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NEW SERIES NO. 23

FLORA COSTARICENSIS

William Burger, Editor

Family #80 Lauraceae

William Burger

Henk van der Werff

Family #81 Hernandiaceae

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Introduction

This is the sixth issue of "Flora Costaricensis." The first dealt with the Piperaceae (Fieldiana, Bot. 35, 1971). The second included families numbered 42 through 53, Chloranthaceae through Urticaceae (Fieldiana, Bot. 40, 1977). The third issue covered the Gramineae and was authored by Richard Pohl (Fieldiana, Bot., new series, No. 4, 1980). The fourth issue included families numbered 54 through 70, Podostemaceae through Caryophyllaceae (Fieldiana, Bot., new series, No. 13, 1983). The fifth issue covered families 200 and 201, the Acanthaceae by L. H. Durkee and the Plantaginaceae (Fieldiana, Bot., new series, No. 18, 1986).

In the figures of Lauraceae, fruits are illustrated along the left side over a grid of square centimeters. Leaves and twigs of each full-page figure are drawn to the same scale, shown with a horizontal centimeter bar. Stamens are depicted along the right at varying scales in millimeters. The stamens shown are part of the outer whorls (series I-II), except in *Licaria*. The drawings are based on dried herbarium specimens. The stamens are drawn from boiled flowers and are diagrammatic; puberulence may not be accurately represented.

Acknowledgments

We are especially grateful for the financial assistance from the National Science Foundation, which has aided this program for many years, both

at Field Museum and in Costa Rican fieldwork. The program was supported most recently by NSF grant DEB-8103184, through the Biological Research Resources Program. A recent grant from the National Geographic Society (#3465-86) supported fieldwork and a review of the Lauraceae in Costa Rican herbaria which led to the discovery of a new genus.

The staff and the facilities of the Museo Nacional de Costa Rica have been a central resource and most helpful to our work for more than two decades. Pablo Sánchez V., in charge of the Natural History section and the Herbario Nacional, has given our work on Lauraceae much support. Jorge Gómez-Laurito provided access to the herbarium of the Universidad de Costa Rica and has been very helpful in many other ways. Luis Poveda led two successful field trips specifically focused on collecting Lauraceae. Recent collections made by programs of the Missouri Botanical Garden have added greatly to our knowledge of the Lauraceae, as has the Flora of La Selva project. We thank the Missouri Botanical Garden for allowing Henk van der Werff to contribute his time and effort to our treatment of the Lauraceae.

Finally, we thank the late Timothy Plowman, Jens Rohwer, Jorge Gómez-Laurito, and two anonymous reviewers for the many corrections and improvements they provided for an earlier draft of this manuscript. However, despite their efforts and our own, many problems remain in our presentation and in our understanding of the plants in these two families.

FLORA COSTARICENSIS

Family #80 Lauraceae

Family #81 Hernandiaceae

LAURACEAE

By William Burger and Henk van der Werff

REFERENCES—C. K. Allen, Studies in the Lauraceae, VI. Preliminary survey of the Mexican and Central American Species. *J. Arnold Arbor.* 26: 280–434. 1945. L. Bernardi, Lauráceas. 355 pp. Universidad de los Andes, Facultad de Ciencias Forestales, Merida, Venezuela. 1962. B. Hammel, New species and notes on Lauraceae from the Caribbean Lowlands of Costa Rica. *J. Arnold Arbor.* 67(1): 123–136. 1986; The vascular flora of La Selva Biological Station, Costa Rica. *Lauraceae. Selbyana* 9: 218–233. 1986. A. J. G. H. Kostermans, *Lauraceae. Reinwardtia* 4: 193–256. 1957; *Bibliographia Lauracearum*, 1,450 pp. Ministry of Natl. Research, Bogor, Indonesia. 1964. C. Mez, *Lauraceae Americanae. Jahrb. Königl. Bot. Gart. Berlin* 5: 1–556. 1889. J. G. Rohwer, *Prodromus einer Monographie der Gattung Ocotea Aubl. (Lauraceae), sensu lato. Mitt. Inst. Allg. Bot. Hamburg* 20: 1–278. 1986.

Medium-sized trees, less often tall canopy trees or shrubs (slender twining parasites with yellowish stems in *Cassytha*), bisexual or unisexual (dioecious); the wood often yellowish, the shoot apex usually with minute lustrous appressed-ascending hairs, the hairs always simple and usually unicellular, stems glabrous or puberulent, often with aromatic oils in bark and leaves; stipules absent. Leaves alternate, less often fasciculate or whorled, rarely consistently opposite (as in *Caryodaphnopsis*), evergreen or deciduous, new leaves often produced in flushes, always simple, usually petiolate, the petioles often with adaxial or lateral margins continuous with the lamina margins, sulcate to flat or rounded on the adaxial surface, rarely clasping the stem; leaf blades always simple and entire, occasionally undulate (lobed in *Sassafras*) but never crenate, serrate or incised, often dark green and lustrous above in life, never scabrous above, sometimes glaucous beneath, usually stiffly chartaceous to co-

riaceous in texture, the venation pinnate to tripliveined (rarely palmate), often with veinlike tissue along the edge of the lamina, glabrous to densely puberulent beneath, “domatia” of tufted hairs or pits sometimes present in the axils of proximal veins on the abaxial (lower) surface, the leaves often turning yellow or orange before falling. Inflorescences usually solitary and axillary, sometimes fasciculate or pseudoterminal, on distal branchlets, usually paniculate with a prominent peduncle and central rachis, less often racemose or umbellate (very rarely spicate or capitulate), distal flower groups often cymose or umbellate and subtended by bracteoles, the flowers sessile or more often pedicellate, (the inflorescence enclosed at first in broad overlapping bracts in a few genera, cf. *Litsea*). Flowers bisexual or less often functionally unisexual (rarely with the unisexual flowers lacking pistilode or staminodes), radially symmetrical, minute (1–3 mm) to small (3–12, rarely 20 mm broad), white to yellowish or greenish (rarely pinkish to red), hypogynous to perigynous with the development of a floral cup or tube; perianth usually of 6 parts in 2 whorls of 3 tepals each, the parts equal or subequal (the outer much shorter than the inner in *Caryodaphnopsis* and a few species of *Persea*, among Costa Rican species), rarely the perianth of 4 or 9 parts in 2 or 3 whorls, free or united at the base above the floral cup, glabrous or puberulent on either or both surfaces; androecium usually of 9 (rarely 12) functional stamens in 3(–4) whorls, the outer 2 whorls (series I–II) of 6 stamens usually similar and appearing as a single whorl (absent in *Licaria* and *Williamodendron*), the outer 6 stamens free and with introrse dehiscence (dehiscence lateral or variable in *Pleurothyrium*), the stamens sessile or with filaments, anthers narrow and rectangular to broad, flat and tepal-like, 4-theous or 2-theous and dehiscing by 4 or 2 valves (flaps), valves opening from the base to the apex, the inner 3 stamens (series III) usually with 2 glands at the base of each filament, inner stamens free (united in some *Licaria* sp.) and usually dehiscing extrorsely, less often laterally or apically, a whorl of 3 staminodes (series IV) present and with well-developed apex or minute or absent; pistil simple and solitary, often narrowed at the base, borne above

the receptacle or within the floral cup or tube, free and superior to perigynous (united to the tube and inferior only in *Hypodaphnis* of West Africa), the ovary with a single locule and solitary pendulous anatropous ovule, the style short or long, the stigma simple to discoid or capitate (rarely deeply lobed). **Fruits** borne on a thickened pedicel (as in *Beilschmiedia*, *Caryodaphnopsis*, and *Persea*) or subtended by a flattened receptacle or borne in a cupulate receptacle, the perianth parts deciduous or persisting but not enlarging in fruits, the cup fleshy or becoming woody, the margin entire or undulate, rarely with multiple ridges (as in *Licaria*), often red-colored at maturity in contrast to the green to blackish fruits; fruits 1-seeded **berries**, usually ellipsoid to ovoid or globose, often flattened at the base and abruptly rounded at the apex, the style base rarely persisting, exocarp usually glossy and smooth, often becoming black or purplish, mesocarp succulent and fleshy; the seed without endosperm, the cotyledons large, flat on the inner faces and convex on the outer side, longitudinally parallel with the axis of the pedicel, white or sometimes pink within.

A family of about 2,000 species of trees (only *Cuscuta* contains herbaceous parasites), abundant in the evergreen tropics and subtropics, with a few species in seasonally very dry and temperate regions. The family's greatest diversity is in Southeast Asia and in South America. The simple, alternate, stiff, entire, aromatic leaves (often dark green and glossy above in life), the lack of stipules, 6-parted perianth (sometimes irregular in number in *Litsea*), nine free stamens (in most), the anthers that always open by valves (flaps), the simple pistil with single style and stigma, solitary pendulous ovule, and fruits often borne in a cup make the Lauraceae a very distinctive family. The petioles are often sulcate above; the shoot apex is usually covered with small (0.1–0.5 mm), slender, appressed-ascending, lustrous simple hairs; and the bark and foliage are usually aromatic. Small "domatia" are present on the lower leaf surfaces of many species. They are too small to accommodate ants; they appear to be associated with mites (cf. Pemberton & Turner, 1989).

The family is an important component of rain forests and cloud forests in Costa Rica. Only about six species occur above 2600 m elevation, and a similar number are found in the seasonally very dry lowlands of Guanacaste. A number of species are important sources of timber, and the avocado (*Persea americana*) is widely cultivated for its nutritious fruits. *Cinnamomum camphora* is a source of camphor and *C. verum* is the source of cinnamon, but they are only occasionally cultivated in Central America.

The Lauraceae are one of the most difficult families in the Neotropics as regards the identification of genera and species (Burger, 1988). Some of the genera are artificial and linked by intermediate species, but better ways of organizing the species are not apparent. We disagree with the submergence of some of these poorly defined genera at this time (cf. Howard, 1981; Kostermans, 1957). We believe that major taxonomic changes must reflect an improved understanding of relationships and should result in better systems of information retrieval. In addition, the perspectives gained in our study of Costa Rican species are insufficient for making decisions regarding generic circumscription. Because many species are large trees with small flowers, their representation in herbarium collections is poor, making the delimitation of species difficult. A number of species groups are very difficult to interpret, and the treatments presented here can only be considered tentative; see the discussions under the species.

Costa Rica differs from neighboring areas in having had a long tradition of resident botanical collectors. The collections of Paul Allen, Alberto Brenes, Gary Hartshorn, Leslie Holdridge, Alfonso Jiménez, Luis Poveda, Alexander Skutch, and Austin Smith have been especially important in working with this family. Determinations by Holdridge and Poveda were very helpful during the early stages of our work. Barry Hammel's collection and study of Lauraceae at La Selva has been a major contribution. We thank the following herbaria for access to their collections or loans for this study: AA, CR, DUKE, F, GH, MO, NY, US, USJ.

The following keys can be used to identify flowering collections in which the androecium and fruiting condition are known (Key 1, **Diagnostic Key to Genera**), or in which fruit and some floral morphology are apparent (Key 2, **Artificial Key to Woody Genera and Species**). In addition, there is a key which should aid in use of the figures (Key 3, **Key to Comparative Figures**); these are grouped according to vegetative similarity and altitudinal range. Identification of individual specimens can be very difficult. Individual trees of the same species can differ greatly in some characteristics, and species with very similar foliage can have significantly different flowers and fruits. Ultimately, the most certain method of identifying a specimen is by careful comparison with properly identified herbarium collections.

Key 1: Diagnostic Key to Genera of Lauraceae

- 1a. Slender twining parasites with yellowish to orange or dull green stems 1–3 mm thick, attached to small shrubs and herbs by haustoria; leaves reduced to scales; each flower with 9 stamens opening by 2 valves; fruits enclosed in a perianth tube *Cassytha*
- 1b. Trees and shrubs with woody stems and green leaves, not parasitic; mature fruits not completely enclosed in a tube 2a
- 2a. Flowers with only 3 stamens, the stamens free or united and forming a central column around the style (in *Licaria* spp.), flowers only 1–3.5 mm long 3a
- 2b. Flowers with 6, 9, or 12 stamens, or with 6, 9, or 12 staminodes in female flowers, stamens rarely connivent and united only at the base, flowers 1–15 mm long 4a
 - 3a. Each stamen 2-thecous and opening laterally or distally with 2 valves (each flower with 6 valves), the staminodes exterior to the stamens and not sagittate; fruits borne in a deep cup, the cup often with a double-margined rim; leaves never obovate in our species, not closely clustered distally *Licaria*
 - 3b. Each stamen with 4 thecae and opening distally with 4 minute valves (each flower with 12 small valves), with 3 sagittate staminodes interior to the stamens; fruits unknown; leaves large and obovate, usually closely clustered distally *Williamodendron*
- 4a. Each stamen opening by 2 valves, anthers 2-thecous 5a
- 4b. Each stamen opening by 4 valves, anthers 4-thecous (rarely with a few stamens with only 2 valves) 8a
 - 5a. Fruits subtended by a thickened pedicel, a fruit cup or disclike receptacle absent; staminodes present and conspicuous, stamens often with the connective slightly prolonged; stigma simple; dried leaves usually with the minor venation forming an elevated reticulum *Beilschmiedia*
 - 5b. Fruits subtended and partly enclosed by a fruit cup or disc; staminodes absent or slender, connective rarely prolonged beyond the thecae; stigma simple or discoid 6a
 - 6a. Flowers functionally unisexual and the trees dioecious; leaves persistently puberulent in the Costa Rican species placed here *Endlicheria*
 - 6b. Flowers bisexual, trees bisexual; leaves glabrous or glabrescent (in Costa Rica) 7a
 - 7a. Flowers glabrous in Central American species; staminodes present or absent, outer stamens with narrow short filaments; ovary ellipsoid to ovoid and borne in an open shallow cup; margin of the fruit cup entire or with persisting perianth lobes *Aiouea*
 - 7b. Flowers puberulent; staminodes absent, outer stamens lacking a differentiated filament and puberulent; ovary very slender ellipsoid to ovoid and included within the narrow floral tube; margin of the fruit cup entire *Aniba*
- 8a. Inflorescences pedunculate umbels, the umbel of flowers at first enclosed in an involucre of broadly imbricate bracts and resembling a flower bud on a pedicel; stamens 9 or 12 *Litsea*
- 8b. Inflorescences paniculate to racemose, rarely umbellate and never involucreate; stamens or staminodes 9 (rarely 6) 9a
- 9a. Stamens with 4 small distal valves which open apically, stamens thick and hairy with a filament not clearly differentiated; fruits over 6 cm long, subtended by a small disc or cup *Povedadaphne*
- 9b. Stamens opening by 4 lateral (usually vertical) valves, the anthers and filaments usually clearly differentiated; fruits 6 cm long only in *Persea* and lacking a basal cup 10a
- 10a. Outer stamens adjacent to large glands which are a part of the periphery of the androecium, the stamens variously bent and usually with lateral dehiscence, outer stamens with the lower pair of valves dehiscing lateral-extrorse, stamens and glands often tightly congested; fruits a deep cup *Pleurothyrium*
- 10b. Outer stamens and the periphery of the androecium without conspicuous glands, the glands present only near the bases of the inner stamens, the outer stamens with all valves introrse, stamens and glands tightly congested only in *Nectandra* 11a
- 11a. Outer stamens with the thecae superposed, the upper valves directly above the lower valves, rarely

- with the lower valves somewhat lateral to the upper valves (in an arcuate arrangement) and then usually with some outer anthers with superposed thecae; filaments shorter than the anthers 12a
- 11b. Outer stamens with the thecae in a single horizontal row or with the lower lateral to the upper in an arcuate arrangement, anthers usually broader than long 15a
- 12a. Fruits borne on a thickened pedicel (lacking a disclike or cupulate receptacle), tepals equal or unequal in length, the tepals often persisting at the base of the fruits; stamens with slender puberulent filaments often exceeding the length of the anthers, staminodes large and sagittate; surfaces of the dried leaves with a raised reticulum in some spp. *Persea*
- 12b. Fruits borne in cups or on a disclike expansion of the receptacle, tepals deciduous or persisting on the margin of the cup; the tepals equal or subequal in length; filaments usually equalling or shorter than the anthers 13a
- 13a. Flowers without staminodes or the staminodes small and linear, staminodes lacking a sagittate or thickened apex and not consistently 3 per flower; leaves rarely tripliveined *Ocotea*
- 13b. Flowers with 3 conspicuous staminodes, the apex of the staminodes cordate-ovate or sagittate; leaves often tripliveined 14a
- 14a. Trees and shrubs of native vegetation; crushed bark not smelling like camphor or cinnamon *Phoebe*
- 14b. Trees and shrubs of parks and gardens; crushed bark smelling like camphor or cinnamon *Cinnamomum*
- 15a. Leaves alternate and never tripliveined; perianth whorls equal or subequal; stamens often subsessile and crowded close together; fruits enclosed in a cup or subtended by a disc *Nectandra*
- 15b. Leaves opposite and tripliveined; outer perianth whorls smaller than the inner; stamens with conspicuous filaments; fruits borne on a thickened pedicel *Caryodaphnopsis*

Key 2: Artificial Key to Woody Genera and Species

(Measurements and leaf color based on dried material; leaf lengths and widths do not include petiole length.)

- 1a. Leaves densely puberulent beneath with conspicuous hairs (0.3–1 mm long), the hairs spreading or appressed, the puberulence of the abaxial (lower) leaf surface soft or slightly rough to the touch 2a
- 1b. Leaves glabrous to sparsely and minutely puberulent beneath, if densely puberulent the hairs minute (0.05–0.2 mm) and difficult to see, puberulence of the lower leaf surfaces not discernable to the touch 29a
- 2a. Largest leaves rarely more than 10 cm long 3a
- 2b. Largest leaves usually more than 13 cm long 7a
- 3a. Hairs spreading; leaf base not decurrent on the petiole, leaves drying chartaceous; fruit cups 6–12 mm broad, fruits 15–25 mm long; flowers usually with well-developed staminodes 4a
- 3b. Hairs appressed and usually parallel on the lower leaf surfaces, lamina base slightly decurrent on the petiole, laminae often drying subcoriaceous; fruit cups 10–16 mm broad, fruits 20–30 mm long; flowers lacking staminodes 5a
- 4a. Hairs slightly rough to the touch on the lower surface; laminae drying yellowish to dark brown or black; 1400–3200 m elevation *Ocotea pittieri*
- 4b. Hairs soft to the touch and slightly grayish on the lower surface; laminae usually drying dark brown above; 1400–2300 m elevation *Ocotea mollicella*
- 5a. Perianth of 2 different sizes and persisting beneath the globose fruits, a fruit cup not developed; leaves narrowly elliptic-oblong, to 2.5 (3.5) cm broad; 1000–3300 m elevation *Persea* spp.
- 5b. Perianth whorls equal or subequal; fruits subtended by a cup; 1400–3000 m elevation 6a
- 6a. Leaves usually elliptic with an acute apex, 1.5–4 cm broad, the lower surfaces remaining

- densely puberulent; (900–)1400–1600 m in the Cordillera de Tilarán and western Meseta Central *Ocotea monteverdensis*
- 6b. Leaves usually oblong with an obtuse apex, 1.5–6 cm broad, the lower surface often becoming glabrescent; 1700–3000 m in the central highlands and Cordillera de Talamanca *Ocotea austini*
- 7a. Margin of the leaf base often broadly revolute to form 1 or 2 pocket-like flaps on the lower surface just above the petiole, leaves up to 36 cm long, usually long-acuminate at the apex, with 6–16 pairs of major secondary veins; fruits borne in shallow cups; stamens tepal-like *Nectandra reticulata*
- 7b. Margin of the leaf base flat to narrowly revolute near the petiole beneath but not forming flaps or auriculae, laminae rarely long acuminate at the apex, with 5–10(–12) pairs of major secondary veins 8a
- 8a. Base of the leaf blade decurrent on the petiole and the petiole often poorly defined, margin of the leaf base often strongly revolute 9a
- 8b. Base of the leaf blade not clearly decurrent on the petiole 13a
- 9a. Trees of montane formations above 1400 m elevation; leaf blades elliptic to oblong (rarely obovate) 10a
- 9b. Trees of lower elevations (below 1200 m) in Costa Rica; leaf blades often slightly obovate 11a
- 10a. Puberulence of the lower leaf surface silky and lustrous; leaves sessile with poorly differentiated petiole, stiffly coriaceous; only found above 2000 m elevation *Ocotea calophylla*
- 10b. Puberulence of the lower leaf surface not lustrous; leaves petiolate and chartaceous to coriaceous; go back to 5a
- 11a. Petioles well defined (the leaf base not long-decurrent), leaves drying stiffly chartaceous and with 4–8 pairs of major secondary veins; fruits borne in a deep cup 10–16 mm broad *Ocotea hartshorniana*
- 11b. Petioles poorly defined, leaf base decurrent on the petiole, leaves drying subcoriaceous and with 9–12 pairs of secondary veins 12a
- 12a. Fruits in a deep cup with lobed rim, berry ellipsoid or oblong *Ocotea dentata*
- 12b. Fruits on a shallow saucer-like cup, berry globose *Ocotea stenoneura*
- 13a. Inflorescences with densely puberulent, peduncles to 16 cm long; laminae often oblong and abruptly rounded at both apex and base; fruits puberulent near the base; flowers becoming rotate and 1–2 cm broad, often pink; trees of seasonally dry forest formations *Nectandra sinuata*
- 13b. Inflorescences with peduncles to 9 cm long or if longer growing in wet forests; fruits glabrous; flowers rarely more than 12 mm broad, never pink 14a
- 14a. Trees from 1000 m elevation or above 15a
- 14b. Trees from below 1000 m elevation 19a
- 15a. Petioles 15–60 mm long; fruits 4–10 cm in diameter and never subtended by or included in a cup; outer stamens 3–5 mm long; leaves drying chartaceous to subcoriaceous; inflorescences much branched 16a
- 15b. Petioles 4–25 mm long; fruits 1.5–2.5 cm in diameter, subtended or included in a cup; outer stamens 1.2–2.5 mm long; leaves usually drying subcoriaceous; inflorescences often with few or widely distant flowers 17a
- 16a. Flowering pedicels 10–26 mm long; leaves usually bluntly rounded at the apex, densely ferruginous-tomentellous beneath; fruits globose ... *Persea schiedeana*
- 16b. Flowering pedicels 2–5 mm long; leaves usually acute to short-acuminate or obtuse at the apex, sparsely puberulent beneath; fruits globose to pyriform *Persea americana*
- 17a. Flowers glabrous on the outside; fruits borne in a cup with entire margins; leaves usually widest at or above the middle; 1200–2200 m elevation *Ocotea valeriana*
- 17b. Flowers densely puberulent on the outside; fruit cups often with lobes on the margins; 800–1600 m 18a

