *M. Nee* 26885 (F); along very winding road from Naolinco to Misantla, 13 km by road S of turnoff to Yecuatla and 6 km by road N of Paz de Enriquez, Mun. Yecuatla, *M. Nee* 26393 (F); about 8 mi N of Teziutlan, toward El Mohon (near border of state of Puebla), *E.W. Manning* 53823 (GH); between Coscomatepec and Huatusco, *F. Boutin* 3480 (F); Camino Bastonal a Santa Marta, *Gomez-Pompa* 5382 (F); Camino a Rancho Nuevo, Huayacotla, *M. Hernandez* M 1499 (F); Cerca de San Fernando, camino a San Fernando, *O.R. Ortega* 1234 (F); Cerro de Macuiltetpetl, Xalapa, *M.G. Zola* 697 (F); Cerro de San Martin, *J.I. Calzada* 539 (F); Cerro de Villa Rica cerca de Mundo Nuevo, *C.G. Castillo* 1803, (F); Coacoatzintla, *R. Ortega* 837 (F); Consolapan, 4 km al norte de la desviacion, *J.I. Calzada* 5250 (F); en el volcan Santa Marta a 25 km al N de Catemaco, *S.E. Martinez* 3972 (MO); entre Zongolica y Nepopoalco, Zongolica, *T.V. Vazquez* 153 (F); gorge at Puente Acabaloya, ca. 1 km SE of Xico Viejo, *M. Nee* 26295 (F);); Jalapa, *C.G. Pringle* 7754 (GH), *C.L. Smith* 1778 (GH); Jardin Botanico y Arboretum de Insitituto de Investigaciones Sobre Recursos Bioticos (INIREB), ca., 4km SSW of Xalapa, *H.H. Iltis* 942 (F); kilometro 7, carretera San Adresito, Xalapa, *M.G. Zola* 616 (F); Lado SE de Laguna Catemaco, *J.H. Beaman* 5148 (F); Los Tuxtlas, Ocotál Grande, 5 km N de Mecayapan, Ibarra, *G. Manriquez* 2339 (MO); Mun. Juchique Ferrer La Cima, Plan de las Hayas, *M. Hernandez* 1610 (F); Mun. San Andres Tuxtla, Cerro Vigia al E de Volcan San Martin, *J.H. Beaman* 6276 (F); Mun. San Andres Tuxtla, cima del Volcan San Martin, *J.H. Beaman* 5970 (F); Mun. Xalapa, Jardin Botanico Clavijero, 3 km SE of Xalapa, *M. Nee* 29700 (F); Nacaxtla, Zongolica, *T.V. Vazquez* 260 (F); N Banderilla, *J. Dorantes* (MO); Bastonal-Sierra Santa Marta road, *A. Gentry* 32417 (MO); Near Highway 130 between Huachinango and Tulancingo, *J. Conrad* 3262 (F); Near Huatusco, *F. Boutin* 3494 (F); Nogales, *E. Matuda* 1157 (MO); Parque Ecologico of the Jardin Botanico Fco. Javier, Clavijero, 2km SW of Jalapa along road to Coatepec, *M. Nee* 23457 (F); Paz de Enriquez cloud forest, 15 km south of Misantla, *L. Bohs* 1798 (GH); Orizaba, *Botteri* 860 (GH); Paxopec, Municipio de Cacoatzintla, *F.A. Ventura* 19250 (MO); Rancho del Mesa, Municipio Banderilla, *R.W. Marquez* 997 (F); Rancho Nuevo entre Plan de las Hayas y Tierra, *C.G. Castillo* 1350 (F); Ridge on S side of gorge of Cascada de Texolo, 3 km SE of Villa Xico (Xico=Jico), *M. Nee* 26005 (F); Road to microwave station from Ran-