- 18a. Laminae usually widest above the middle, often obovate; hairs of lower leaf surface less than 0.4 mm long *Pleurothyrium palmanum*
- 18b. Laminae usually widest at the middle, often suborbicular; hairs of lower leaf surface more than 0.5 mm long *Ocotea gomezii*
- 19a. Inflorescences pendulous on long (to 15 cm) thin (1–2 mm) peduncles with conspicuous long (1–2 mm) thin straight hairs; perianth usually glabrous on the outside; fruits borne in a shallow cup; leaves often narrowly obovate to pandurate, acuminate at the apex and often slightly rounded at the base *Ocotea helicterifolia*
- 19b. Inflorescences pendulous only in fruit, the peduncles not so thin, hairs rarely more than 1 mm long; perianth usually puberulent on the outside; laminae obovate and rounded at the base only in *Nectandra belizensis* and *Ocotea valeroides* 20a
- 20a. Fruits avocado-like, more than 5 cm long, never subtended by a cup or saucer-like disc; leaves sparsely puberulent beneath, leaves often broadly elliptic-oblong to ovate, rounded and short-acuminate at the apex, stiffly chartaceous 21a
- 20b. Fruits less than 4 cm long, globose to ellipsoid and always subtended by a cup or saucer-like disc; leaves sparsely to densely puberulent beneath, drying chartaceous to coriaceous . 22a
- 21a. Flowers 5–8 mm long; petioles 1–6 cm long, lower leaf surfaces with slender grayish hairs 0.1–0.4 mm long, leaves with 5–9 pairs of secondary veins .. *Persea americana*
- 21b. Flowers ca. 3 mm long; petioles 1–3 cm long, lower leaf surfaces with slender brownish hairs 0.2–0.6 mm long, leaves with 4–14 pairs of major secondary veins *Beilschmiedia anay*
- 22a. Leaves usually tapering to a long-acuminate apex, 12–32(–40) cm long with 9–14 pairs of major secondary veins, often drying dark brown; fruit cups 6–10 mm deep; inflorescences paniculate with many (over 50) flowers *Nectandra kunthiana*
- 22b. Leaves rarely long acuminate (except in *N. belizensis* and *Endlicheria* sp.?), not so long and usually drying yellowish brown; fruit cups rarely more than 5 mm deep 23a
- 23a. Leaves gradually narrowed at the base and slightly rounded, narrowly to broadly obovate or pandurate, with short (4–14 mm) petioles; inflorescences racemose with short lateral branches and thick ferruginous peduncles 24a
- 23b. Leaves gradually or abruptly narrowed at the base but not rounded at the base, rarely slightly obovate, 4–12 cm broad 25a
- 24a. Leaves 13–38 cm × 10–22 cm, with 8–12 pairs of major secondary veins, tertiary veins often subparallel; petioles 4–14 mm long; flowers 8–10 mm broad *Ocotea valeroides*
- 24b. Leaves 9–16 cm × 3.5–6 cm, with 4–8 pairs of secondary veins, tertiary veins not subparallel; petioles 4–8 mm long; flowers 5–7 mm broad *Nectandra belizensis*
- 25a. Petioles to 3 cm long, leaves often drying subcoriaceous; inflorescences racemose or paniculate and usually with short unbranched lateral branches, peduncles often densely short-puberulent and ferruginous 26a
- 25b. Petioles to 2 cm long, leaves usually drying chartaceous; inflorescences paniculate, the primary branches often with secondary branches, peduncles glabrous to puberulent 27a
- 26a. Leaves often broadly elliptic, the major veins broadly impressed above and the surface rounded between the major veins; fruits on a dislike receptacle 6–8 mm broad and 1–2 mm deep; stamens not congested *Ocotea babosa*
- 26b. Leaves elliptic-oblong to obovate, the major veins and the upper surface flat; fruit cups 2 cm broad and 1 cm deep; glands and stamens closely congested into an androecial dome *Pleurothyrium gulfodulcense*
- 27a. Leaves broadly elliptic, 6–14 cm broad, rounded at the apex and short-acuminate, the 5–9 pairs of secondary veins not loop-connected near the margin; fruit cups ca. 1.5 cm broad and with persisting perianth-bases along the margin *Ocotea mollifolia*
- 27b. Leaves narrowly oblong (2.5–6 cm broad) and often long-acuminate, with 8–14 pairs of major secondary veins; fruit cups without persisting perianth on the margins 28a
- 28a. Secondary veins loop-connected near the margin, leaves chartaceous; fruit cups 12–14 mm broad, with a simple margin ?*Endlicheria* sp.

- 28b. Secondary veins not loop-connected near the margin, leaves subcoriaceous; fruit cups 16–22 mm broad, with a double margin *Licaria multinervis*
- 29a. Leaves tripliveined with 2 major lateral veins arising from near the base and extending beyond the middle of the lamina to the distal half of the lamina, and with additional secondary veins arising from the distal half of the lamina 30a
- 29b. Leaves pinnately veined, rarely with the basal secondary veins strongly ascending, and with several pairs of secondary veins usually arising in the proximal half of the lamina 34a
- 30a. Trees of parks and gardens, rare in our area; bark with the odor of camphor or cinnamon; leaves often opposite *Cinnamomum*
- 30b. Trees of native vegetation; bark lacking the odor of cinnamon or camphor when crushed 31a
- 31a. Leaves consistently opposite, the lateral veins reaching the apex of the lamina; domatia absent *Caryodaphnopsis*
- 31b. Leaves alternate, rarely subopposite, the lateral basal veins often reaching only the middle of the lamina; pit domatia and tufted domatia often present in the vein axils 32a
- 32a. Leaves drying stiffly chartaceous and usually dark in color; inflorescences racemose and few-flowered, the flowers 7 mm long and 10 mm broad; 1600–2700 m elevation *Ocotea holdridgeiana*
- 32b. Leaves drying yellowish brown to olive green; flowers less than 5 mm long and 6 mm broad 33a
- 33a. Leaves usually drying subcoriaceous and often yellowish brown, secondary veins not loop-connected distally; inflorescences paniculate to racemose; 0–2000 m elevation *Phoebe* spp.
- 33b. Leaves drying chartaceous and usually dark olive green, secondary veins loop-connected distally; inflorescences paniculate; 0–500 m, moist forests of the Pacific lowlands *Aiouea obscura*
- 34a. Distal leafy stems hollow and often harboring small ants; leaves narrowly oblong to elliptic-oblong or narrowly obovate, 10–50 cm long, glabrous beneath; small trees in evergreen forest understorey 35a
- 34b. Distal leafy stems solid, the center with wood or pith, not consistently hollow; small to large trees in deciduous or evergreen forests 40a
- 35a. Leaves usually drying chartaceous, and often with a slender acuminate tip 1–3 cm long; fruit cups 1–3 mm deep; 0–1100 m elevation 36a
- 35b. Leaves usually drying subcoriaceous and grayish green to orange brown in color, with long acuminate tips only in *O. dendrodaphne* 37a
- 36a. Leaves often drying very dark, usually obovate, 12–32(–55) cm long; fruit cups 6–10 mm broad *Ocotea atirrensis*
- 36b. Leaves drying grayish to dark brown, usually elliptic-oblong, 12–27 cm long; fruit cups 5–8 mm broad *Ocotea wedeliana*
- 37a. Distal stems strongly angled with 3–5 prominent longitudinal ridges; leaves narrowly obovate, 14–40(–55) cm long, with 7–12 pairs of secondary veins; fruit cups ca. 8 mm broad and 1–2 mm deep and often with persisting perianth on the rim; 0–1100 m *Ocotea nicaraguensis*
- 37b. Distal stems without prominent longitudinal ridges and not strongly angled in cross section; leaves with 5–11 pairs or major secondary veins 38a
- 38a. Leaves drying grayish green, usually elliptic-oblong, 14–36 cm long and 5–14 cm broad; fruit cups ca. 15 mm broad and 3–7 mm deep with a single or double margin; flowers 4–6 mm long; common, 0–1500 m *Ocotea dendrodaphne*
- 38b. Leaves drying grayish to brown, usually narrowly oblong, 10–30 cm long and 3–8 cm broad; flowers 2–3 mm long; rarely collected 39a
- 39a. Fruit cups 6–12 mm broad and 1–2 mm deep, without a flaring ridge beneath the distal rim; 600–2300 m *Ocotea paulii*
- 39b. Fruit cups 20–25 mm broad and 5 mm deep, with a prominent ridge around the periphery just below the distal rim; 0–1400 m elevation *Licaria brenesii*

- 40a. Leaf blades 20–50 cm long, usually becoming more than 30 cm long (not including the petiole-length), 10–23 cm broad; 0–500 m in evergreen forests 41a
- 40b. Leaf blades less than 30 cm in length, rarely exceeding 13 cm in width 43a
- 41a. Petioles 2–6 cm long; leaves broadly elliptic to elliptic-oblong, drying grayish green and subcoriaceous, with 6–10 pairs of major secondary veins; Caribbean slope *Phoebe chavarriana*
- 41b. Petioles ca. 1 cm long; leaves obovate, drying chartaceous and brownish, with 9–14 pairs of major secondary veins; Golfo Dulce area 42a
- 42a. Leaves broadly obovate, 15–23 cm broad, lamina attenuate at the petiole, the secondary veins not loop-connected near the margin *Ocotea rivularis*
- 42b. Laminae narrowly oblanceolate, 10–15 cm broad, lamina slightly rounded at the petiole, secondary veins often loop-connected near the margin .. *Pleurothyrium hexaglandulosum*
- 43a. Fruits borne on a thickened pedicel and not subtended by a cup or expanded disc; dried leaves with the minor venation nearly always raised on the upper and/or lower surfaces and often forming a reticulum of well-defined isodiametric areolae; petioles often more than 25 mm long (in *Persea*) 44a
- 43b. Fruits borne in a deep or shallow cup or subtended by a dislike receptacle expanded beyond the thickened pedicel; minor venation inconspicuous or slightly raised on the dried leaf surfaces but rarely forming a reticulum of well-defined areolae (compare dichotomy 74a); petioles exceeding 25 mm in length only in unusually large leaves or in *Williamodendron* 45a
- 44a. Fruits becoming ellipsoid; perianth deciduous and not persisting at the base of the fruits; rarely collected trees, except for a common species with smaller (10 × 3 cm) leaves at 800–2000 m elevation *Beilschmiedia* spp.
- 44b. Fruits becoming globose to ovoid, pyriform or reniform; the perianth bases often persisting at the base of the fruits; both common and rare species, but those with smaller leaves above 2000 m elevation *Persea* spp.
- 45a. Fruits usually borne in small umbellate groups of 3 at the apex of a short (1 cm) peduncle, the pedicels slightly expanded beneath the fruits to form a disc 2–4 mm broad; leaves small (to 12 × 3 cm) and stiff; rare unisexual trees of the Pacific slope, 1500–2000(–3000) m *Litsea glaucescens*
- 45b. Fruits never borne in umbellate groups on such short peduncles; peduncles more than 2 cm long, fruiting receptacle forming a cup or disc more than 4 mm broad 46a
- 46a. Distal branches strongly alate with narrow longitudinal wings 2–3 mm high, the stems 3–5-angled in cross section; laminae narrowly oblong to narrowly obovate, drying coriaceous; Pacific slope of Costa Rica, 0–700 m *Ocotea aurantiiodora*
- 46b. Distal branches not alate, occasionally with longitudinal ridges and angular in cross section but not winged 47a
- 47a. Leaf base decurrent on the petiole, the leaf base and petiole poorly differentiated, the leaf margin often revolute near the base, the leaves petiolate, subsessile or sessile 48a
- 47b. Leaf base not usually decurrent on the petiole, the leaf blades acute to obtuse or rounded at the base and usually clearly differentiated from the petiole, the leaves petiolate, never sessile or subsessile 60a
- 48a. Leaf base broadly revolute (auriculate) and forming 2 broad flaps beneath just above the petiole, petiole poorly differentiated and the leaf subsessile, broadly obovate and often coriaceous; 700–2300 m *Ocotea endresiana*
- 48b. Leaf base flat or revolute beneath but not forming broad flaps beneath, usually petiolate 49a
- 49a. Leaves usually with slender appressed ascending hairs on lower surfaces, hairs often parallel with the secondary veins; trees often with prop roots 50a
- 49b. Leaves glabrous or with thin irregular hairs on the lower surfaces in early stages; trees without prop roots 52a
- 50a. Leaf blades with the base usually long-decurrent, the narrowed portion of the leaf base

- to 5 cm long, leaf narrowly elliptic-obovate to elliptic, 2–5 cm broad, with 5–9 pairs of secondary veins; 600–1400 m elevation (if from higher elevations go to 51a)
Ocotea skutchii
- 50b. Leaf blades not long decurrent at the base, broadly obovate, 4.5–11 cm broad, with 7–12 pairs of major secondary veins 51a
- 51a. Leaves drying dull above and the minor venation not raised on the upper surface; fruits ovoid and 3–4 cm long; Caribbean lowlands *Ocotea caracasana*
- 51b. Leaves usually drying lustrous above and with the minor venation slightly raised on the upper surface; fruits globose to oblong, 2–3 cm long; 1500–2500 m on the Pacific slope and in Chiriquí *Ocotea glaucosericea*
- 52a. Leaves often rounded at the apex or bluntly obtuse (rarely acute to short-acuminate in smaller leaves), often obovate and rarely oblanceolate, usually drying coriaceous to subcoriaceous and often yellowish or grayish brown; fruiting receptacles cupulate and often with persisting perianth bases along the rim of the cup, fruits ellipsoid, 1–2 cm long 53a
- 52b. Leaves bluntly acute to acuminate at the apex, sometimes bluntly obtuse but never rounded, often oblanceolate to narrowly elliptic-obovate or oblong; fruiting receptacles flat and disclike or cupulate but without persisting perianth at the rim 54a
- 53a. Stamens opening by 4 valves; leaves (2–)5–9(–12) cm broad and often obovate, drying dark reddish brown to pale yellowish brown; fruit cups with or without persisting perianth parts along the rim; 0–2000 m *Ocotea insularis*
- 53b. Stamens opening by 2 valves; leaves 1.5–6(–8.5) cm broad and often oblong-obovate, drying dark brown to yellowish brown; fruit cups with persisting perianth; 1100–2500 m *Aiouea costaricensis*
- 54a. Mature fruits usually more than 15 mm long; leaves often drying subcoriaceous 55a
- 54b. Mature fruits usually less than 15 mm in length, globose to oblong, often borne on flat receptacles; leaves usually drying stiffly chartaceous 56b
- 55a. Fruits becoming ellipsoid, 1–2 cm in diameter, in cupulate receptacles 8–14 mm broad; domatia rarely present; 1200–2500 m elevation *Ocotea whitei*
- 55b. Fruits becoming globose-pyriform, to over 5 cm in diameter, the receptacle only slightly expanded below the fruits; leaves with pit domatia; 500–1100 m
Povedadaphne quadriporata
- 56a. Leaves narrowly oblanceolate to elliptic-obovate, gradually narrowed at the base, leaves often drying dark (gray to blackish); fruit cups gradually thickened to the flat or concave apex and 4–6 mm broad distally (but not forming a flat disc); 0–1000 m elevation 57a
- 56b. Leaves usually elliptic to oblong-obovate and rarely oblanceolate, gradually to abruptly narrowed at the base, the leaves drying grayish to brownish (58a) or dark (60a) 58a
- 57a. Fruits globose, 5–8 mm in diameter (dried); 0–500 m, Caribbean lowlands in Costa Rica *Ocotea bijuga*
- 57b. Fruits oblong, 9–18 mm long and 7–9 mm in diameter; (0–)400–1000 m
Ocotea oblonga
- 58a. Fruits globose or subglobose, 1–2 cm in diameter and borne on a flat disc or shallow cup 6–12 mm broad; 0–1500 m elevation 59a
- 58b. Fruits and receptacle otherwise 60a
- 59a. Fruits subglobose, 10–16 mm in diameter and usually with persisting style base at the apex, borne on a thick double-rimmed flat disclike receptacle 6–10 mm broad; leaves usually drying grayish green and the stems black *Ocotea floribunda*
- 59b. Fruits globose, 12–20 mm in diameter, without persisting style base, borne on a shallow cup 9–12 mm broad; leaves drying yellowish brown to grayish, stems drying gray or brown *Nectandra cissiflora*
- 60a. (from 47b and 58b) Leaves drying dark (almost black) and thin-chartaceous; fruiting receptacle gradually expanded (obconic) to the 1 cm broad apex, concave or slightly cupulate, fruits becoming 2–3 cm long and 1–2 cm thick 61a

- 60b. Leaves drying grayish to dark brown, stiffly chartaceous to coriaceous if drying very dark . . . 62a
- 61a. Leaves elliptic to elliptic-oblong, 7–16(–20) cm long, glabrous, with 4–7 pairs of major secondary veins; flowers 1.5–3 mm long; 0–1700 m elevation *Ocotea tenera*
- 61b. Leaves ovate to broadly elliptic, 6–12(–15) cm long, sparsely puberulent, with 3–5 pairs of major secondary veins; flowers 3–5 mm long; 900–2000 m elevation *Ocotea brenesii*
- 62a. Fruit cups with a double margin distally, an elevated ridge or flange present in addition to the distal edge of the cup and encircling the cup close to the edge, the distal edge usually entire and the subtending ridge or margin often undulate 63a
- 62b. Fruit cups without a conspicuous double margin distally or the fruits subtended by a flat disc and a cup absent 69a
- 63a. Cups well developed and 5–10 mm deep, rounded to conical in form; species of *Licaria* 64a
- 63b. Cups shallow or saucer-like, rarely more than 5 mm deep 68a
- 64a. Leaves becoming narrowly elliptic-oblong to lanceolate, usually 3–4 times longer than broad 65a
- 64b. Leaves elliptic to elliptic-oblong, usually only 2–3 times longer than broad 66a
- 65a. Leaves with 8–14 pairs of major secondary veins and minutely puberulent beneath; 500–1000 m elevation *L. multinervis*
- 65b. Leaves with 5–10 pairs of major secondary veins, glabrous beneath; 150–2300 m elevation *L. excelsa*
- 66a. Fruit cups 8–12 mm broad; leaves 10–20 cm long, 3–7 cm broad, often lustrous above; Caribbean slope, 0–700 m *L. sarapiquensis*
- 66b. Fruit cups 11–28 mm broad at the top 67a
- 67a. Trees of the Caribbean slopes and central highlands, 0–1400 m elevation; leaves 5–16 cm long, 2–6 cm broad *L. triandra*
- 67b. Trees of southwestern (Pacific) Costa Rica, 0–1000 m elevation; leaves 9–18 cm long, 3–7 cm broad *L. cufodontisii*
- 68a. Leaves obtuse to bluntly acute at the apex; fruit cups shallow and with ellipsoid fruits; very dry deciduous to partly deciduous forests of the Pacific slope *Ocotea veraguensis*
- 68b. Leaves acute to short-acuminate at the apex; fruit cups very shallow and often disclike, fruits subglobose; evergreen and partly deciduous forests *Ocotea floribunda*
- 69a. Leaves usually less than 9 cm long and 3 cm wide, narrowly elliptic to narrowly elliptic-oblong, usually drying dark brownish with the minor venation slightly raised above 70a
- 69b. Leaves usually becoming much more than 9 cm long and 3 cm wide, if small the leaves usually drying pale greenish gray or yellowish 74a
- 70a. Trees of lower-elevation (0–1600 m) wet evergreen forest formations; fruits 10–18 mm long, globose to ellipsoid 71a
- 70b. Trees of montane forest formations above 1600 m elevation 72a
- 71a. Leaves with the upper surfaces drying lustrous and with the tertiary venation conspicuously raised; fruits ellipsoid in development; 600–1600 m *Nectandra salicina*
- 71b. Leaves with the upper surfaces dull or lustrous when dry, tertiary venation only slightly raised; fruits globose in all stages of development; below 500 m *Nectandra salicifolia*
- 72a. Basal secondary veins often strongly ascending and almost tripliveined, leaves often drying very dark and lustrous above, pit domatia usually present in vein axils beneath; flowers to 7 mm long and 10 mm broad *Ocotea holdridgeiana*
- 72b. Basal secondaries not strongly ascending, the leaves never tripliveined, pit domatia absent; flowers 2–4 mm long and 2–5 mm broad 73a
- 73a. Stems minutely puberulent in early stages; leaves 2–8 cm long and up to 2.4 cm broad, acute to short acuminate, venation flat above; Cordillera de Talamanca . . . *Aiouea talamancensis*
- 73b. Stems glabrous in early stages; leaves 3–12 cm long and up to 4 cm broad, often long-acuminate, venation slightly raised above when dry; Chiriquí highlands . *Ocotea viridiflora*
- 74a. Minor venation raised (elevated) on the lower leaf surface when dry and forming small areolae