cho Chula Vista near Coscomatepec, *F. Boutin* 3485 (F); Sierra de Sta. Marta, *M. Sousa* 3548 (F, MO); Loc. Choapan, Mpio. Santiago Choapan, *L.P. Tenorio* 5329 (MO); Tenejapa, carretera Huatusco - Coscomatepec, *R. Avendaño* 277 (F); Tlalneuayocan, *M.G. Zola* 651 (F); Vaxin, cerca del Volcan San Martin, *M. Sousa* 3433 (F, MO); vicinity of small dam, 1/2 km W of Cinco Palos and 8 km NW of Consolapan, Mun. Jalapa, *M. Nee* 29689 (F); Xonamanca, Zongolica, *T.V. Vazquez* 286 (F); Camino al Sumidero, Xalapa, *M.G. Zola* 746 (F). **NICAGARAGUA: Jinotego:** Esteli, N slope of Cerro El Fraile, *W.D. Stevens* 18095 (MO); Finca Aventina, in sierra east of Jinotega, *P.C. Standley* 10026 (F); Hacienda La Balestina, situada a unos 10 km E de la ciudad de Jinotega, *A. Grijalva* 250 (MO); Macizos de Penas Blancas, *W.D. Stevens* 11510 (MO); N slope of Volcan Yali, *W.D. Stevens* 15074 (MO); **Madriz:** 5 km SW of San Juan de Rio Coco, *W.D. Stevens* 17665 (MO); 5.2 km N of San Fernando, *W.D. Stevens* (MO); Cerro El Fraile, *P.P. Moreno* 22766 (MO); **Matagalpa:** 5 km east of Yucul, *C.E. Hughes* 330 (MO); Cerca de entrada a bosque de Selva Negra, *M. Araquistain* 3538 (MO); El Ocotal km 134 between Matagalpa and Santa Maria, *R.A. Molina* 20435 (F, MO); Macizos de Penas, Blancas, SE side, *W.D. Stevens* 21054 (MO); Sta. Maria de Ostuma, Cordillera Central de Nicaragua, *L.O. Williams* 28004, 23388 (F); **Wiwili:** Departamento de Nueva Segovia: ca. 5.2 km N of San Fernando, valley of Rio San Fernando, *G.W. Stevens* 3248 (MO); Jinotega, Municipio de Wiwili, Reserva Natural Kilambe, Comunidad Aguas Frias, sector Caballo, *R. Rueda* 16311 (MO); **Nueva Segovia:** Cerro Mogoton, *J.T. Atwood* 9 (MO), *D.A. Neil* s.n. (F); Cerro Mogoton, 0.5 km W of El Volcan, 3.5 km NE of Dipilto, *S. Tomlin* 176 (MO); Dipilto, El Placer, km 247 carretera a Las Manos, *P.P. Moreno* 25910 (MO); Rio Arenal de Yali, Jalapa, *J.T. Atwood* 6816 (MO). **U.S.A.: Alabama:** Alabama Biological Survey, Auburn, Earle, F. S., (MO); Alabama, Rt. 11, near Knoxville, *C.F. Reed* 102737 (MO); Bienville Blvd., near Cadillac Sq., Dauphin Island, *R. Deramus* 1043 (MO); Rt. 21, 1 mi S of Riedmont, *C.F. Reed* 149022 (MO); Rt. 31, near Stapleton, *C.F. Reed* 103825 (MO); **Arkansas:** 0.8 mi north of Arkansas-Louisiana state line; Hulton, *B.F. Bush* 2425 (MO); Boston Mountains, *P.H. Raven* 26323 (MO); Bottoms, P.O. Malvern, Hot Springs Co., *D. Delmaree* 14502 (MO); Brazil, *D. Delmaree* 10971 (MO); Bruton, *J.M. Greenman* 4299, (MO); Flat woods, P.O. Star City, *D. Delmaree* 16748 (MO); Lake City, *D. Delmaree* 6945 (MO); Lookout Mountain. Near the line between Tennessee and Georgia which crosses the mountain, *J.R. Churchill* s.n. (MO); Monticello PO, *D. Delmaree* 1661 (MO); Near Nogo, *G.M. Merrill* 61 (MO); Nogo, *G.M. Merrill* 168 (MO); Ponca, *L. Hubricht* 1357 (MO); Rush, Marion County, along streams, *E.J. Palmer* 6031 (MO); Springs National Park, *L.H. Pammel* 189 (MO); Westfork, *E.J. Palmer* 8223 (MO); Woods along White River, near Calico Rock, *E.J. Palmer* 35546 (MO); Yell County: Bridge over the Petit Jean River, 2.6 miles north of Ola on State Hwy., *T.G. Lammers* 8304 (F); **Connecticut:** Driftway Lane, *F.C. Seymour* 20577 (MO); Woods, Tokeneke, near Darien, *R. C. Ward* s.n. (MO); **Florida:** Eglin Air Force Base; 11.7 mi east of Florida State Route 285 on Air Force Base Route 213, *J.S. Miller* 9554 (MO); Gainesville and vicinity of Lake Alice, *T.B. Croat* 25056 (MO); Near Jacksonville, *A.H. Curtiss* 4530 (MO); Hummock land, vicinity of Eustis, Lake County, *G.V. Nash* 860 (MO); Swales along Rt. 17, N of Yulee near Goodbread Circle, *C.F. Reed* 102948 (MO); Tall Timbers Research Station on S-12 north of

Tallahassee, *D.A. Breil* 376 (MO); Woods near Oak Hill, Volusia Co., *C.F. Reed* 35659 (MO); Woods, Rt. 41, 2 mi N of Brooksville, *C.F. Reed* 101308 (MO); **Georgia**: 1/2 mi S of Brewton, *G.L. Bracewell* 42 (MO); 2.4 mi E of Ailey on US 280, *J.C. Solomon* 2070 (MO); Alapha River swamp, 6 mi S of Stockton, *J. Norsworthy* (MO); Edge of Damp woods, Leslie, *R.M. Harper* 1391 (MO); Farm Woods, Rt. 301 just N of Ogeeche River, *C.F. Reed* 116746 (MO); Flood plain and banks of Ty Creek, *W.R. Faircloth* 3374 (MO); Hammock area (elevated terrain) surrounded by low pinelands on the E side of Moody AFB Reservation, *W.R. Faircloth* 3709 (MO); **Illinois**: 2.9 mi S of Gorham Rd. on ILL 3, then 3.9 mi E on Turkey Bayou Rd., bank of the big muddy river, *J.C. Solomon* 3719 (MO); Fountain Bluff, mesic woods along summit roadside, *R. Carlson s.n.* (MO); Horseshoe Island, *G.N. Jones* 12054 (MO); Mound city, *E.J. Palmer* 14826 (MO); Near Mississippi River, Chester, *E.J. Palmer* 44553 (MO); Tunnel Hill, *E.J. Palmer* 15227 (MO); **Indiana**: Awensville, *C.F. Reed* 3213 (MO); Near Arlington, *C.F. Reed* 3494 (MO); Brandywine, *C.F. Reed* 2840 (MO); Calvert Co., *C.F. Reed* 2463 (MO); Damp woods along River R. near Herald Beach, *C.F. Reed* 30915 (MO); David Hill Park, Balto, *W.N. Lee* 6 (MO); Double Rock Park, Parkerville, *L.E. Schauer s.n.* (MO); Flats Region, Guthrie Memorial Tract, *R.C. Friesner* 10161 (MO); Indian Head, *C.F. Reed* 3079 (MO); Lower Marlboro, *C.F. Reed* 4829 (MO); marches just south of Curtes Bay, Brandens Shore, *C.F. Reed* 31066 (MO); Middle River, *C.F. Reed* 3094 (MO); Oak-maple woods, Rt. 313, 1 mi N of Mossey, *C.F. Reed* 127985 (MO); on Rantan Formation, Elk Neck State Park at Rogus Harbor Boating facility cutoff, *C.F. Reed* 126623 (MO); Pt. Lookout .527, St. M., *C.F. Reed* 2476 (MO); Shiloh, *C.F. Reed* 409 (MO); Swampy woods E of Patiewment, S of Upper Marlboro, *C.F. Reed* 22817 (MO); Swampy woods near Pomonkey, *C.F. Reed* 23414 (MO); Wicomico, *C.F. Reed* 2533 (MO); woods along road to Southland Bog, *C.F. Reed* 125997 (MO); woods just north of East Riverside, *C.F. Reed* 29353 (MO); Woods Point Park, Bush R., *C.F. Reed* 128078 (MO); woods south of Drum Point, *C.F. Reed* 29290 (MO); Warwick, between Rt. 282 and Rt. 301, *C.F. Reed* 136283 (MO); **Kentucky**: 1 mile north of Cogswell, Rowan County, wet ditches, *C.F. Reed s.n.* (MO); 1 mile north of Cogswell, Rowan County, wet ditches, *C.F. Reed* 13437 (MO); along Ison Creek, on igneous mica-peridotite dike west of Stephens, *C.F. Reed* 115816 (MO); along Axley Brank, Morehead, *H. Williston* 111 (MO); along Maxon Rd., just w of Concord, off Rt. 60, *C.F. Reed* 110706 (MO); Bowling Green, *S.F. Price s.n.* (MO); Georgetown, *C.F. Reed* 81477 (MO); Low woodlands, Rte. 68, near Erie, *C.F. Reed* 129641 (MO); Near Reed, Rt. 60, *C.F. Reed* 117576 (MO); Near Wago, Rt. 90. 3 mi W of Albany, *C.F. Reed* 52888 (MO); Redd Hallow, L.B.L., 0.5 mi W of Kentucky 94, *K. Hutchens* 12 (MO); Rt. 42, Skylight, *C.F. Reed* 44907 (MO); Robey's Swamp, 3 mi NW of Franklin, *C.F. Reed* 82311 (MO); Rt. 45, 1.5 mi NE of Water Valley, *C.F. Reed* 52801 (MO); Rt. 470, Larue Co., near Buffalo, *C.F. Reed* 45066 (MO); Woods at Lovely, *C.F. Reed* 75623 (MO); Woods, Di-ohmans Springs, 7 mi NW of Barbourville, *C.F. Reed* 7176 (MO); Woods near Goddard, Fleming Co., *C.F. Reed* 10446 (MO); **Louisiana**: 15 ft. from University Lake along Louisiana 42, S of Baton Rouge, *K. Sijam s.n.* (MO); 2 miles north of Gorum, Kisatchie Wood, Natchitiches Parish, *J. Ewan* 17630 (MO); 6 mi West of Ruston on Louisiana 507, *P. Lohman* 31 (MO); Cemetery, waste area and neighboring woodlands, *J.K. Parrott* 427