- 0.3–1 mm broad, the areolae often with subequal sides, the laminae often drying yellowish green or grayish 75a
- 74b. Minor venation not raised and forming a distinct reticulum on the lower (abaxial) leaf surfaces when dried, areolae very irregular if present 79a
- 75a. Leaves gradually narrowed to the base, usually narrowly obovate and drying grayish green; fruits globose with a short persisting style at the apex and subtended by a small, flat, disclike receptacle *Ocotea floribunda*
- 75b. Leaves abruptly narrowed to the base (obtuse to acute); fruits never with a persisting style base, mostly ellipsoid and borne in cupulate receptacles 8–14 mm broad and 2–5 mm deep 76a
- 76a. Leaves large (14–30 × 7–18 cm) and obovate, rounded to bluntly obtuse at the apex, drying yellowish brown and subcoriaceous; fruit cups often with irregular margins; wet forests, 500–1000 m *Ocotea* sp. aff. *O. laetevirens*
- 76b. Leaves not becoming so large and never broadly obovate, not more than 10 cm broad, usually acuminate at the apex 77a
- 77a. Leaves with 4–9 pairs of major secondary veins, petioles 7–15 mm long and 2–3.5 mm thick; inflorescences densely and very minutely puberulent; 0–1000 m *Aniba venezuelana*
- 77b. Leaves with 3–6(–7) pairs of major secondary veins, petioles 5–30 mm long, 1–2.5 mm thick; inflorescences glabrous or very minutely and sparsely puberulent 78a
- 78a. Leaves drying stiffly chartaceous and often grayish; fruit cups 2–3 mm deep; 0–2100 m elevation *Ocotea meziana*
- 78b. Leaves drying subcoriaceous or stiffly chartaceous and often yellowish green; fruit cups 3–5 mm deep; 1200–2000 m *Ocotea laetevirens*
- 79a. Trees not known from below 1400 m elevation; petioles, stems, and inflorescence axes often reddish brown and glabrescent, the leaves often drying reddish brown to yellowish, often lustrous and coriaceous 80a
- 79b. Trees not known from above 1400 m elevation (except in *O. leucoxylon* and *N. membranacea* and those not drying reddish or yellowish) 81a
- 80a. Upper leaf surfaces usually drying lustrous and with the tertiary venation raised; fruits globose and becoming more than 2 cm in diameter *Nectandra cufodontisii*
- 80b. Upper leaf surfaces drying dull and the tertiary venation not raised; fruits ellipsoid, ca. 1 cm in diameter *Phoebe hammeliana*
- 81a. Leaves conspicuously glaucous beneath, drying chartaceous, to 29 cm long and 12 cm broad; evergreen forests below 600 m elevation 82a
- 81b. Leaves not conspicuously glaucous beneath 83a
- 82a. Petioles 0.5–1.5 cm long, leaves usually elliptic with 3–6 pairs of major secondary veins; flowers 2.5 mm long *Nectandra hypoleuca*
- 82b. Petioles 2–7 cm long, leaves usually obovate with 9–14 pairs of major secondary veins, clustered at the ends of twigs; flowers ca. 1.5 mm long .. *Williamodendron glaucophyllum*
- 83a. Fruits borne in deep (3–6 mm) well-developed cups usually more than 10 mm broad at the top; fruits usually ellipsoid to ovoid; stamens with 2 or 4 valves; leaves and inflorescences essentially glabrous; trees of the wet Caribbean slope 84a
- 83b. Fruits borne in shallow (1–3 mm) cups rarely more than 8 mm broad or on shallow saucer-like receptacles to 12 mm broad; fruits globose to ovoid; stamens with 4 valves 86a
- 84a. Leaves drying grayish or yellowish green, usually caudate-acuminate at the apex with a narrow (3 mm) tip to 2 cm long; laminae usually oblong and less than 16 cm long, chartaceous; flowers usually drying black *Ocotea cernua*
- 84b. Leaves not drying grayish and rarely caudate-acuminate (gradually acuminate when with a long tip) 85a
- 85a. Leaves drying subcoriaceous to stiffly chartaceous and lustrous above with the tertiary venation obscure, 10–20 cm long and elliptic-oblong; fruit cups sometimes with a double margin, fruits ca. 1 cm in diameter *Licaria sarapiquensis*

- 85b. Leaves drying chartaceous and dull above, the tertiary venation usually visible on the upper surfaces, 10–30 cm long and elliptic; fruits ca. 2 cm in diameter *Aiouea* sp.?
- 86a. Fruit cups drying dark and with conspicuous paler colored lenticel-like warts, fruits 8–10 mm in diameter and subglobose; young stems strongly ridged or 3–4-angled in cross section; leaves usually elliptic-oblong and drying grayish, usually subcoriaceous and margin revolute throughout; flowers unisexual, anthers with superposed thecae *Ocotea leucoxylo*
- 86b. Fruit cups not drying dark with conspicuous lighter colored warts or lenticels, fruits often borne on shallow saucer-like receptacles to 12mm broad, fruits globose or (less often) oblong-ellipsoid and less than 15 mm long; young stems not strongly angled or ribbed; outer anthers with the thecae in a single horizontal plane or arc. (The following are all species of *Nectandra* and very difficult to identify in the absence of flowers or with atypical foliage.) 87a
- 87a. Largest leaves rarely more than 17 cm long 88a
- 87b. Largest leaves usually more than 20 cm long 91a
- 88a. Leaves minutely puberulent beneath, never drying lustrous above; flowers 6–14 mm broad 89a
- 88b. Leaves glabrous beneath (except in early stages); flowers 5–8 mm broad 90a
- 89a. Leaves slightly decurrent at the base but not revolute, narrowly elliptic to narrowly elliptic-oblong, to 20 cm long, usually drying dark brown; flowers ca. 8 mm broad; 0–1400 m *Nectandra globosa*
- 89b. Leaves slightly decurrent on the stem and often revolute at the base, ovate to narrowly elliptic, to 15 cm long, usually drying very pale brown; flowers ca. 10 mm broad; Pacific slope, 0–1400 m *Nectandra ramonensis*
- 90a. Leaves usually drying brownish and often lustrous above, usually with the minor venation raised beneath when dry, secondary veins usually loop-connected distally *Nectandra salicifolia*
- 90b. Leaves usually drying grayish and rarely lustrous above, the minor venation obscure (in the central highlands and Caribbean slope) beneath or slightly elevated and clearly visible (on the Pacific slope where leaves are often very narrow), secondaries not loop-connected *Nectandra turbacensis*
- 91a. Leaves with the major secondary veins often loop-connected near the margin, usually drying dark brownish and lustrous above with the tertiary venation slightly raised, glabrous beneath, laminae ovate-elliptic to elliptic-oblong, 13–24 cm long and 5–11 cm broad in Costa Rica; Caribbean lowlands *N. latifolia*
- 91b. Leaves with the major secondary veins not (or only very weakly) loop-connected near the margin, tertiary venation prominent above usually only in *N. martinicensis*; absent from the Caribbean lowlands (except for *N. membranacea*) in Costa Rica 92a
- 92a. Leaves usually drying subcoriaceous, slightly decurrent on the petiole and the margin often revolute above the petiole, minutely puberulent beneath, often ovate-lanceolate in shape 93a
- 92b. Leaves usually drying stiffly chartaceous, some leaves may be slightly decurrent on the petiole but rarely with the margin revolute near the base, usually with 4–8 pairs of major secondary veins, puberulent or sometimes glabrous beneath in *N. martinicensis*; flowers 5–8 mm broad 94a
- 93a. Leaves with 4–8(–10) pairs of major secondary veins arising throughout the length of the midvein, often drying yellowish green or yellowish brown; flowers 6–12 mm broad; common in deciduous and partly deciduous forest, 0–700 m *N. globosa*
- 93b. Leaves with 3–5 pairs of major secondary veins arising from the proximal ½ (⅔) of the midvein and arcuate-ascending, often drying dark brown; evergreen or partly deciduous forest formations, 0–1700 m *N. membranacea*
- 94a. Leaves usually drying dull or slightly lustrous above and greenish or brown, laminae often elliptic-oblong, 12–28 cm long and 4–8.5 cm broad; twigs glabrous or sparsely puberulent *N. martinicensis*
- 94b. Leaves usually drying dark and very lustrous on the upper surfaces, often lanceolate or very narrowly elliptic, 10–30 cm long and 3–7 cm broad; twigs densely puberulent *N. nitida*

Key 3: Key to Comparative Figures of Costa Rican Lauraceae

- 1a. Leaves tripliveined or with the basal pair of secondary veins strongly ascending **Fig. 1**
- 1b. Leaves rarely tripliveined 2a
- 2a. Leaves usually exceeding 30 cm in length (not including the petiole length) **Fig. 2**
- 2b. Leaves rarely exceeding 30 cm in length 3a
- 3a. Distal stems hollow; leaves glabrous and often narrowly oblong or narrowly obovate **Fig. 3**
- 3b. Distal stems solid; leaves variously shaped 4a
- 4a. Leaves usually less than 10 cm long, elliptic to narrowly oblong; from above 1000 m elevation .
..... **Fig. 4**
- 4b. Leaves usually becoming more than 10 cm long or lowland species 5a
- 5a. Leaves very stiffly coriaceous; montane species from above 1500 m elevation **Fig. 5**
- 5b. Leaves not stiffly coriaceous *and* from montane habitats 6a
- 6a. Leaves densely puberulent beneath, the trichomes easily seen and the vesture apparent to touch
..... 7a
- 6b. Leaves glabrous beneath or the puberulence very small or difficult to see, lower surface smooth to
touch 10a
 - 7a. Montane species, (1000–)1500–2500 m elevation **Fig. 6**
 - 7b. Species of lower habitats, 0–1500 m elevation 8a
 - 8a. Pubescence usually becoming dark brown beneath **Fig. 7**
 - 8b. Pubescence rarely becoming dark brown beneath 9a
 - 9a. Pubescence dense on the lower surface. **Fig. 8**
 - 9b. Pubescence sparse to moderately dense beneath **Fig. 9**
- 10a. Leaves usually distinctly decurrent on the petiole and often cuneate at the base 11a
- 10b. Leaves not usually decurrent or only slightly decurrent at the base 12a
 - 11a. Leaves generally broad, often obovate **Fig. 10**
 - 11b. Leaves generally narrow, often elliptic (see also fig. 20) **Fig. 11**
- 12a. Montane species from 1500 to 3000 m, with leaves often lustrous above, mostly glabrous
..... **Fig. 12**
- 12b. Lowland or montane species, if montane the leaves not lustrous on the upper surface when dry
..... 13a
- 13a. Leaves drying grayish green, yellowish green, or very dark (almost black) on the upper surface .
..... 14a
- 13b. Leaves usually drying pale grayish, yellowish or dark 15a
 - 14a. Leaves drying very dark **Fig. 13**
 - 14b. Leaves drying grayish or yellowish **Figs. 13–14**
- 15a. Fruits not subtended by cups or discs **Fig. 15**
- 15b. Fruits subtended by a cup or flattened disc 16a
- 16a. Fruit cups usually with a double-rimmed edge; stamens 3 and often connate (*Licaria*) .. **Fig. 16**
- 16b. Fruit cups with a single edge 17a
- 17a. *Nectandra salicifolia* and related/similar species **Fig. 17**
- 17b. *Nectandra globosa* and similar/other species **Fig. 18**

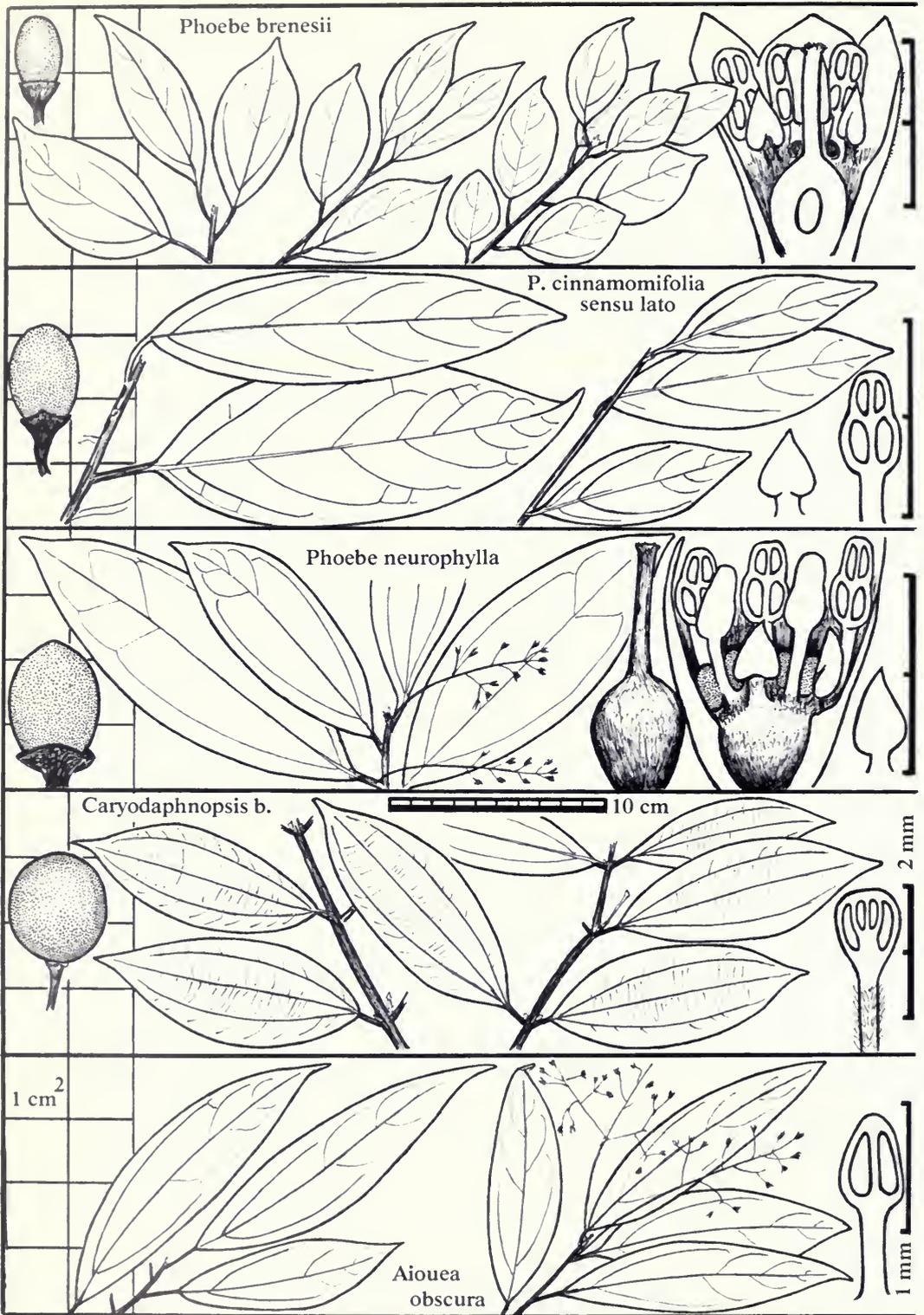


FIG. 1. Lauraceae: Tripliveined and palmately veined species.

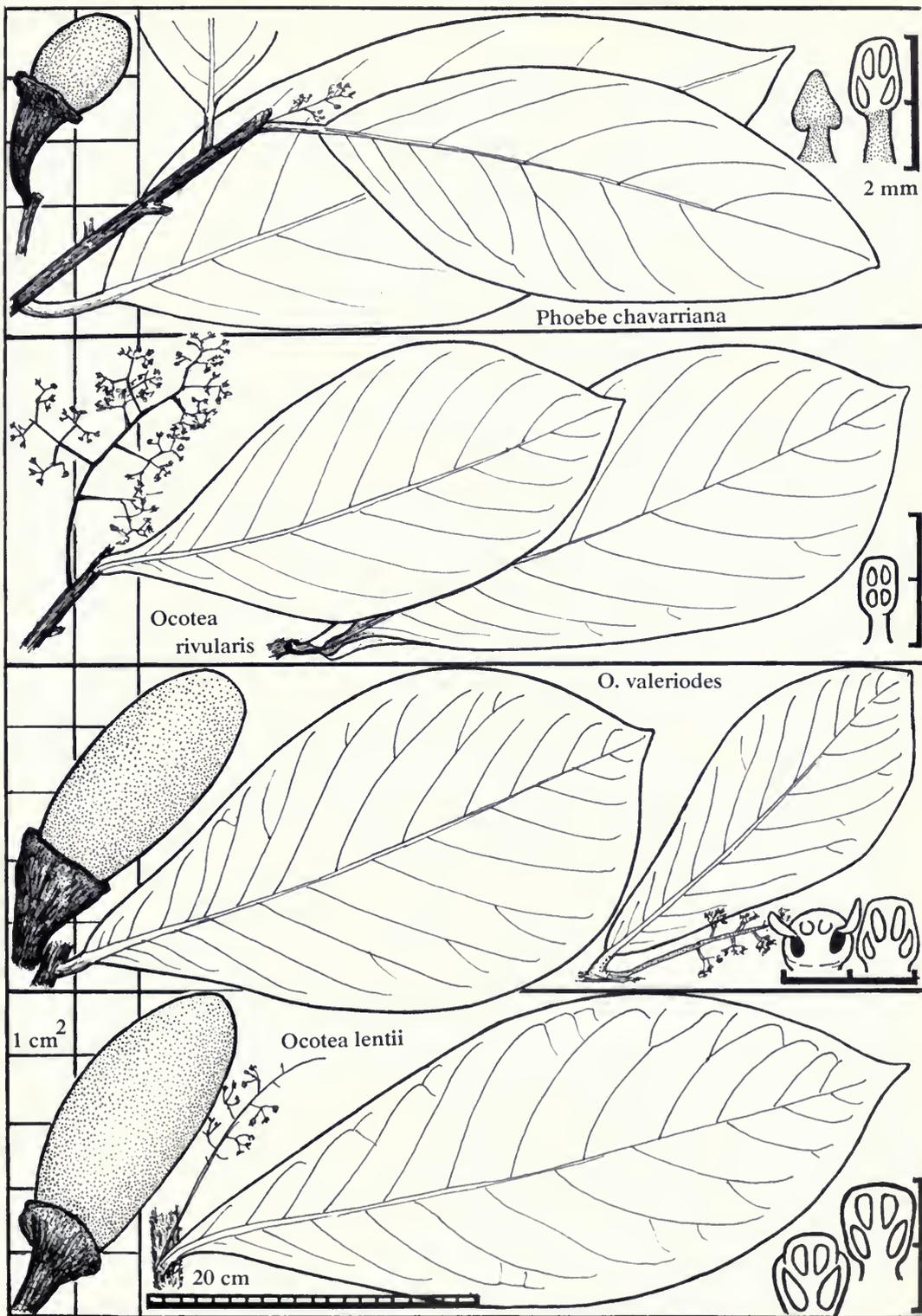


FIG. 2. Lauraceae: Large-leaved species.