(MO); Cypress Creek bottom, two miles N of Vienna, *G. Fischer* 20 (MO); just north of D'Arbonne Fire Tower, *P. Both* 315 (MO); Ponchatoula, Williams Lumber, (MO); **Mississippi**: Meramec State Park. Cambell Hollow, *D. Dress* 4 (MO); Natchez, *F. Shimak* s.n. (MO). Ocean Springs, Shekan, J., (MO); **Missouri**: at base of limestone bluffs alongs Frederick Pork near "The Narrows", west of Calm, *J.A. Steyermark* 18919 (MO); base of Black Mtn., *J.A. Steyermark* 21077 (MO); base of wooded lime slopes along spring branch of Williams spring on east side of current river, T25N, R1E, sect. 34, SW of Grandin, *J.A. Steyermark* 11853 (MO); Bilsted, Gum near Illmo, *A. Christ* s.n. (MO); Campbell Mts., *B.F. Bush* 227 (MO); Ca. 8 mi NE of Salem (T35 R4W S33 S2 SE4), Upper Ozark Section of Ozark Natural Division. Indian Trail conservation Area, *T. Smith* 3500 (MO); Columbia, near corner of Paquin an Waugh Streets, *C. Dietrich* 265 (MO); Kirkwood, *F. Comte* 437 (MO); low ground area in valley Blue Spring Itol, T27 N, R7 E sect. 20, 2 mi E of Chaonia, *J.A. Steyermark* 6313 (MO); lowland woods between Menfro and Belgique, 2 mi southwest of Belgique, *J.A. Steyermark* 14027 (MO); on a siding of the Terminal Railroad Association, *V. Muehlenbach* 3361 (MO); Pleasant Grove, *B.F. Bush* 258 (MO), *K.K. Mackenzie* 421 (MO); Poplar Bluffs, *G. Letterman* s.n. (MO), *H. Eggert* s.n. (MO); rich swampy woods on elevated portion, *J.A. Steyermark* 8662 (MO); Timber Tract, 10 mi southwest of Wolf Island; Low woods along mud creek, T26N, R7E, sect. 20, 2 mi northwest of Rombauer, *J.A. Steyermark* 11294 (MO); Williamsville, *E.J. Palmer* 4805 (MO); Woods, Butler County, *B.F. Bush* 3721 (MO); **North Carolina**: Dry open woods east of Chapel Hill off 15-501, *J.P. May* 95 (MO); near Sisk's house, foot of Table rock, *S.K. Small* 292 (MO); Swamps, Bladen Country, Biltmore, 4178, (MO); Open marshy area, Durham, *C. Henninger* s.n. (MO); Woods just S of Grandy, Currituk Co., *C.F. Reed* 41634 (MO); **Oklahoma**: Broken Bow, *E.J. Palmer* 10496 (MO); growing on flat ground in valley, *H. Newton* 94 (MO); near Page, *G.W. Stevens* 2634 (MO); wet sandy loam soil in a wood, 4 mi SW of Broken Bow, *R. Stratton* 585 (MO); **Pennsylvania**: N of Boulevard, along Philadelphia-Trenton border of P.R.R., Cedar Grove, *J.W. Adams* 177 (MO); **South Carolina**: 1 mile north of Bloomfield, low pasture, beside Hwy 25, *A. Chandler* 2047 (MO); Anderson, *J. Davis* s.n. (MO); McKinney Spring, *J. Davis* s.n. (MO); Simpson's Mill near Anderson, *J. Davis* s.n. (MO); Upper coastal plain, sandy soil, *M.L. Conrad* 11171 (MO); **Tennessee**: Hancock-Claiborne County line, Damp cove, *Vogenberger* 8066 (MO); Knoxville, *A. Ruth* s.n. (MO); Aumville (?), *A. Ruth* 271 (MO); Nashville 12 mi west on River Rd., *E. Quaterman* 1036 (MO); Near Memphis, *E.J. Palmer* 17516 (MO); Near Shepherd, *E.J. Palmer* 17478 (MO); **Texas**: 2nd Bottom, *E.D. Marshall* 8711 (MO); Big Thicket National Preserve. Lance Rosier Unit. Ca., *J. Stone* 3096 (MO); Houston, *B.F. Bush* 16, 22 (MO); Livingston, Polk county, *E.J. Palmer* 5235 (MO); **West Virginia**: Banks of James River, near Richmond, *J.R. Churchill* s.n. (MO); Camden Ave., near Ritchie St., Buchanan, *G.B. Rossbach* s.n. (MO); Carrollton, Isle of Wight Co, *C.F. Reed* 102408 (MO); Huntington, *Williams* 306 (MO); Miles Creek, Rt. 58, 6 mi S of South hill, *C.F. Reed* 53398 (MO); Paducah, McCracken County, *E.J. Palmer* 17884 (MO); Pigeon creek near Enons School, Mingo County, *E.E. Berkley* 966 (MO); Rt. 617 off Rt. 205, NE of Edgehill, *C.F. Reed* 130382 (MO); woods near Norfolk, *F. Blanchard* vicinity of Norfolk, *M.C. Jensen* s.n. (MO); Walls Run Creek at Rt. 10 near Rt. 609, *C.F. Reed* 89698 (MO);

woods south of Suffolk, *C.F. Reed* 8946 (MO); *s.n.* (MO); woods, 8 mi SW of South Hill, Rt. 58, Mecklenburg Co., *C.F. Reed* 53404 (MO); woods along Rt. 14, Mattaponi, King and Queen Co., *C.F. Reed* 45994 (MO); woods just E of Pohick Church, on Old Colchester Rd., *C.F. Reed* 103177 (MO); woods just W of Camplain P.O., Rt. 17, *C.F. Reed* 100957 (MO).

15. *Liquidambar yunnanensis* (Rehder & Wilson) Ickert-Bond & J. Wen, comb. nov. Basionym: *Altingia yunnanensis* Rehder & Wilson, in Sargent Pl. Wilson. I: 422 (1913). TYPE. CHINA: Yunnan: Mengtze, A. Henry 10395 (Holotype: A [A0043393!]; isotypes: K [H2007/01764!], NY [NY00356723!]).

urn:lsid:ipni.org:names:77134714-1

http://species-id.net/wiki/Liquidambar_yunnanensis

Distribution. China (Yunnan), Vietnam. **Representative specimens examined.** China, Yunnan, Mengtze, A. Henry 11082 (A). Vietnam: **Lao Cai:** road to O'Qui Ho, SaPa, *Institute Bot. Yunnanica s.n.* (HN); **Cao Bang:** Cao Son, *Poilane* 19024 (P000317376).