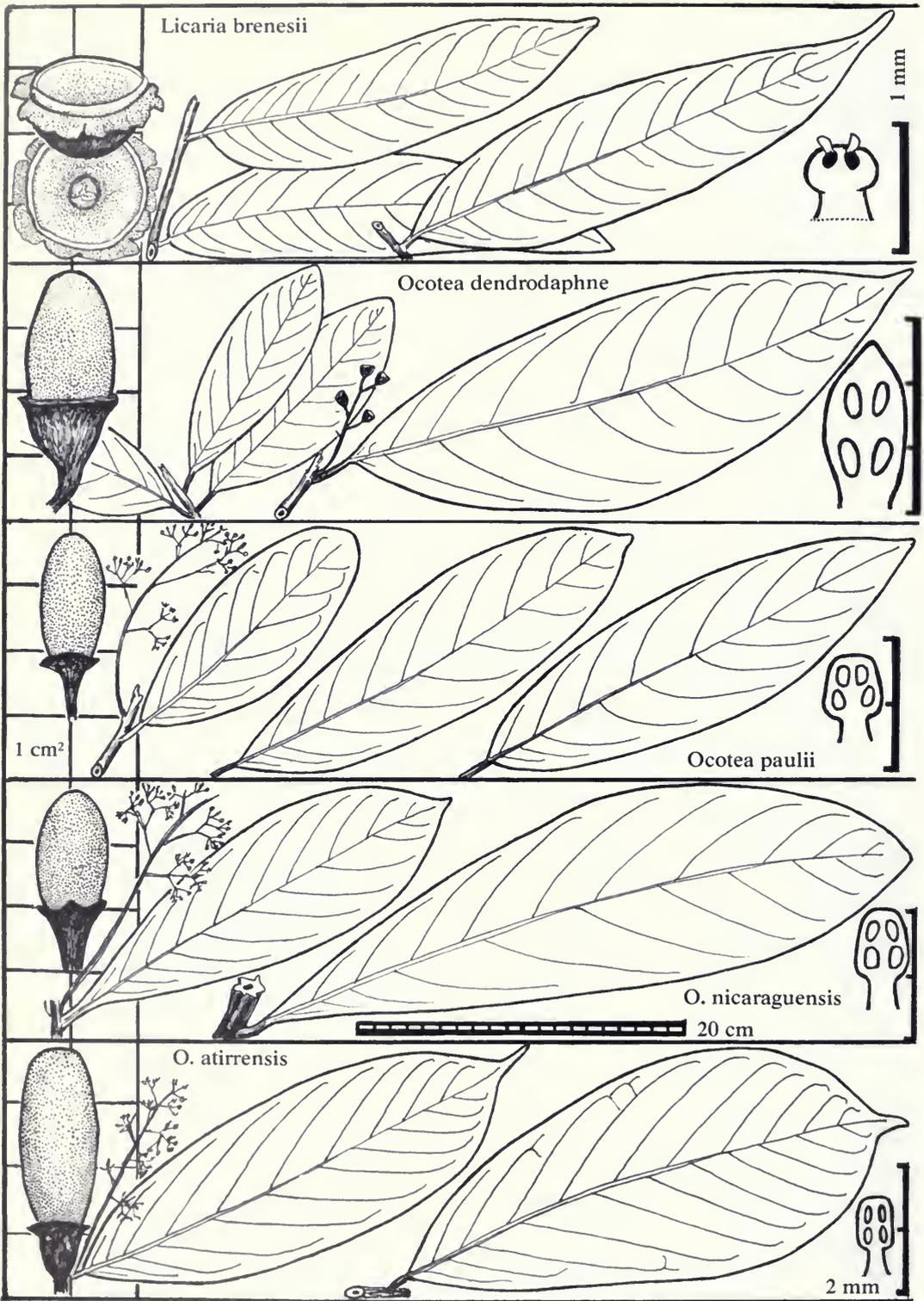


FIG. 3. Lauraceae: Species with hollow distal stems.

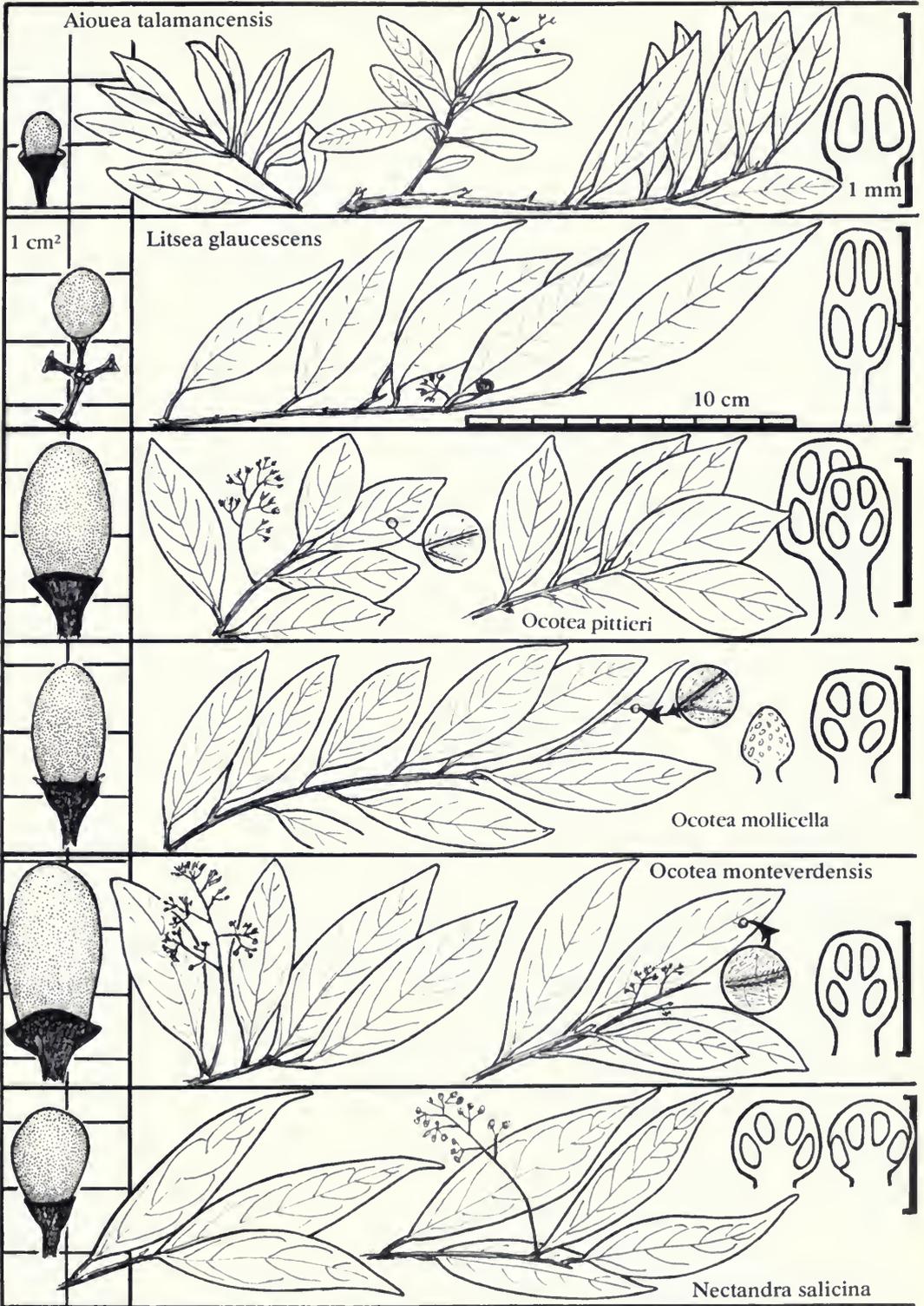


FIG. 4. Lauraceae: Montane species with small leaves.

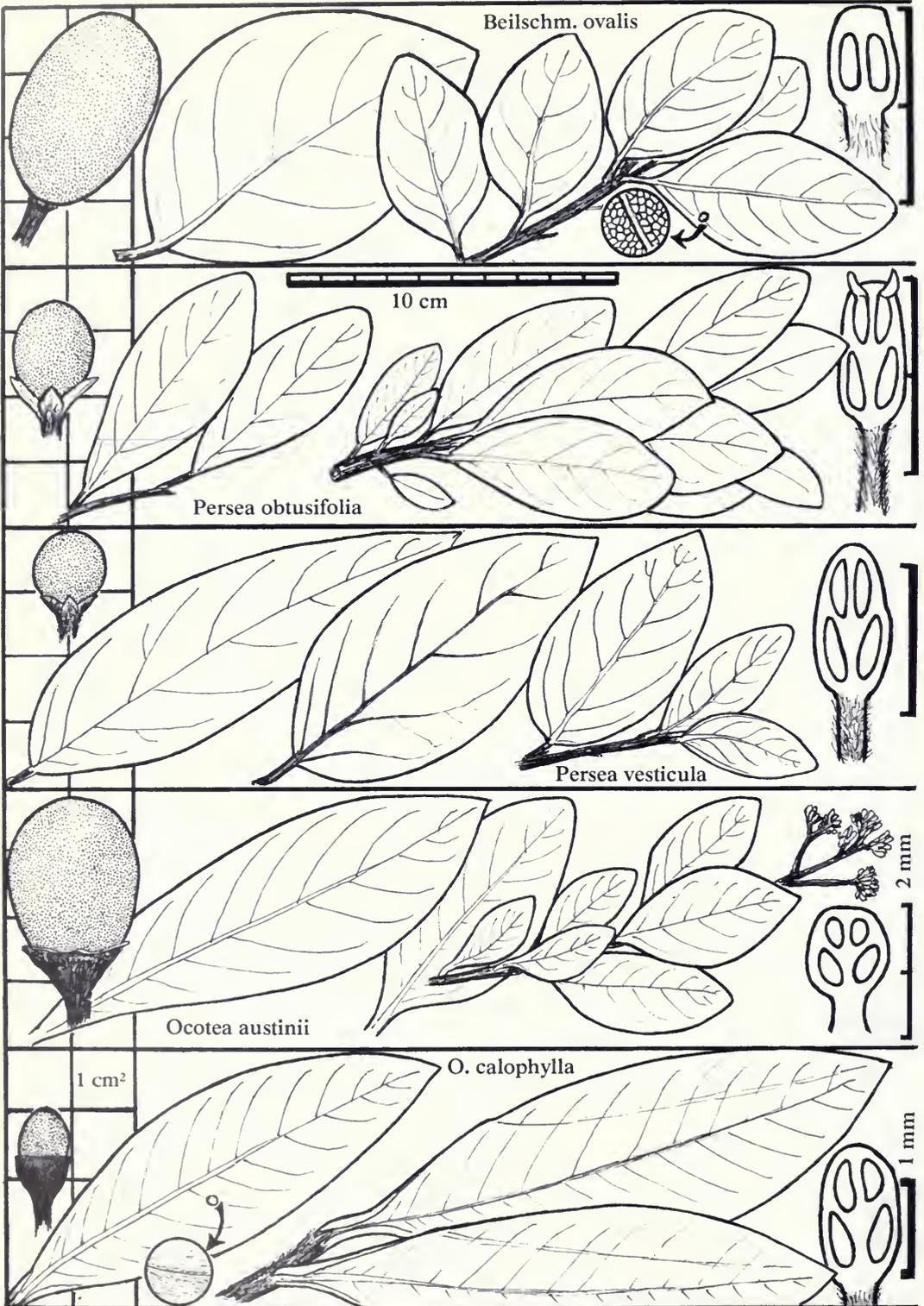


FIG. 5. Lauraceae: Montane species with thick coriaceous leaves.

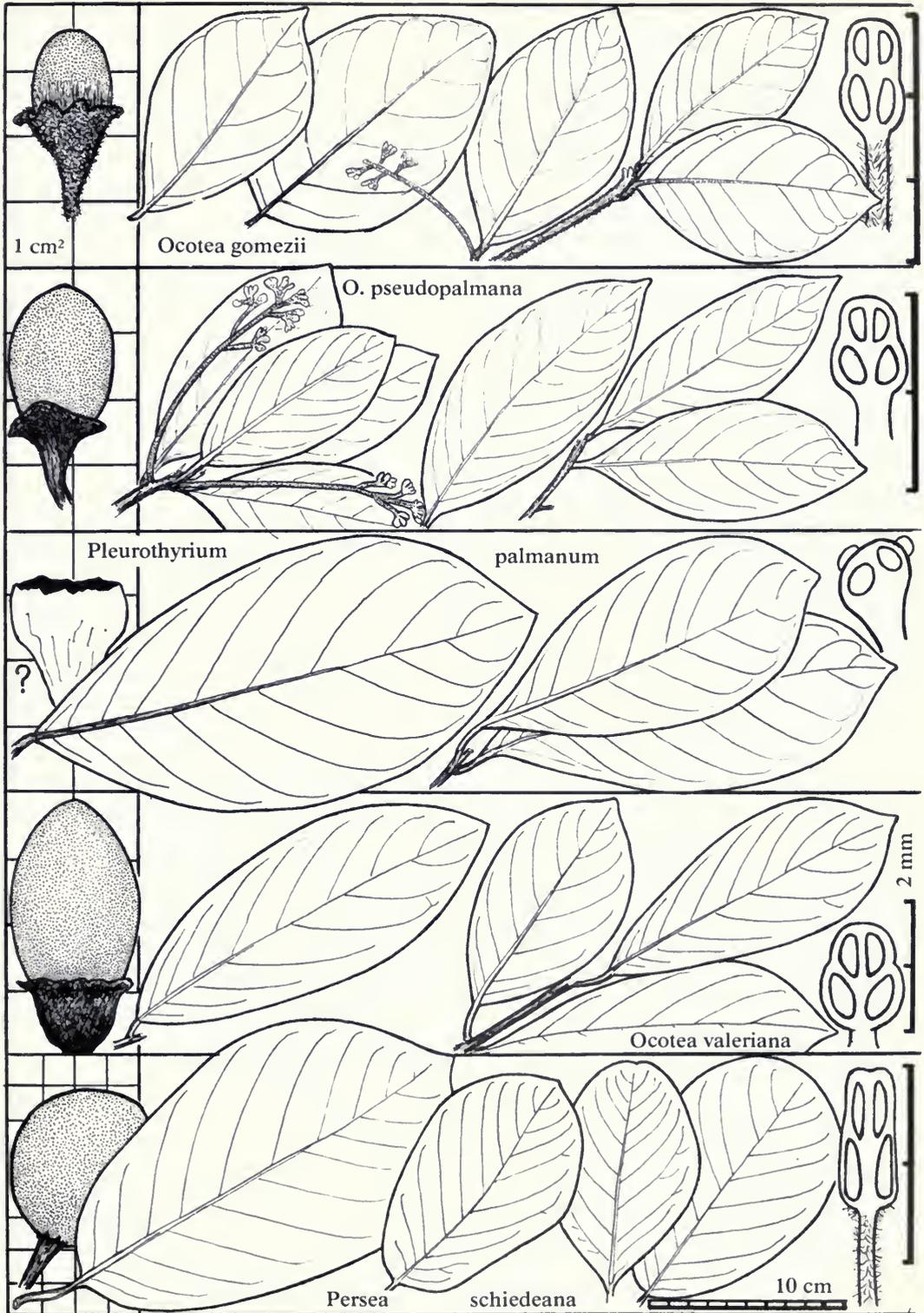


FIG. 6. Lauraceae: Montane species with densely puberulent leaves.

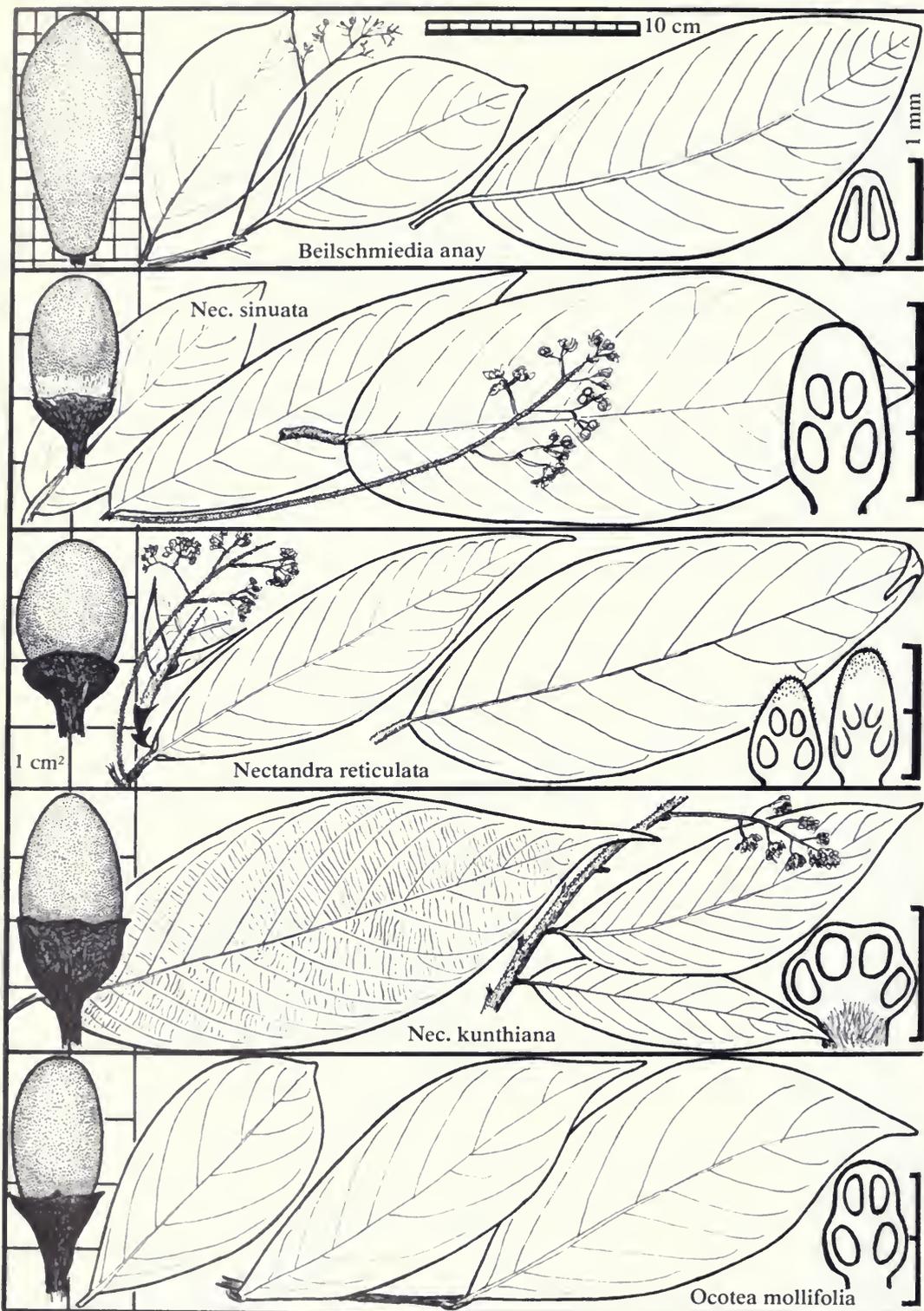


FIG. 7. Lauraceae: Lower-elevation species with densely puberulent leaves.