Doubtful names

1. *Altingia indochinensis* H. T. Chang, Acta Sci. Nat. Univ. Sunyatseni, 1961 (4): 53 (1961). Type: Indochina, without locality, *M. Poilane* 2000. We have not located the type specimen.

According to Chang (1961), this species is closely allied to *A. gracilipes* Hemsl. and its variety *A. gracilipes* Hemsl. var. *serrulata* Tutch., but differs from them by longer, oblanceolate or oblong leaves which are cuneate at the base, more robust petioles, and multiflorous heads.

Excluded names

1. [Araucariaceae *Altingia cunninghamii* in Hort. Brit. [Loud.] 403 (1830).

Notes: =*Araucaria cunninghamii*]

Altingia cunninghamii J. Ross, Hobart Town Almanack (1835) 66.

Remarks. Given as a name without description by G. Don in J.C. Loudon, Hort. Brit. (1830) 403. Not in Index Kewensis. "lately discovered by Mr. Ronald Gunn, at the falls of the river Meander and also by Mr. J.W. Scott, the collector on the banks of the Huon".

2. [Araucariaceae *Altingia excelsa* in Hort. Brit. [Loud.] 403 (1830).

Notes: =*Araucaria excelsa*]

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Renfrow, J. 16 (styraciflua)

Reyes Rivera, J. 257 (styraciflua)

Rivera, R.J. 907 (styraciflua)

Rock, J.F. 2768 (excelsa), Rock 7174 (excelsa)

Rodriguez, V.J. 1883 (styraciflua), 2840 (styraciflua)

Rosbach, G.B. s.n. (styraciflua)

Rubio, A. 63 (styraciflua)

Rueda, R. 16311 (styraciflua)

Ruth, A. 271 (styraciflua), s.n. (styraciflua)

S.Y. Hu 20064 (formosana)

SABE 1950 (acalycina)

Saito, S. 8371 (formosana),

SAYTBET 45208 (formosana), 45272 (formosana)

Schauer, L.E. s.n. (styraciflua)

Seigler, D. 3601 (styraciflua)

- Seler, E., 3024 (styraciflua)
 Seymour, F.C. 205 (styraciflua)
 Shekan, J. s.n. (styraciflua)
 Shimak, F. s.n. (styraciflua)
 Sijam s.n. (styraciflua)
 Skutch, A.F. 1739 (styraciflua)
 Small, S.K. 292 (styraciflua)
 Smith, C.L. 1778 (styraciflua)
 Smith, J.D. 1855 (styraciflua)
 Smith, T. 3500 (styraciflua)
 Smitinand, T. 10848 (excelsa)
 Soejarto, D.D. 11399 (formosana), DDS 13 (siamensis)
 Solomon, J.C. 2070 (styraciflua), 3719 (styraciflua)
 Song, X.H. 1348 (chinensis)
 Sousa, M. 3433 (styraciflua)
 Sozan, T. 13490 (formosana)
 Standley, P.C. 10026 (styraciflua), 13708 (styraciflua), 23747(styraciflua), 56158 (styraciflua), 6497 (styraciflua), 70309 (styraciflua), 887 (styraciflua), Tsoong 256 (multinervis),
 Stevens W.D. s.n. (styraciflua), 11510 (styraciflua), 15074 (styraciflua), 17665 (styraciflua), 18095 (styraciflua), 21054 (styraciflua)
 Stevens, G.W. 2634 (styraciflua), 3248(styraciflua)
 Steward, A.N. 107 (formosana), 1075 (formosana), 29 (formosana), 442 (formosana)
 Steyermark, J.A. 29732 (styraciflua), 42409 (styraciflua), 49713 (styraciflua), 5172 (styraciflua), 11294 (styraciflua), 11853 (styraciflua), 18919 (styraciflua), 21077 (styraciflua), 6313 (styraciflua), 8662 (styraciflua)
 Stone, J. 3096 (styraciflua)
 Stratton, R. 585 (styraciflua)
 Sun, S.C. 1302 (formosana)
 Taam, Y.M. 779 (formosana)
 Tan, P.X. 57605 (formosana), 58681 (chingii)
 Tang Khoi, N. 420, 421 (formosana)
 Tang, C.C. 4655 (formosana)
 Tang, H.C. 1473 (formosana)
 Tenorio, L.P. 14900 (styraciflua), 5329 (styraciflua)
 Thai Van Trung 108 (siamensis)
 Thorne, R.F. 40034 (styraciflua)
 Tien Ba, N. 110 (siamensis)
 Tomlin, S. 176 (styraciflua)
 Torres, R. 2541 (styraciflua)
 Tsai, H.T. 61528 (excelsa)
 Tsang, W.T. 20128 (chinensis), 20927 (formosana), 21514 (gracilipes), 21697 (gracilipes), 21817 (formosana), 22189 (chinensis), 22788 (chinensis), 23613

- (formosana), 25942 (chinensis), 28068 (formosana), 28544 (chinensis), 20927 (formosana), 6412 (styraciflua)
- Tsang, W.T. 21697 (gracilipes), 23613 (formosana)
- Tsiang, Y. 6677 (siamensis)
- Tso 1803 (formosana)
- Tso. C.L. 21049 (chinensis)
- Tsoong, T.S. 8197 (formosana), 81972 (formosana)
- Tsui, T.M. 417 (formosana), 516 (formosana), 660 (formosana)
- Tucker, J. M. 1209 (styraciflua)
- Tue, H. 523 (siamensis)
- Tuerckheim, H. 1804 (styraciflua)
- Tutcher, W. J. s.n. (gracilipes)
- van Beusekom, C. F. 4102 (siamensis)
- van de Koppel 3299 (excelsa)
- Vargaz Ruiz, E. 44, 124 (styraciflua)
- Vazquez, T.V. 260 (styraciflua), 286 (styraciflua)
- Ventura, F.A. 1925 (styraciflua)
- Vidal, J.E. 4461 (siamensis)
- Vogenberger 8066 (styraciflua)
- Wan, X. 153 (gracilipes)
- Wang, C. 31824 (formosana), 31828 (chinensis), 35099 (obovata), 35691 (obovata), 35897 (obovata), 36153 (obovata), 36638 (obovata), 37057 (gracilipes), 39334 (chinensis), 44102 (acalycina)
- Wang, Y.-J. 56484 (gracilipes)
- Warburg, O. 9810 (formosana)
- Ward, R.C. s.n. (styraciflua)
- Webster, G.L. 17747 (styraciflua)
- Wei, Z. 120217 (gracilipes), 120579 (gracilipes)
- Williams 306 (styraciflua)
- Williams, L. 12190 (styraciflua)
- Williams, L.O. 17113 (styraciflua), 28004 (styraciflua), 23388 (styraciflua)
- Williston, H. 111 (styraciflua)
- Wilson, E.H. 10031 (formosana), 1628 (formosana), 218 (formosana), 513 (acalycina), 795 (formosana), 1639 (formosana), 513 (formosana),
- Wu, Z. 85062 (chingii)
- Wuyi Shan Team 80-225 (acalycina)
- Xiong, B. 20927 (formosana), 2922 (formosana), 5706 (formosana)
- Yao, K. 11486 (acalycina)
- Yao, K. 11561 (formosana)
- Yao, K. 8505 (formosana)
- Ye, C.-L. 9689 (formosana)
- Yin, H.L. 2031 (formosana)
- Yu, B. 103106 (gracilipes)

- Yu, T.T. 229 (*formosana*)
Yuncker, T.G. 5830 (*styraciflua*), 8776 (*styraciflua*)
Zeng, H. 72101 (*gracilipes*)
Zhang, Z.-Y. 14271 (*formosana*)
Zhong, Y. 4321 (*obovata*)
Zola, M.G. 500 (*styraciflua*), 616 (*styraciflua*), 651 (*styraciflua*), 697 (*styraciflua*), 746 (*styraciflua*)
Zou, H.-Y. 140 (*formosana*), 151 (*gracilipes*), Zou 1984 (*acalycina*), 307 (*chinensis*), 761 (*chinensis*), 762 (*gracilipes*), 79 (*gracilipes*)
Zuo, J.B. 356 (*acalycina*)