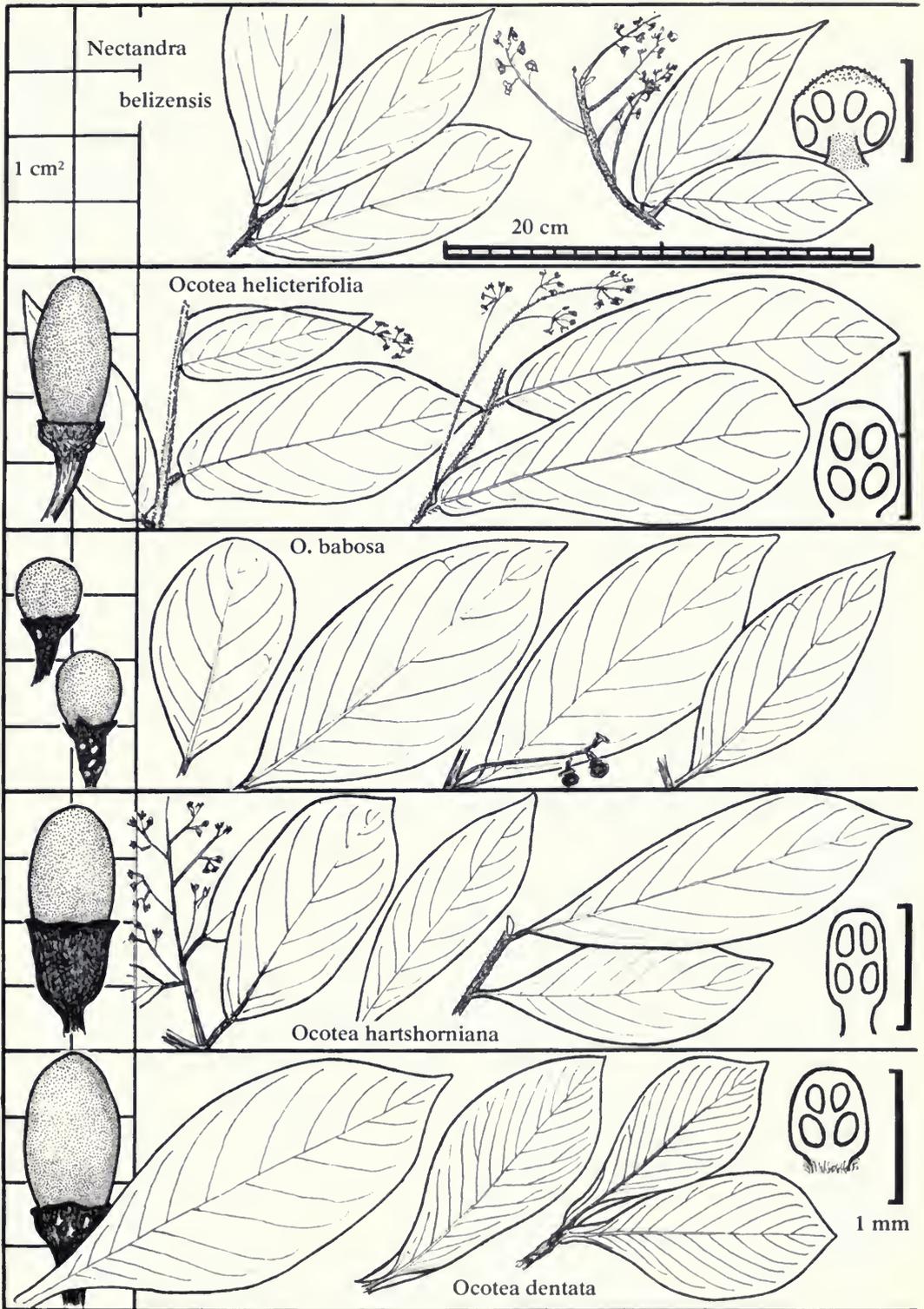


FIG. 8. Lauraceae: Lower-elevation species with densely puberulent leaves.

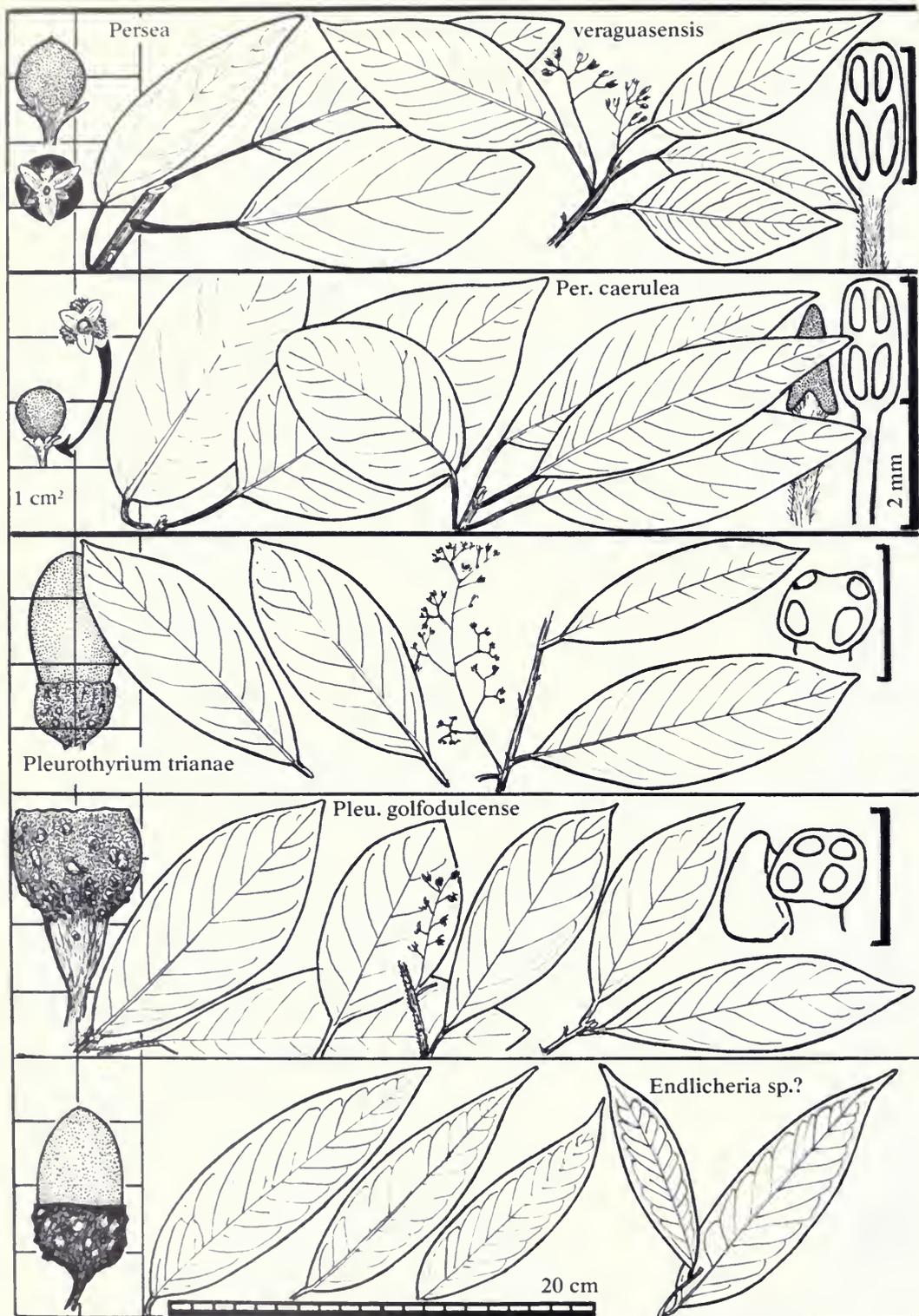


FIG. 9. Lauraceae: Lower-elevation species with sparsely puberulent leaves and two species of *Persea*.

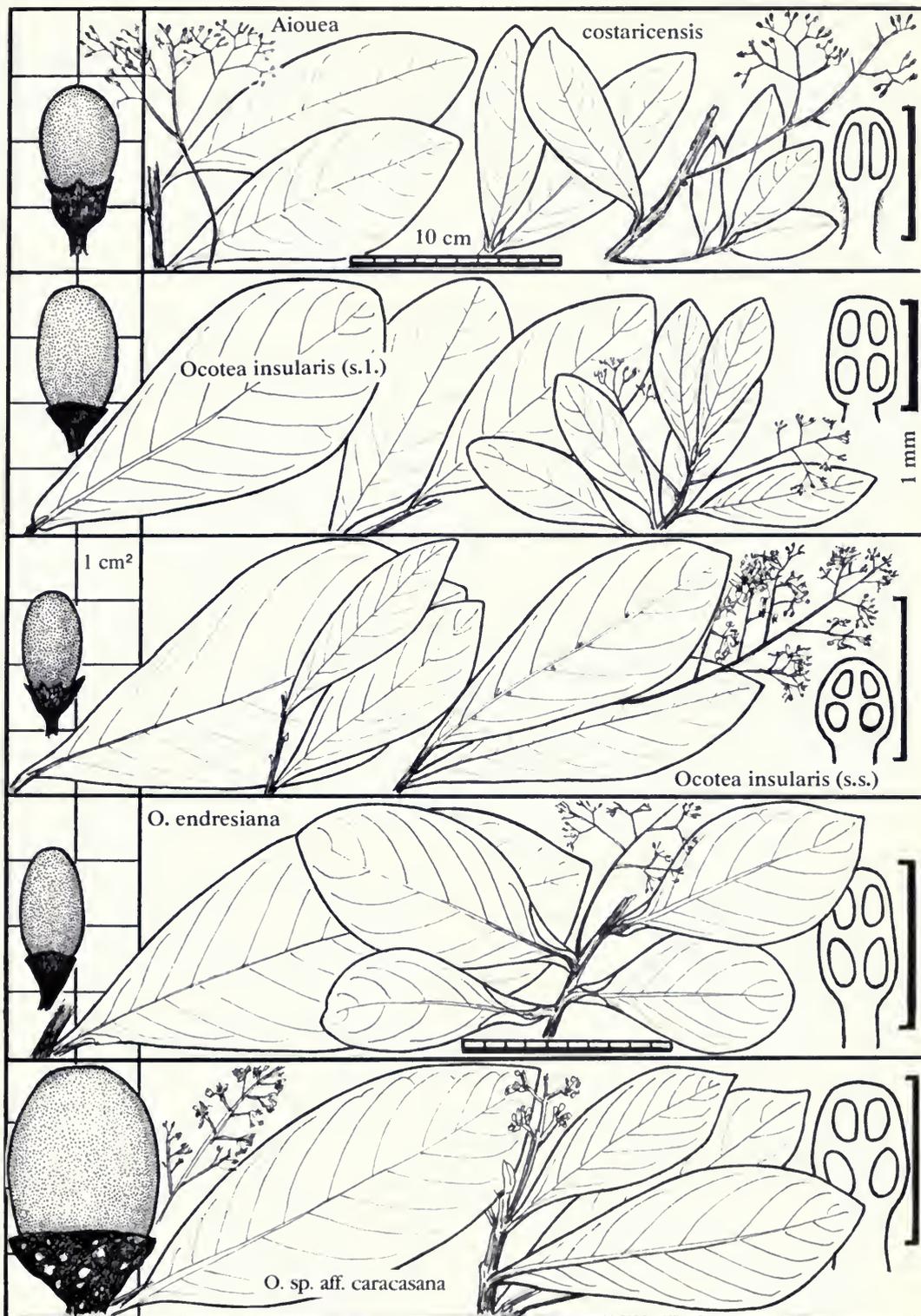


FIG. 10. Lauraceae: Species with decurrent lamina bases (larger-leaved species).

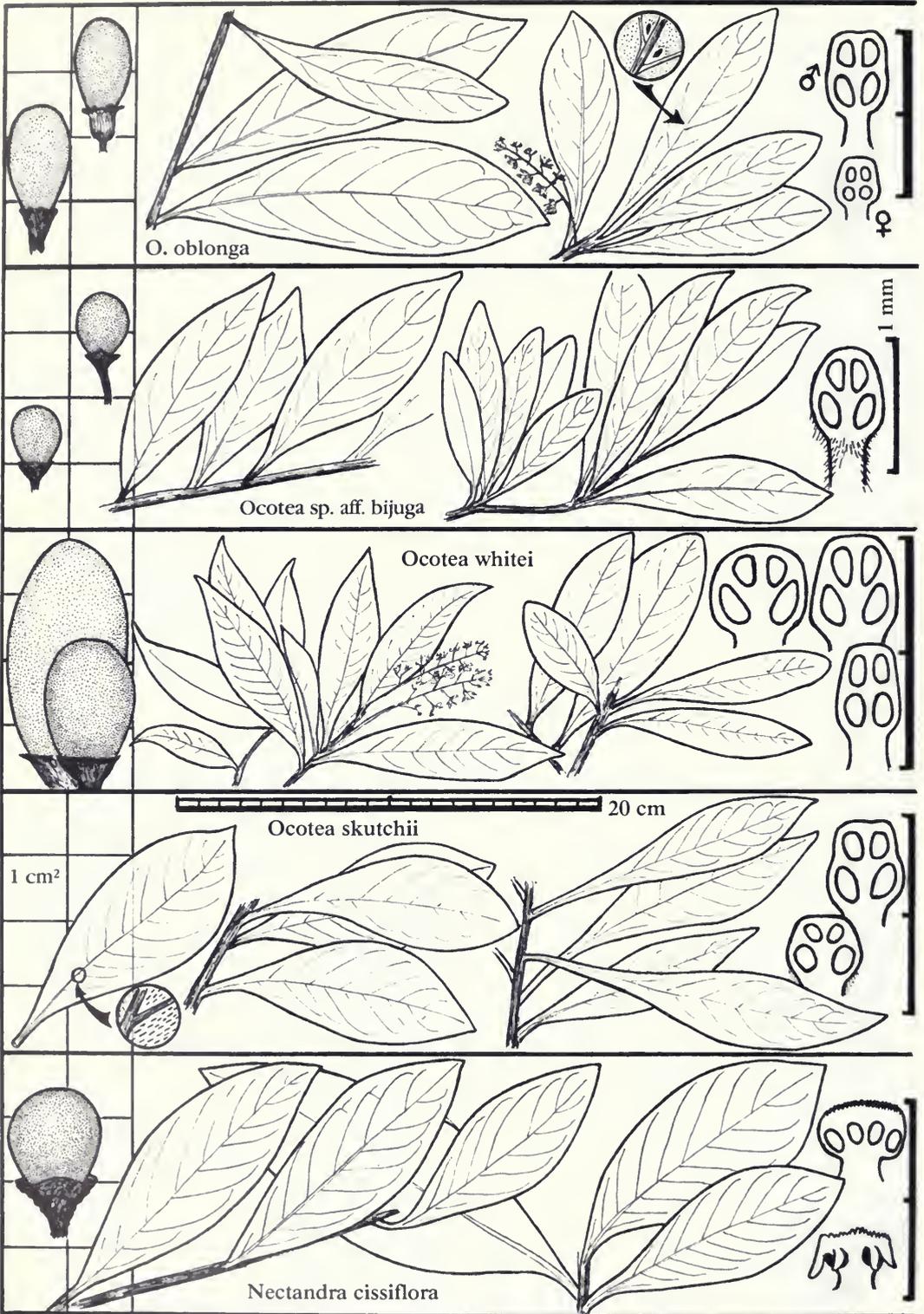


FIG. 11. Lauraceae: Species with decurrent lamina bases (smaller-leaved species).

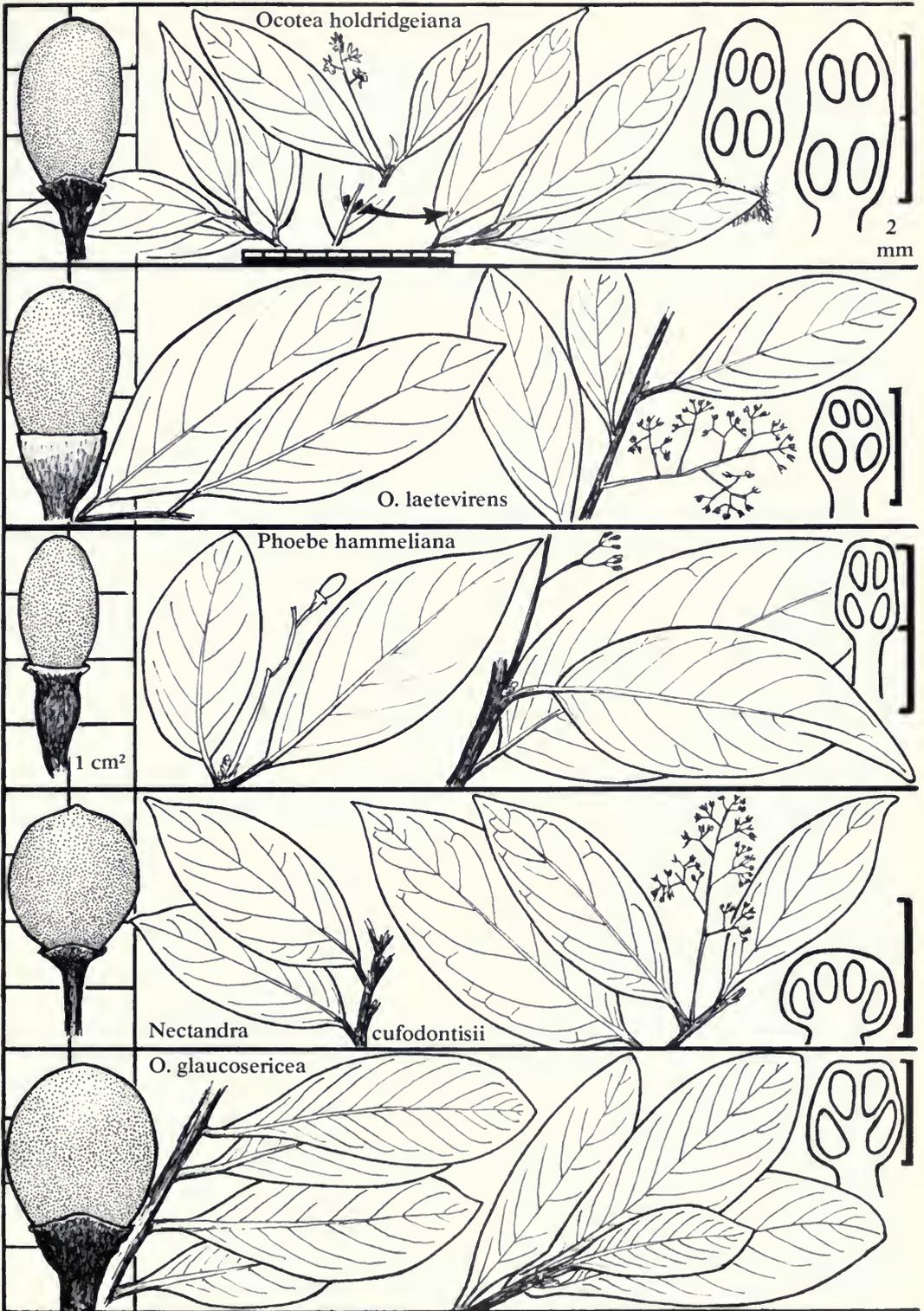


FIG. 12. Lauraceae: Montane species with the laminae often lustrous above.

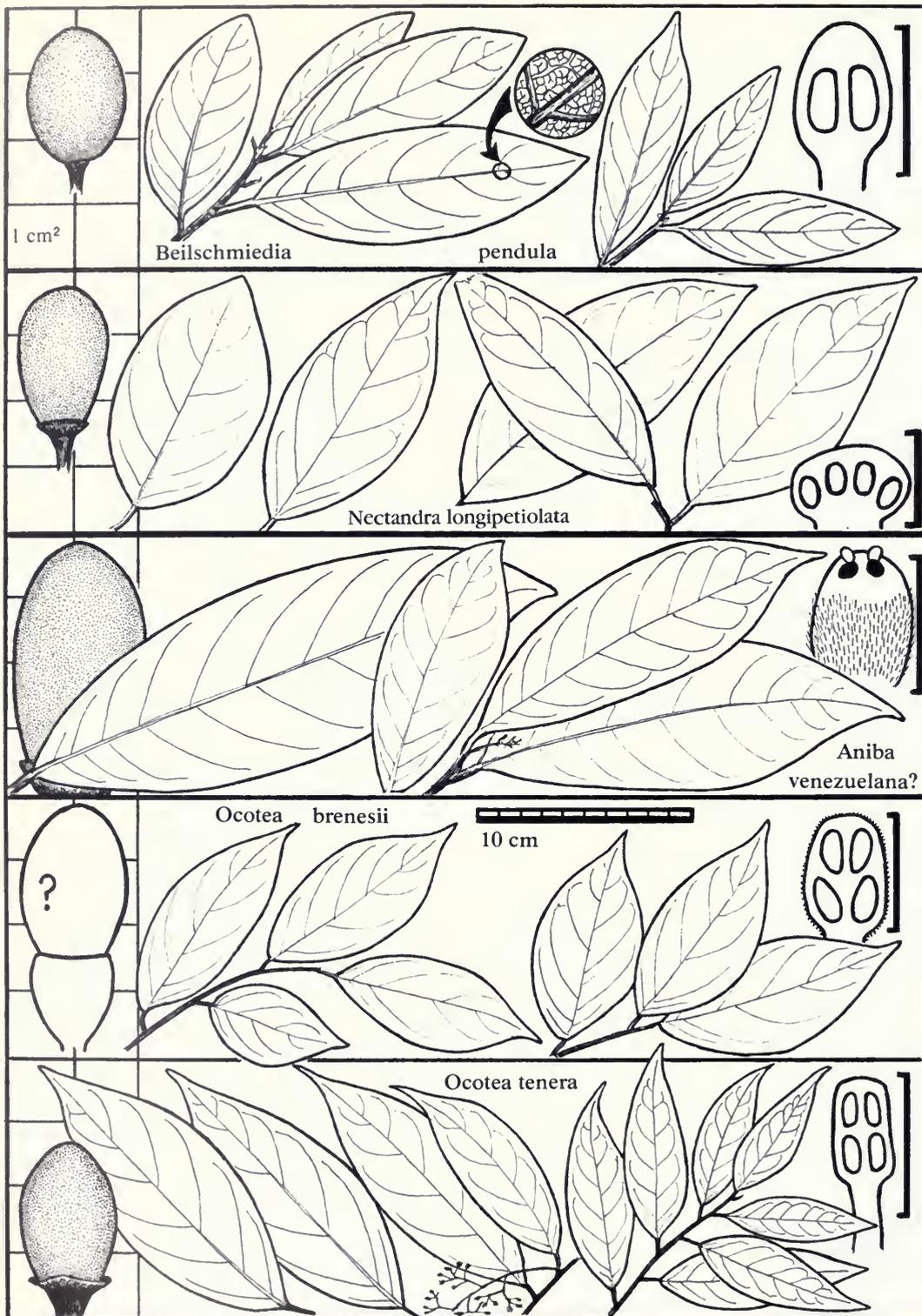


FIG. 13. Lauraceae: Species with glabrous leaves often drying dark or grayish.

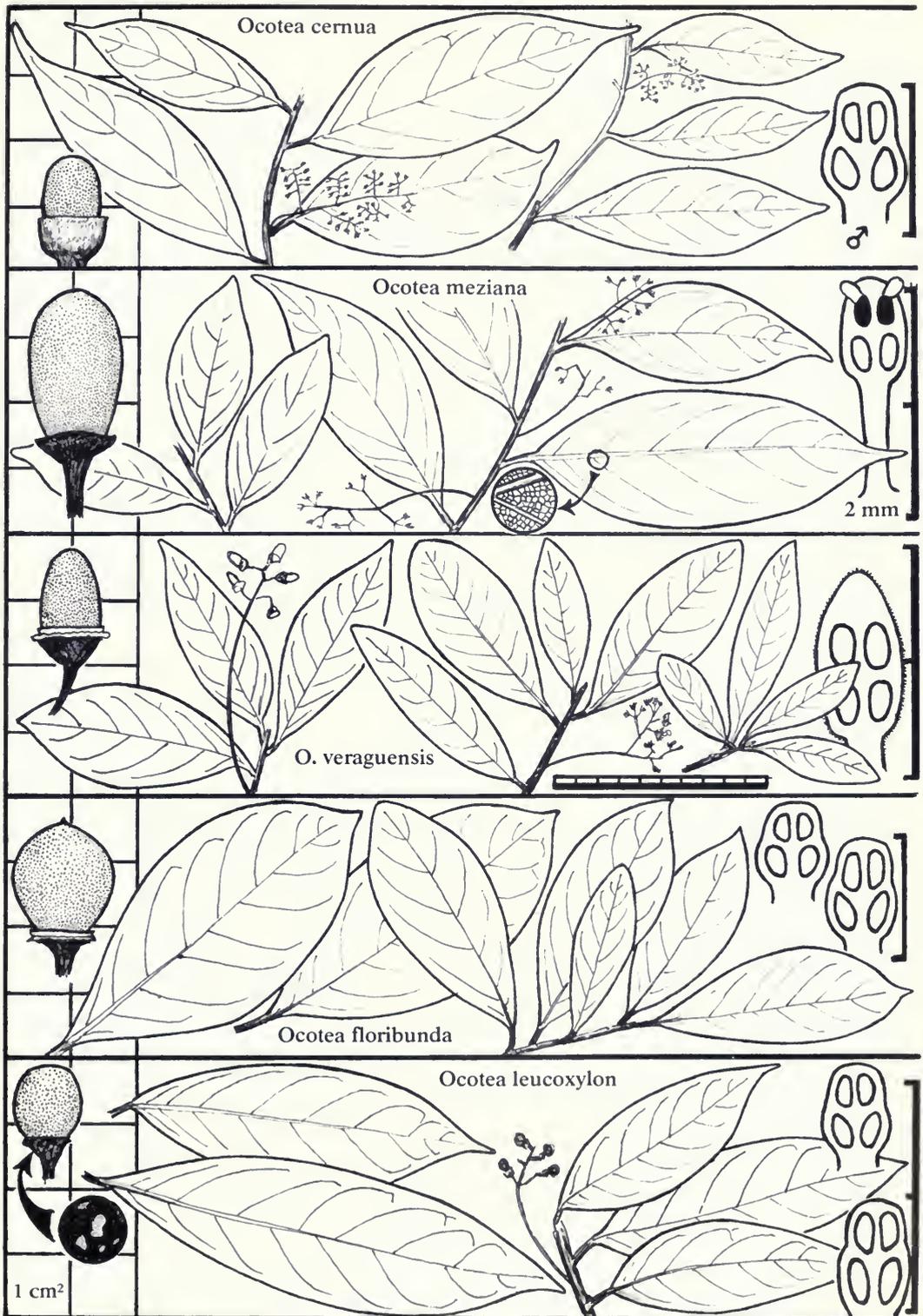


FIG. 14. Lauraceae: Species with glabrous leaves often drying gray or greenish.

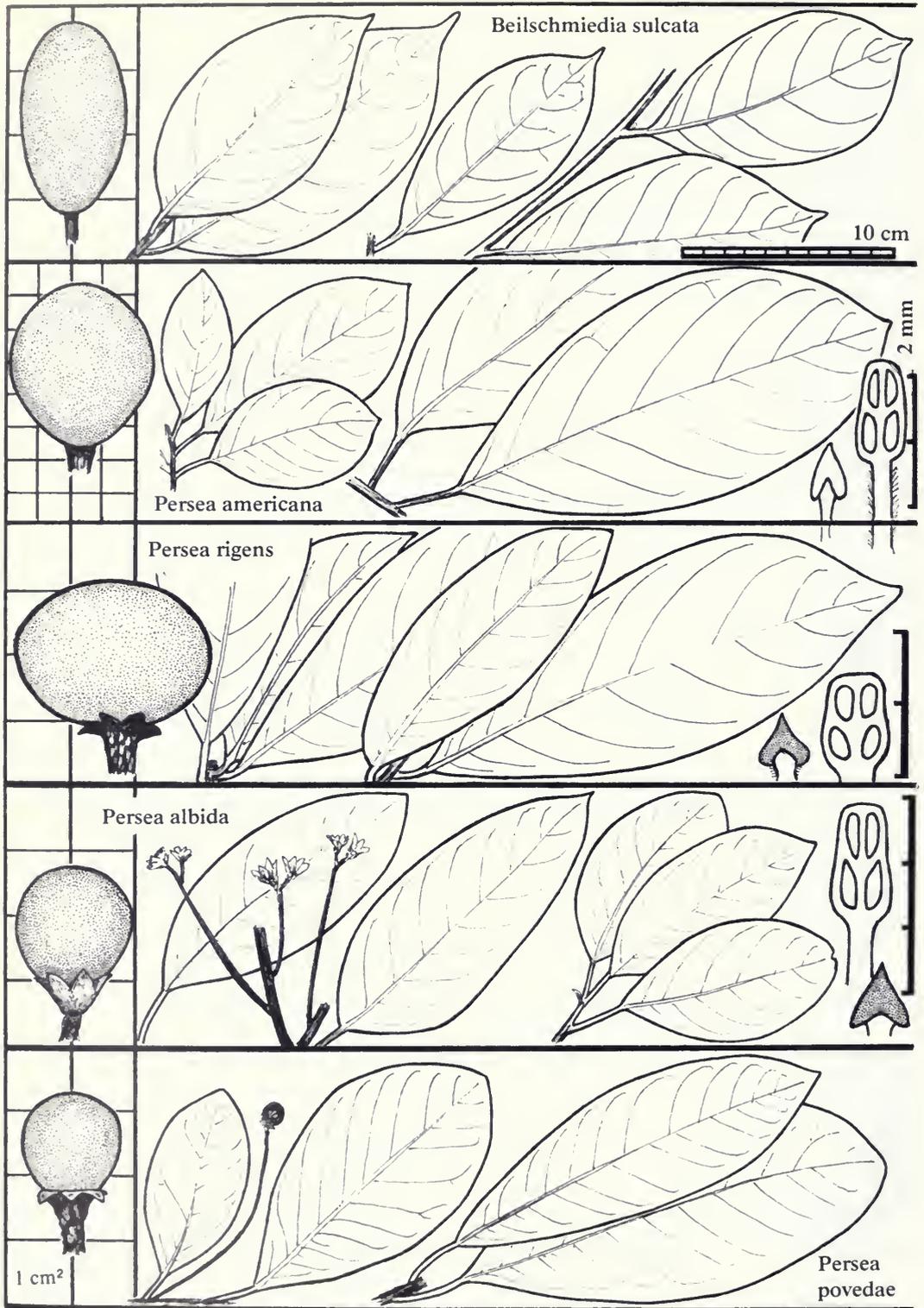


FIG. 15. Lauraceae: Species of *Beilschmiedia* and *Persea*, the fruits not subtended by a cup.

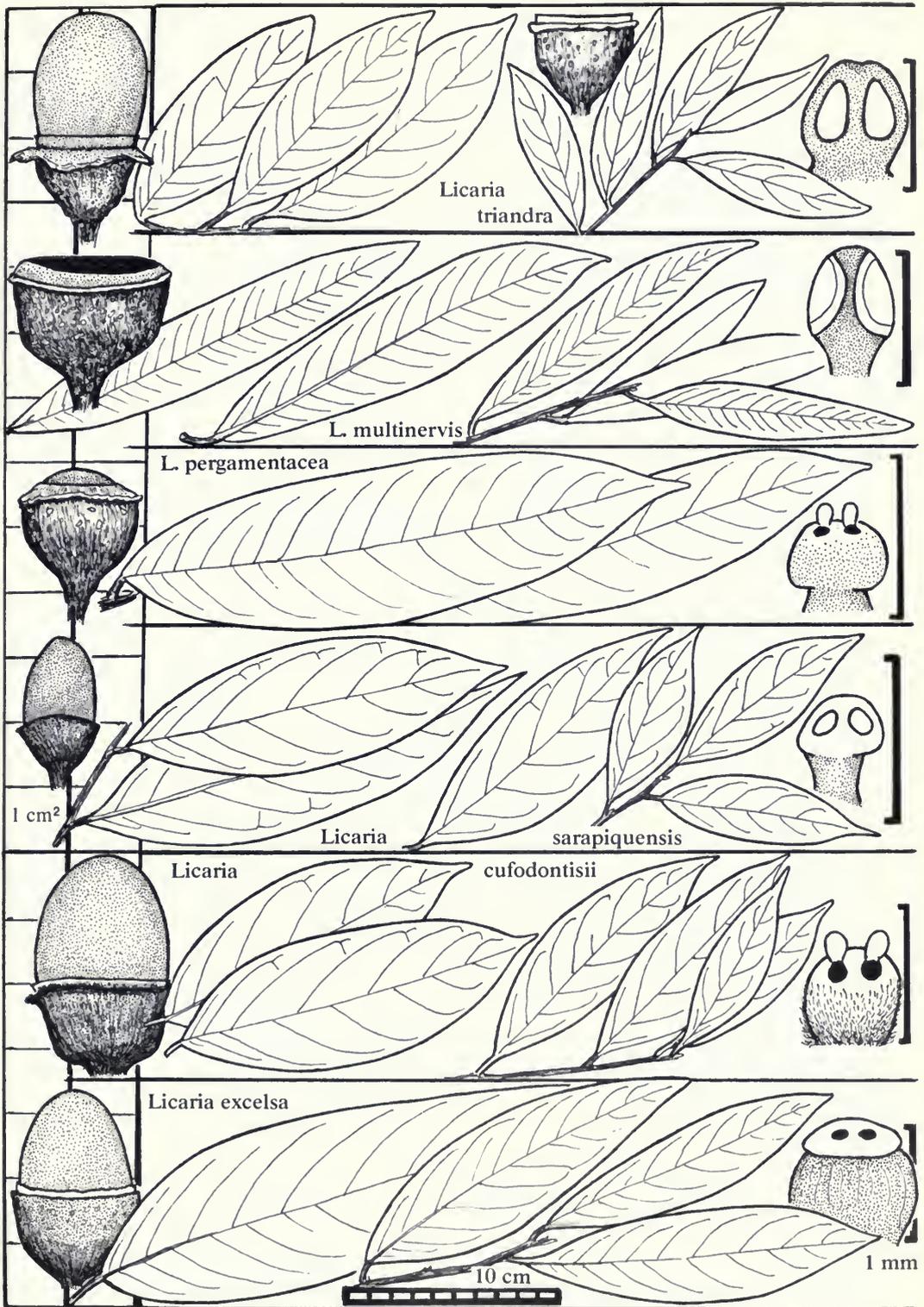


FIG. 16. Lauraceae: Species of *Licaria*, the fruit cup usually with a double margin.

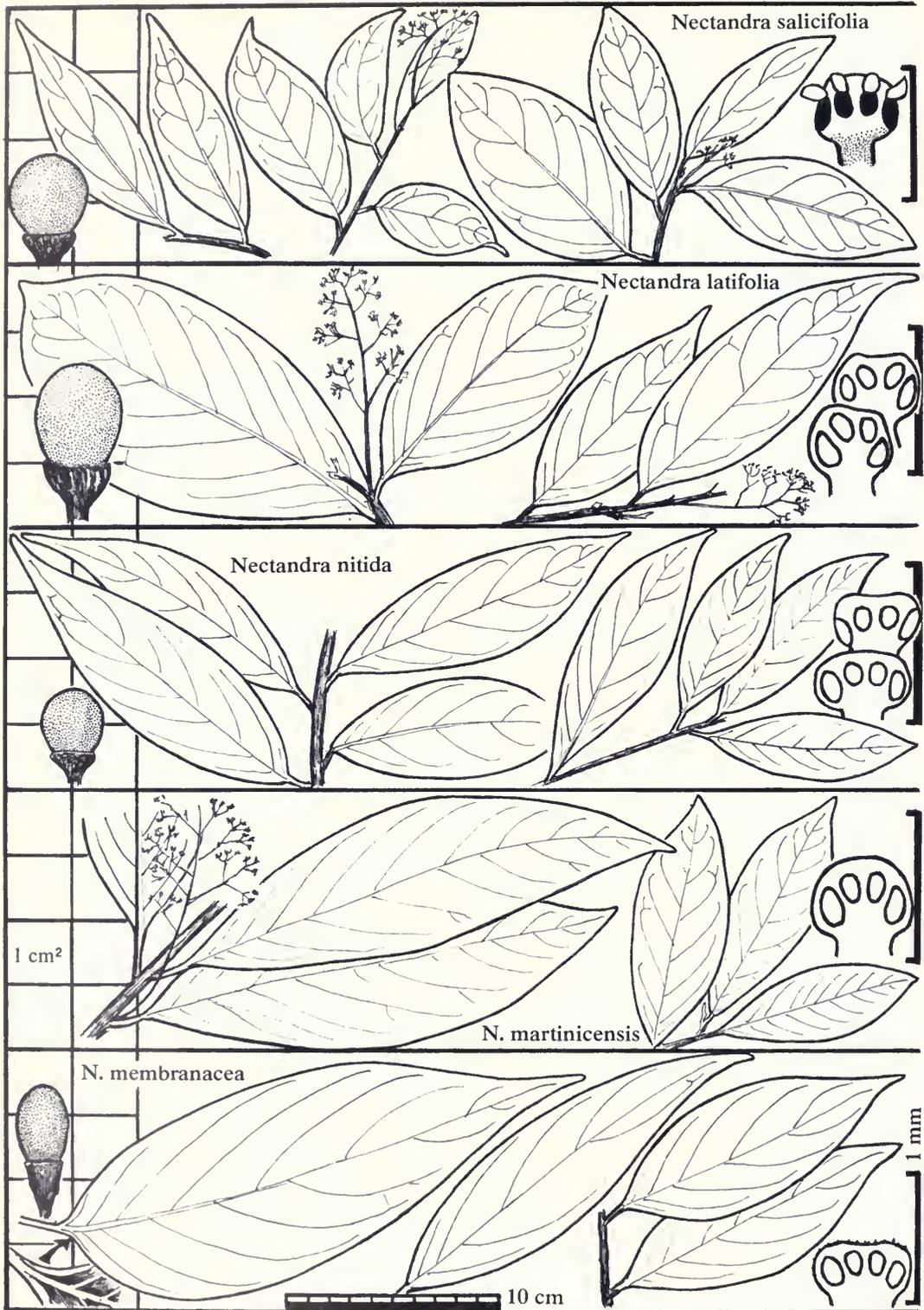


FIG. 17. Lauraceae: *Nectandra salicifolia* and similar species.

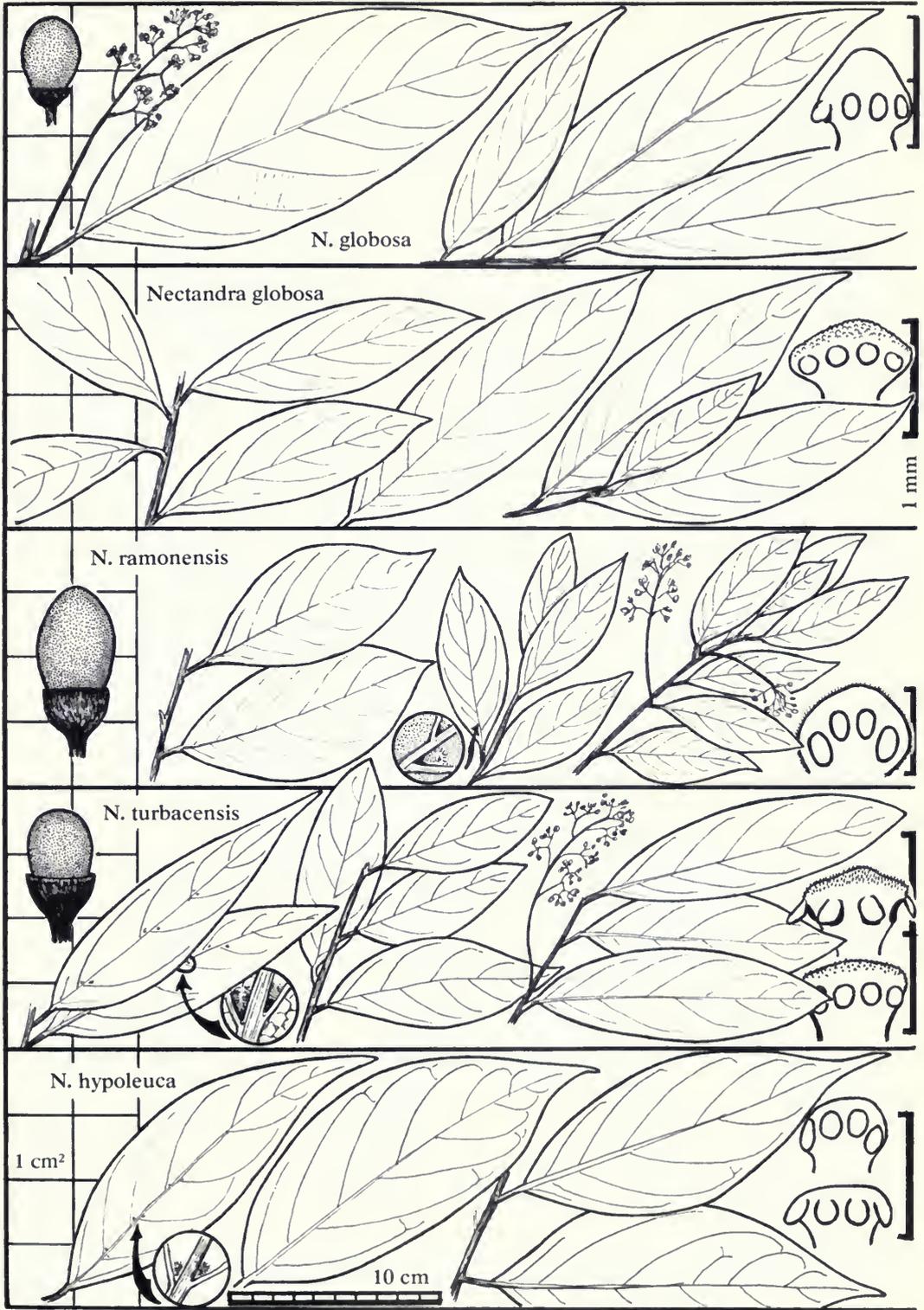


FIG. 18. Lauraceae: *Nectandra globosa* and similar species.



FIG. 19. Lauraceae: *Williamodendron glaucophyllum*. A, branchlet of the type collection; B, two flowers.



FIG. 20. Lauraceae: *Ocotea dentata*. A, branchlet of the type; B, base of two leaves; C, lower leaf surface; D, part of the inflorescence; E, flower viewed from the side; F, flower from above; G, stamens and pistil; H, young fruits; I, flower of *Ocotea insularis* for comparison.

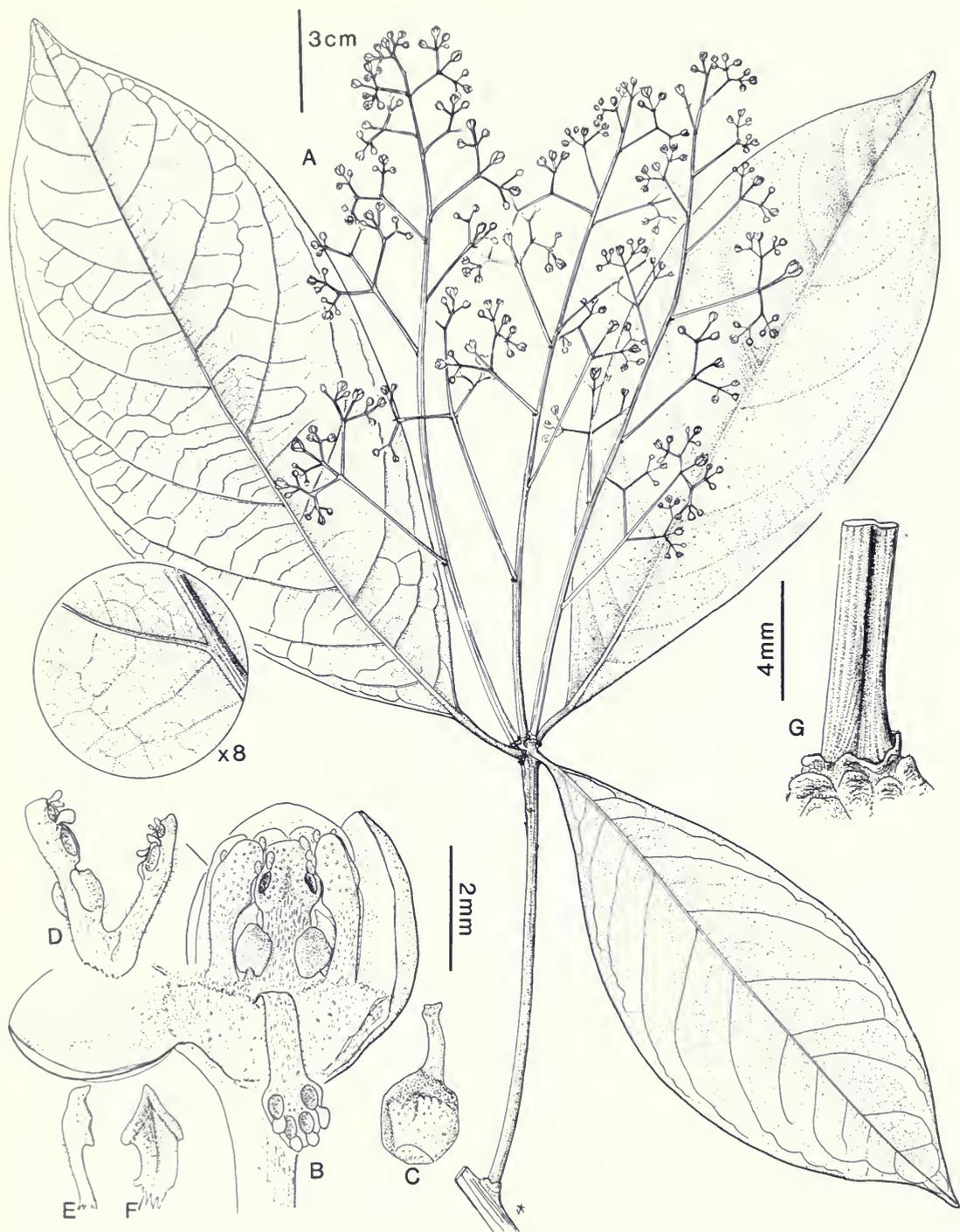


FIG. 21. Lauraceae: *Persea silvatica*. A, branchlet of the type; B, flower with 4 tepals removed showing reflexed outer stamens and inner stamens with glands; C, pistil; D, inner and outer stamens; E-F, lateral and frontal view of a staminode; G, base of inflorescence with bracts.



FIG. 22. Lauraceae: *Povedadaphne quadriporata*. A, branchlet of the type; B, floral diagram; C, two stamens; D, flower from above; E, flower in cross section; F, domatia on lower leaf surface.

Aiouea Aublet

REFERENCE—S. Renner, *Aiouea*. *Flora Neotropica* 31: 85–124. 1982.

Small to medium-sized trees (rarely shrubs), bisexual. Leaves alternate, usually well-spaced along the stems, leaf blades glabrous above, glabrous or rarely puberulent beneath, pinnately veined or rarely tripliveined, domatia present in only 2 species in South America. Inflorescences axillary to distal leaves or clustered near the tips of branchlets, paniculate, 10–15 cm long, each pedicel subtended by a small bract and with 2 bracteoles. Flowers small (1–4 mm) and bisexual, usually obconic to obovoid, glabrous or puberulent, floral tube short and puberulent within, perianth of 6 equal parts in 2 whorls; fertile stamens 9 in 3 whorls in ours (rarely with only 6 or 3 fertile stamens), the outer 6 stamens with 2 large introrse thecae in each anther, the inner 3 stamens with 2 thecae or with 4 thecae and the upper smaller, inner

3 stamens biglandular, staminodia (series IV) stipitiform, clavate, triangular or absent; pistil glabrous, style slender, stigma simple or capitate (often depending on stage of development). Fruits borne in a shallow cupulate receptacle, rim of the cup entire, undulate or with persisting perianth parts, at first fleshy but becoming woody; berry ovoid to ellipsoid.

Aiouea is a Neotropical genus of about 25 species ranging from Mexico and the West Indies southward to 30°S latitude. The three whorls of usually nine fertile 2-thecous stamens, the well-developed staminodes in most species, and the cupulate fruiting receptacle distinguish this genus. However, it appears that three Costa Rican species, *A. costaricensis*, *A. obscura*, and *A. talamancensis*, may be independent 2-thecous derivatives of species of *Ocotea*; see the discussions under these species.

Key to Costa Rican Species of *Aiouea*

- 1a. Venation tripliveined, lamina drying thin-chartaceous, dark gray or olive green; lowland forests of the Golfo Dulce area *A. obscura*
- 1b. Venation pinnate; trees not known to inhabit the Pacific lowlands 2a
- 2a. Leaves obtuse to rounded at the apex, 4–14(–19) cm long, subcoriaceous and yellowish or pale grayish when dry; staminodia usually absent; rim of fruiting receptacle with persistent perianth; (600–)1100–2300 m alt. *A. costaricensis*
- 2b. Leaves acute to acuminate at the apex, usually chartaceous and dark when dried; rim of fruiting cupule entire or unknown 3a
- 3a. Leaf blades 2–8 cm long and 0.8–2.4 cm broad; staminodes usually absent; known only from the Cordillera de Talamanca at 1600–2300 m alt. *A. talamancensis*
- 3b. Leaf blades 16–22 cm long and 7–9 cm broad; slender staminodes usually present; known only from the Caribbean escarpment at 400–700 m alt. *Aiouea* sp.?

Aiouea costaricensis (Mez) Kosterm., Meded. Bot. Mus. Herb. Rijks. Univ. Utrecht 46: 73. 1938 (and Recueil Trav. Bot. Néerl. 35: 73. 1938). *Bellota costaricensis* Mez, Jahrb. Königl. Bot. Gart. Berlin 5: 27. 1889. *Boldus costaricensis* (Mez) Kuntze, Rev. gen. pl. 2: 569. 1889. Figure 10.

Trees 5–15(–20) m tall, trunk to 50 cm d.b.h., branchlets 2–6 mm thick, at first densely brownish sericeous with thin straight ascending hairs 0.1–0.4 mm long, longitudinally ridged but becoming terete and glabrous. Leaves alternate in a spiral, petioles 2–10 mm long, usually flat above, with lateral margins continuous with the lamina margins; leaf blades 4–14(–19) cm long, 1.5–6(–8.5) cm broad, obovate, elliptic-obovate, oblong or spatulate, usually bluntly obtuse to rounded at the apex, tapering gradually to the cuneate base and decurrent on the petiole, margin entire and often revolute (especially near the base), drying subcoriaceous and yellowish brown

to gray, smooth and glabrous above, becoming glabrous beneath, with 5–7 major secondary veins on each side, tertiary venation raised on the lower surface, domatia absent. Inflorescences 10–20 cm long, peduncle 4–10 cm long, paniculate with open widely spaced branches to 6 cm long, glabrous or very minutely and remotely puberulent, pedicels ca. 5 mm long and with a small bract or scar at the base. Flowers 2.5–4 mm long, 2–3 mm broad, yellowish and glabrous, perianth parts 1–2 mm long and 1.5 mm broad, glabrous on both surfaces; outer stamens with short (0.3 mm) filaments, outer anthers 0.5–0.8 mm long, usually longer than broad, with only 2 thecae, inner stamens 2-thecous and ca. 1.4 mm long, with hairs at the base of the anthers, staminodes absent; pistil 1.5–2 mm long, style 0.6–1 mm long, stigma simple or slightly discoid. Fruits borne on a cupulate receptacle 5–6 mm long and 6–8 mm broad, with persisting perianth lobes (ca. 1 mm long and 2 mm broad) on the rim, obconic and very shallow (1–3 mm deep) but enclosing the fruits in early stages and only the base at maturity, becoming red; berry ellipsoid, 1–1.5 cm long and 0.8–1.1 cm thick, green.

Trees of wet evergreen forest formations between 1100 and 2500 m elevation; a single collection has been made at 600 m near Cariblanco in the valley of the Río Sarapiquí. Flowers have been collected in March–September; fruiting material has been collected in March–May, July, October, and December. The species ranges along the Caribbean side of the Cordillera Central (Zarcelero, Palmira, Poás, Barva [Barba], Carpintera, Cachí), the southeastern edge of the Meseta Central (Tablazo, Tarbaca), and the Cordillera de Talamanca, probably into Panama.

Aiouea costaricensis is recognized by its 2-thecous anthers, the generally small, stiff, obovate leaves with bluntly obtuse or rounded apices, and cuneate bases decurrent on the petiole. The leaves usually dry grayish or yellowish brown and with the tertiary venation slightly raised beneath when dry (but not forming a conspicuous reticulum). The small, shallow fruit cups with persisting perianth lobes, the glabrous flowers, and restricted middle-elevation montane habitat are additional characteristics. This species has not been found at Monteverde in the Sierra de Tilarán, but there is an almost identical population of *Ocotea insularis* (*O. tonduzii* in a more narrow sense) at Monteverde with 4-thecous anthers. This near-identity makes it appear that *A. costaricensis* may be nothing more than a 2-thecous derivative of some highland populations of *O. insularis* (in a wide sense). A recent collection from Río Cotón in easternmost Costa Rica (Davidse et al. 25529, CR, MO) is placed here because it is consistently 2-thecous. It may be related to the population of *O. insularis* which was the basis of the name *Aiouea hundelliana* and in which some anthers are 2-thecous. See the discussions under *O. insularis*.

Aiouea obscura van der Werff, Ann. Missouri Bot. Gard. 75: 402. 1988. Figure 1.

Trees ca. 10 m tall, leafy branchlets 1–2 mm thick, glabrous, dark brown, terete. **Leaves** alternate and distant, petioles 10–18 mm long, 0.9–1.4 mm thick, terete but flat or slightly sulcate above, glabrous; **leaf blades** (8–)11–17 cm long, 2.5–5.3 cm broad, narrowly elliptic to narrowly elliptic-oblong, tapering gradually to an acute or acuminate apex, tip 5–10 mm long, acute at the base and slightly decurrent on the petiole, drying thin-chartaceous or membranaceous, dark gray or olive green when dry and dull above, the midvein prominent above, glabrous and slightly lustrous beneath, tripliveined with a prominent pair of basal secondary veins arising 8–15 mm above the petiole and ascending beyond the middle of the lamina, with 2–3 additional secondaries on each side in the distal half of the lamina, the secondaries

usually connected to form a submarginal vein 1.5–5 mm from the margin, minor venation usually flat above and prominent beneath, inflated domatia with minute pore-like openings sometimes present in the axils of the major veins beneath. **Inflorescences** pseudoterminal in the axils of deciduous bracts, solitary, open-branched panicles with relatively few (ca. 50) flowers, 7–15 cm long, peduncle 1–6 cm long and 0.7 mm thick, glabrous and drying dark, pedicels 5–10 mm long, thin. **Flowers** bisexual, 2–2.5 mm long, 3 mm broad, glabrous on the outside, tepals equal, 1–1.5 mm long and ca. 1.2 mm broad; **outer stamens** 1.2–1.4 mm long with prominent minutely puberulent filaments, outer anthers ca. 0.7 mm long and 0.5 mm broad, with the connective slightly prolonged beyond the thecae, glands of the inner stamens ca. 0.4 mm in diameter, staminodes absent; **pistil** ca. 1.6 mm long, style 0.5 mm long, stigma simple. **Fruits** and fruiting cupules unknown.

Trees of the southern Pacific slope southeast of Palmar Norte on steep slopes of evergreen rain forest at about 50 m elevation. At present the species is known from only a single flowering collection made in May 1986 by Hammel, Grayum, and de Nevers (15197, CR, F, MO, the holotype).

Aiouea obscura is distinguished by its thin, narrow, glabrous leaves with strongly ascending basal secondary veins, and the small flowers with nine 2-thecous stamens. This is an unusually glabrous species; the shoot apex is almost glabrous except for minutely ciliate margins of the young leaves. The relationships of this species are rather uncertain.

Aiouea talamancensis W. Burger, sp. nov. Figure 4.

Arbor 4–10 m alta, ramulis foliiferis 0.6–2 mm crassis. Folia alterna, petiolis 3–7 mm longis, 1 mm latis, laminis (1.5–)2.5–8 cm longis, 0.8–2.4 cm latis, anguste ellipticis, ellipticis vel elliptico-oblongis, apice acuto vel breviter acuminato, subtus glabrescentibus, nervis secundariis 3–6 paribus. Inflorescentiae paniculatae, 2–6 cm longae. Flores 2–2.5 mm longi, 2–3 mm lati, extus glabri vel minute puberuli, tepalis aequalibus; stamina ser. I–II filamentis brevibus, antheris 0.5–0.7 mm longis, staminodiis nullis; gynoecium ca. 1.8 mm longum, stylo 0.6–0.8 mm longo.

Small trees, 4–10 m tall, leafy branchlets 0.7–2 mm thick, sparsely and minutely (0.1–0.2 mm) puberulent but quickly becoming glabrous, with ca. 3 prominent longitudinal ridges but becoming terete and grayish. **Leaves** alternate in a spiral, petioles 3–7 mm long, ca. 1 mm thick, glabrous or very minutely puberulent, with 2 lateral ridges continuous with the lamina margins, flat or broadly sulcate above; **leaf blades** (1.5–)2.5–8 cm long, 0.8–2.4 cm broad, narrowly elliptic to elliptic-oblong, tapering to an acute or short-acuminate apex, tapering gradually to the acute base and decurrent on the

petiole, drying stiffly chartaceous, glabrous above and grayish or dark, dull or lustrous above, glabrescent beneath, with 3–6 major secondary veins on each side, tertiary venation slightly raised beneath. **Inflorescences** 2–6 cm long in distal leaf axils, 2–6 cm long, paniculate but few-branched and few-flowered, peduncle to 3 cm long, glabrous or minutely puberulent, pedicels 2–4 mm long. **Flowers** yellowish, 2–2.5 mm long, 2–3 mm broad, glabrous or minutely puberulent on the outside, perianth parts equal in length; outer **stamens** with short (0.5 mm) filaments and anthers 0.5–0.7 mm long, inner stamens ca. 1.4 mm long, staminodes absent; **pistil** ca. 1.8 mm long, the narrow style 0.6–0.8 mm long, stigma subcapitate. **Fruits** borne in a shallow obconical cup about 5 mm long and 5–7 mm broad; berry ca. 6 mm long and 5 mm in diameter, ovoid (fruit characters based on *Orozco 12/10/45* seen at CR).

TYPE—Costa Rica, Prov. San José, Pan-American Highway between San Isidro del General and División, elevation 1900 m, 4 March 1966, *Antonio Molina R., William C. Burger & Bruce Walenta 18359* (holotype, F 1749014; negative, 61125; isotypes, CR, NY).

Trees of montane cloud forest formations from 1600 to 2300 m elevation in the Cordillera de Talamanca. Flowering collections have been made in February, September, and November. This species is known only from Costa Rica; it has been collected from near Patarra (southwest of San José), northwest of San Isidro del General, and near Cerro Kamuk. Collections in addition to the type are *Chacón & Herrera 1547*, CR, F; *Davidse & Herrera 29178*, CR, MO; and *L. Orozco 12/10/45*, collected 9 March 1985 and seen at CR).

Aiouea talamancensis is distinguished by its very small elliptic glabrescent leaves, small few-flowered inflorescences, the 2-thecous anthers, and the montane habitat. The small narrow leaves, tapering gradually at both ends and decurrent on the petiole, strongly resemble the leaves of some specimens of *Ocotea whitei*, and it may be that this species is a 2-thecous derivative of that species of *Ocotea* or one of its close allies. *Aiouea parvissima* (Lundell) Renner has similarly small leaves but much longer petioles, subcoriaceous leaf texture, clavate staminodes and grows in lowland forests of Petén, Guatemala.

Aiouea sp.?

Small trees ca. 5 m tall, leafy branchlets 2–3 mm thick, glabrous. **Leaves** alternate in a spiral, petioles 16–20 mm long, 1.5–2 mm thick, narrowly sulcate above, glabrous; **leaf blades** 16–22 cm long, 7–14 cm broad, elliptic-oblong to slightly obovate, acuminate at the apex, obtuse

at the base, drying stiffly chartaceous, glabrous above and with minute appressed hairs below, with 4–6 major secondary veins on each side, tertiary veins slightly elevated beneath when dry. **Inflorescences** axillary to distal leaves or leafless nodes, 12–14 cm long, paniculate with widely spaced branches and ca. 30 flowers, peduncle 2–4 cm long, 1–1.5 mm thick, glabrous, pedicels 1–4 mm long, slender. **Flowers** greenish, ca. 2.5 mm long and 3 mm broad, glabrous on the outside, perianth parts ca. 1.5 mm long, 1.2 mm broad; outer **stamens** ca. 1.4 mm long with anthers 0.8 mm long, connective expanded at the apex and apiculate, staminodes ca. 1 mm long and slender; **pistil** ca. 1.8 mm long with a short (0.5 mm) style, stigma simple. **Fruits** borne in a saucer-like cup 1.5–2 cm broad and 2–4 mm deep, abruptly expanded above the thickened (5–7 mm) pedicel, rose-brown in color; berry 32 mm long and 20 mm in diameter, ellipsoid-oblong.

Small trees of the very wet forests of the Caribbean escarpment in tropical forest-premontane forest transition zone. At present, this taxon is known only from a single collection by I. A. Chacón and G. Herrera (*1722*, CR, F, MO), from Estación Carillo de 700 a 450 m de la Fila al Caño del R. Sucio, 12 Nov. 1983, near the juncture of the provinces of Cartago, Limón, and San José.

This collection is provisionally placed in *Aiouea* because of its nine 2-thecous stamens. Unusual for *Aiouea* is the fact that the thecae had not opened in any of the four dissected flowers, suggesting that the flowers are unisexual. The erect tepals and the well-developed staminodia are arguments against placing this taxon in *Endlicheria*; a genus characterized by unisexual flowers with nine 2-thecous stamens. It is possible that the flowers are abnormal; all dissected flowers contained a small insect larva. Vegetatively, this taxon is unlike any species we have seen, and we do not doubt that it is undescribed. Given the fact that it is only known from one collection, it seems prudent to wait with a formal description until more collections are available and a generic determination can be made without doubt.

Aniba Aublet

REFERENCE—K. Kubitzki, *Aniba*. *Flora Neotropica* 31: 1–84. 1982.

Small to medium-sized trees (rarely shrubs or very large trees). **Leaves** alternate, well-spaced along the stems or in distal clusters; leaf blades usually elliptic to oblong or lanceolate (rarely cordate), entire, glabrous above, glabrous or puberulent below, pinnately veined. **Inflorescences** in the axils of leaves or caducous bracts, solitary, paniculate with relatively short lateral branches, bracts

caducous, pedicels well developed. **Flowers** usually small, bisexual, with a conspicuous (often urceolate) floral tube which enlarges in fruits, perianth of 6 parts in 2 whorls, equal or the outer smaller than the inner; **stamens** 9 in 3 whorls, 2-thealous, the outer 6 with introrse or apical-introrse dehiscence, filaments as wide and thick as the anthers (less often slender), inner 3 stamens (rarely staminodial) extrorse or extrorse-lateral and each with 2 large sessile glands, staminodes (series IV) small and stipitiform or absent; **pistil** slender, ovary ellipsoid or ovoid, glabrous or puberulent, included in the floral tube, style slender, stigma minute. **Fruits** borne in a deeply cupulate or hemispheric receptacle, rim simple or rarely double-margined, often with wartlike spots or lenticel-like pits in the outer surface.

A Neotropical genus of 41 species in six species groupings, ranging from Costa Rica to Bolivia and Brazil. The genus is distinguished by the nine 2-thealous anthers, poorly developed or absent staminodes, slender pistils, well-developed floral tube, and deep fruiting cup. The often thick (poorly differentiated) filaments, floral tube, slender pistils, and occasionally double-rimmed cups indicate a close relationship with *Licaria*; also, their foliage is similar. This genus was unknown in Central America until 1982.

Aniba venezuelana Mez, Jahrb. Königl. Bot. Gart. Berlin 5: 63. 1889. Figure 13.

Trees 10–20 m tall, leafy branchlets 2–6 mm thick, very minutely (0.05–0.1 mm) puberulent with brownish hairs in early stages, becoming terete and pale brown, with large central pith. **Leaves** alternate (occasionally subopposite), well spaced along the stems, petioles 7–15 mm long, 2–3.5 mm thick, orange brown, with 2 adaxial ridges usually forming a narrow sulcus above; **leaf blades** 11–27 cm long, 5–10 cm broad, elliptic to elliptic-oblong or elliptic-obovate, short-acuminate at the apex with a tip 0.5–2 cm long (occasionally caudate-acuminate), acute to obtuse at the base, margin entire and slightly revolute (especially at the base), drying very stiffly chartaceous to subcoriaceous, dull grayish or yellowish green and the midvein flat or slightly raised above, yellowish green beneath and glabrous or sparsely puberulent along the midvein, with 4–9 major secondary veins on each side, the central secondaries arising at angles of 50°–70°, smaller veins slightly raised beneath and forming a poorly defined reticulum with areolae 0.5–0.9 mm in width. **Inflorescences** axillary to distal leaves or near-terminal from leafless nodes, 7–18 cm long with distant lateral branches and relatively few (30–40) flowers, peduncles 5–8 cm long, very minutely (0.05 mm) papillate-puberulent, reddish brown, pedicels ca. 2 mm long. **Flowers** 2–3 mm long (including the obconic floral tube), 2–2.6 mm broad, greenish, minutely (0.05 mm) papillate-puberulent on the outside, floral cup 0.5–1 mm long and glabrous within, perianth parts subequal; **outer stamens** ca. 1 mm long and 0.7 mm broad, puberulent, the filament not differentiated from the anther, thecae dehiscing

near the apex with small flaps, inner stamens poorly developed in our material, staminodes absent; **pistil** 1.8 mm long, puberulent, ovary ca. 0.5 mm thick, style ca. 0.7 mm long, stigma minute. **Fruits** enclosed in the lower part by a reddish brown cup ca. 2 cm long; berry ellipsoid, ca. 3.5 cm long and 2 cm in diameter.

Trees of evergreen rain forest formations in the Caribbean lowlands of Costa Rica, to as high as 2300 m elevation in Venezuela. This species has only been collected near Siquirres and Puerto Viejo de Sarapiquí from 100 to 300 m elevation (but see below). Flowers were collected in June (*Gómez-Laurito* 79, CR, USJ) and July (*Hammel & Trainer* 13111, DUKE); fruits were collected in August (*Hammel* 13366, DUKE). The species, as here interpreted, is found in Costa Rica, the Chocó of Colombia, and in Venezuela.

Aniba venezuelana is recognized by the stiff, oblong, essentially glabrous leaves on thick sulcate petioles and the small puberulent flowers with well-developed floral tube and nine stamens, each with only two thecae. Costa Rican material is quite similar to *Cuatrecasas* 21541 from Chocó and also resembles a photo of *Fendler* 2394 from Venezuela; the only other collection is the lectotype *Funck & Schlim* 569 from Venezuela. Kubitzki identified our Costa Rican material as *Aniba*, probably new species related to *A. intermedia* (Meissn.) Mez. In Costa Rican material the anthers appear to open upwardly, and while the filaments seem thicker, and the form of the stamen somewhat different, we prefer to place this material under *A. venezuelana* at the present time. As Kubitzki mentions in his monograph, a large number of species in this genus are known only from a few collections and, despite his excellent monograph, many specific concepts may have to be revised as more material is collected. Two sterile collections from the Caribbean slope are very probably this species: *Gómez-Laurito* 9900 (CR) and *Poveda* 1021 (CR).

Beilschmiedia Nees

REFERENCE—A. J. G. H. Kostermans, A monograph of the genera: *Anaueria*, *Beilschmiedia* (American species) and *Aniba*. Recueil Trav. Bot. Néerl. 35: 834–928. 1938.

Trees or shrubs. **Leaves** alternate or subopposite (rarely opposite); leaf blades chartaceous to coriaceous, glabrous to puberulent, often glaucous beneath, venation pinnate, the minor venation usually elevated (raised) on the dried leaf surfaces above and/or below and often

forming a raised reticulum with small areolae, domatia absent. **Inflorescences** paniculate and usually few-branched and with relatively few flowers, solitary and axillary to distal leaves or clustered at the tips of branches. **Flowers** bisexual and small, narrowly campanulate in our species, perianth parts 6 in 2 whorls, equal or the outer somewhat shorter than the inner, deciduous (sometimes coming off as a whorl united at the base); **stamens** 9, 2-valved and free (said to be 4-valved in *B. sulcata*), the 6 outer with filaments or subsessile, outer anthers usually ovate and flattened, usually with the connective slightly prolonged distally beyond the thecae, introrse, the 3 inner stamens with well-developed filaments and 2 basal glands, with narrow anthers dehiscing laterally or extrorse, staminodes 3 and well-developed, ovate to triangular and narrowed to an acute or apiculate tip, cordate to truncate and sessile or stipitate; **pistil** with ovoid or subglobose ovary, glabrous (except in *B. rigida*), gradually narrowed into a thick style, stigma simple and often oblique. **Fruits** not subtended by an enlarged receptacle, pedicel thickened but not conspicuously expanded beneath the fruits; berry usually ellipsoid and rounded at the apex, 2–15 cm long, outer fleshy layer usually thin.

The genus *Beilschmiedia* ranges from Africa and southern Asia to Australia, New Zealand, and the New World tropics. The Costa Rican species display a series of concordant character states, suggesting that the genus may be a natural and monophyletic group. The well-developed staminodes, 2-thealous anthers often with an extended apical connective, and simple or oblique stigma characterize the flowers. The usually ellipsoid fruits subtended only by a stout pedicel, and a general tendency for the minor venation to be elevated on the surfaces of the dried leaves, further distinguish *Beilschmiedia*. Nevertheless, fruits, flowers, and vegetative characteristics seem to vary greatly from tree to tree, and make species delimitation difficult. The species concepts used here should be considered no more than tentative; see the discussions under the species.

Key to Species of *Beilschmiedia*

- 1a. Leaves relatively thin in texture (usually chartaceous), 10–25 cm long, broadly ovate to obovate, usually abruptly rounded and short-acuminate at the apex; known only from below 500 m elevation (in Costa Rica) 2a
- 1b. Leaves usually stiffly chartaceous to coriaceous, 5–16(–20) cm long, narrowly to broadly elliptic, ovate or suborbicular, rarely short-acuminate when abruptly rounded at the apex; known only from above 500 m elevation 3a
 - 2a. Lower leaf surface with short straight erect hairs to 0.6 mm long, with 4–14 pairs of secondary veins; fruits becoming more than 6 cm long *B. anay*
 - 2b. Lower leaf surface glabrous or with minute (0.2 mm) appressed hairs, with 3–7 pairs of secondary veins; fruits not exceeding 5 cm in length *B. sulcata*
- 3a. Leaves usually broadly ovate to suborbicular, usually coriaceous, reticulum of fine venation forming areolae 0.1–0.3 mm broad; evergreen montane forest formations from (1100–)1800–2800 m elevation *B. ovalis*
- 3b. Leaves usually elliptic to oblong, often stiffly chartaceous but not usually coriaceous, reticulum of fine venation forming areolae 0.5–1.5 mm broad on the lower surface (or the areolae not well developed); evergreen or partly deciduous forest from 600–1800 m elevation (in Costa Rica) *B. pendula*

Beilschmiedia anay (S. F. Blake) Kosterm., *Revue de Botanique Néerl.* 35: 847. 1938. *Hufelandia anay* S. F. Blake, *J. Wash. Acad. Sci.* 9: 459. 1919. Figure 7.

Trees to 22 m tall, bark dark brown to reddish brown, inner bark orange, leafy branchlets 2–5 mm thick, at first densely puberulent with slender brownish hairs 0.1–0.5 mm long. **Leaves** alternate and often crowded distally, petioles 10–22(–35) mm long, 1.5–3 mm thick, densely brownish puberulent, flat or slightly sulcate above; **leaf blades** (9–)13–25 cm long, 5.5–9(–12) cm broad, broadly

elliptic to ovate, gradually or abruptly narrowed and rounded to a short acuminate (ca. 1 cm) apex, obtuse to acute at the base, drying stiffly chartaceous, upper surface minutely puberulent above the veins, but glabrous and with the minor venation slightly raised between the veins, lower surface conspicuously soft puberulent with slender brownish hairs 0.2–0.6 mm long, with 4–10(–14) major secondary veins on each side, tertiary venation often subparallel, smaller veins forming a slightly raised reticulum with areolae 0.2–0.5 mm broad, sometimes glaucous beneath. **Inflorescences** axillary to distal leaves, paniculate but few-branched, 6–15 cm long, primary peduncle to 9 cm long, ca. 1 mm thick and minutely

brownish, puberulent, pedicels 2–5 mm long. **Flowers** ca. 3 mm long and 3 mm broad, narrowly campanulate, sparsely puberulent on the outside, perianth parts 2–2.5 mm long, 1–1.5 mm broad; outer **stamens** subsessile on very short (ca. 0.3 mm) puberulent filaments, anthers ca. 1 mm long, with or without a distally prolonged (0.1–0.4 mm) connective, inner stamens ca. 2 mm long and biglandular, staminodes 1–1.5 mm long, triangular to ovate and apiculate at the apex, truncate and sessile to stipitate and cordate, puberulent at the base; **pistil** ca. 2 mm long, ovary gradually narrowed to the style and equal in length, stigma simple and oblique. **Fruits** not seen, said to be 6–15 cm long and 2.5–6 cm thick, ellipsoid-pyriform, skin thin and the seed very large, becoming black.

Rarely collected trees of wet evergreen forest formations from near sea level to 500 m elevation on both the Pacific and Caribbean slopes in Guatemala. Hammel (1986) reports that the species flowers in July and fruits in February at La Selva. Blake (1919) cited reports of flowering in May; he also listed Guatemalan specimens flowering in December–January and fruiting in August–September. At present the species is only known from Guatemala and Costa Rica.

Beilschmiedia anay is recognized by its large avocado-like fruits, small flowers with nine 2-theccous anthers, and the broad thin-textured leaves with soft brownish hairs beneath. The leaves, often rounded and short-acuminate at the apex, resemble those of *Ocotea mollifolia*. *Beilschmiedia aloiophylla* (Rusby) Kostermans from Colombia may prove to be a synonym of this species.

Beilschmiedia ovalis (S. F. Blake) C. K. Allen, J. Arnold Arbor. 26: 418. 1945. *Hufelandia ovalis* S. F. Blake, J. Wash. Acad. Sci. 9: 461. 1919. *Persea austin-smithii* Standley, Publ. Field Mus. Nat. Hist., Bot. Ser. 18: 1552. 1938. *B. austin-smithii* (Standley) C. K. Allen, loc. cit. 418. 1945. Figure 5.

Small to medium-sized **trees**, 7–20 m tall, leafy branchlets 3–6 mm thick, minutely (0.2 mm) brownish-puberulent at first, becoming glabrescent and dark in color. **Leaves** alternate and usually clustered at the tips of branchlets, petioles 6–20 mm long, 2–3 mm thick, with 2 adaxial ridges forming a shallow sulcus or flat above; **leaf blades** 5–14(–18) cm long, 3–8(–10) cm broad, broadly ovate to broadly elliptic or suborbicular, obtuse to rounded at the apex (rarely short-acuminate), obtuse to truncate or rounded at the base, drying subcoriaceous and often yellowish or reddish brown, glabrous or minutely puberulent above the veins, flat or with the minor venation slightly raised to form an obscure reticulum, lower surface often whitish-glaucous, with slender hairs 0.3–0.5 mm long near the veins or with minute (0.1 mm)

appressed ascending hairs over the lower surface, with (3–)4–6(–8) major secondary veins on each side, the smaller venation often raised beneath and forming a reticulum of minute (0.1–0.3 mm) areolae. **Inflorescences** axillary to distal leaves, 4–20 cm long, paniculate with short lateral branches and relatively few flowers, peduncle 2–9 cm long, 1–2.3 mm thick, minutely puberulent, pedicels 1–2 mm long. **Flowers** ca. 3.5 mm long and 3.5 mm broad, puberulent, perianth parts ca. 1.8 mm long and 1.3 mm broad; outer **stamens** 1.4–2 mm long, anthers oblong and 1–1.4 mm long, often with the connective slightly developed beyond the two thecae, inner stamens biglandular, staminodes subsessile, 0.8–1.2 mm long, ovate with an apiculate apex; **pistil** ca. 2 mm long, ovary gradually narrowed into the style, stigma simple. **Fruits** borne on a slightly thickened (ca. 3 mm) pedicel, the receptacle not expanded; berry ovoid or short-ellipsoid, ca. 3 cm long and 2 cm in diameter, becoming black.

Infrequently collected trees of montane evergreen wet forest formations along the northern edge of the Cordillera Central (from Palmira in Alajuela to Cerro de las Vueltas in San José), and in the southern part of the Cordillera de Talamanca and adjacent Chiriquí, at altitudes of (1100–)1800–2800 m. Flowers have been collected in March–May; fruits have been collected in September and March. This species appears to range from Costa Rica into the northern Andes.

Beilschmiedia ovalis is recognized by the stiff, almost glabrous, rounded leaves with fine reticulation on the lower surfaces, small puberulent flowers with nine 2-theccous anthers, fruits subtended by a narrow stalk, and higher-elevation habitat. This species resembles some specimens of *Persea vesticula*, which is found at similar elevations. Submersion of *Beilschmiedia ovalis* under *B. sulcata*, as suggested by Kostermans (1938), seems ill advised. A Ruiz and Pavón collection at F has larger somewhat obovate leaves with short-acuminate apices, closely resembling the original illustration of *Laurus sulcata* Ruiz & Pavón, but atypical of *B. ovalis*. In addition, this Ruiz and Pavón collection has thin-textured leaves very unlike the leaves of *B. ovalis*.

An unusual collection of *Beilschmiedia*, *Gómez-Laurito 9800* (CR, F), is tentatively placed here. It has narrower elliptic leaves with more veins (eight per side) and much longer (6.5 × 2.8 cm) narrowly ellipsoid fruits. This collection was made between 1300 and 1500 m at Cerros de La Palma de San Ramón in late January. Another unusual collection is *Zamora 1215* (CR) from Muñeco de Cartago, with fruiting in March and with larger (to 23 × 16 cm) subopposite leaves. This last collection resembles *Hartshorn 2166* (CR, F), and the two may represent larger-leaved trees from lower elevation.

Beilschmiedia pendula (Sw.) Hemsley, Biol. centr. amer., Bot. 3: 70. 1882. *Laurus pendula* Sw., Prodr. 65. 1783. *Hufelandia costaricensis* Mez & Pittier, Bull. Herb. Boissier, ser. 2, 3: 228. 1903. *B. costaricensis* (Mez & Pittier) C. K. Allen, J. Arnold Arbor. 26: 415. 1945. *B. brenesii* C. K. Allen, loc. cit. 415. 1945. *Cryptocarya kostermansiana* C. K. Allen, loc. cit. 423. 1945. Figure 13.

Trees 6–30(–40) m tall, bark smooth in younger trees and developing square patches in age, inner bark reddish, leafy branchlets 1.5–3.5 mm thick, minutely yellowish brown, appressed, puberulent at first but quickly becoming glabrous. Leaves alternate (subopposite or opposite in *B. brenesii*, see below), petioles 6–15 mm long (to 28 mm in Panama), 1–2 mm thick, with 2 adaxial ridges forming a shallow sulcus above; leaf blades 5–16(–20) cm long, 3–6(–9) cm broad, elliptic to oblong-elliptic or occasionally elliptic-obovate, short-acuminate to acute or bluntly obtuse at the apex, acute to obtuse at the base and slightly decurrent on the petiole, margin entire or undulate, the laminae drying stiffly chartaceous (coriaceous), glabrous above or with minute hairs above the major veins, usually with the minor venation raised above but not forming a well-defined reticulum, lower surface glabrous or with minute (0.2 mm) straight slender appressed-ascending hairs, with 4–7 major secondary veins on each side, smaller venation raised beneath and often forming an irregular reticulum of areolae 0.5–1.5 mm broad. Inflorescences axillary to distal leaves, 2–8(–15) cm long, paniculate or racemose with short lateral branches, peduncle 1.5–3 cm long and 1 mm in diameter, sparsely and minutely puberulent, pedicels 1.5–4 mm long. Flowers 2.3–3.5 mm long, 2–3 mm broad, sparsely and minutely puberulent on the outside, perianth parts ca. 1.7 mm long and 1.3 mm broad, sometimes dehiscent as a whorl united at the base; outer stamens with short filaments or subsessile, anthers 0.8–1 mm long, ca. 0.6 mm broad, oblong or narrowed at the apex and often with the connective prolonged distally beyond the thecae, inner stamens 1.5–2.8 mm long, staminodes 0.8–1 mm long and ca. 0.7 mm broad, triangular to ovate and often apiculate at the apex, cordate to truncate and sessile or subsessile, puberulent at the base; pistil 1.5–2.1 mm long, style 0.4–0.9 mm long, stigma simple. Fruits borne on slightly thickened (to 5 mm) pedicels but the receptacle not expanded and the perianth deciduous; berry ellipsoid, 2–5.5 cm long, 1–3 cm in diameter, green becoming dark purple or black, pericarp thin (ca. 1.5 mm).

Trees of evergreen or partly deciduous forest formations from 600 to 2000 m elevation in Costa Rica, but close to sea level in central Panama and elsewhere. Flowering collections have been made in December–May, and fruits have been collected in February–September in Costa Rica. The species occurs in the Cordillera de Tilarán, the northwestern part of the Meseta Central (San Ramón to Zarcero) and the Cordillera de Talamanca. The

species ranges from Mexico to Panama, and in the West Indies from Cuba to northern Venezuela.

Beilschmiedia pendula is recognized by the often smaller elliptic, essentially glabrous, leaves with tertiary veins raised on one or both surfaces, the nine 2-theous anthers, subsessile staminodes, and ellipsoid fruits lacking an expanded receptacle. This species may resemble small-leaved specimens of *Ocotea meziana*, *Nectandra cufodontisii*, and *Aiouea costaricensis*, which share some of the same montane habitats but differ in leaf venation. This species displays considerable variation, both in the West Indies and in our area. The Costa Rican collections differ from Caribbean material in having more elliptic and slightly more puberulent leaves. Our highland plants (above 1000 m) may be worthy of subspecific recognition (but see below). Common names recorded in Costa Rica are: *Chanco blanco*, *Come negro*, *Tiguissaro*, and *Volador*.

The present circumscription of *Beilschmiedia pendula* in Costa Rica includes a variety of material, and it is probable that more than one species is included here. *Beilschmiedia brenesii* may be a separate species; it often has opposite or clustered leaves with short petioles and thickened nodes. Unfortunately, there is so much variation in *B. pendula* that it is difficult to know if the characteristics of *B. brenesii* represent a different species or a local variety. Likewise, some of the collections from the General Valley below 1000 m elevation resemble collections from Barro Colorado Island in Panama, and may represent another entity. These plants deserve careful study in the field.

Beilschmiedia sulcata (Ruiz & Pavón) Kosterm., Recueil Trav. Bot. Néerl. 35: 850. 1938. *Laurus sulcata* Ruiz & Pavón, Laurografia t. 11. ca. 1830, and Fl. peruv. prodr. 4: pl. 356; text published in Anal. Inst. Bot. Cavanilles 13: 21. 1954. Figure 15.

Trees or shrubs, to 30 m tall, leafy branchlets 1.5–4.5 mm thick, minutely brownish, appressed, puberulent. Leaves alternate, petioles 6–18 mm long, 1.5–2.5 mm thick, minutely (0.1 mm) appressed, puberulent with 2 adaxial margins usually forming a narrow (0.5 mm) and deep (0.7 mm) sulcus above distally; leaf blades 8–18 cm long, 3.5–9(–12) cm broad, broadly elliptic to elliptic-obovate or elliptic-oblong, abruptly narrowed to an obtuse or rounded and short-acuminate apex, obtuse and very slightly decurrent at the base, margin entire or undulate, drying stiffly chartaceous, glabrous above but with minute hairs usually present on the slightly raised midvein, the minor venation slightly raised above, lower

surface glabrous or with minute (0.2 mm) thin appressed parallel hairs, with 4–7 major secondary veins on each side, smaller veins raised beneath and forming a loose reticulum with areolae 0.2–0.7 mm broad. **Inflorescences** shorter than the leaves, solitary in distal leaf axils, paniculate, minutely appressed puberulent. **Flowers** not seen (depicted as having 4-theous anthers by Ruiz and Pavón). **Fruits** borne on slightly thickened (2–6 mm) pedicels; berry 3.5–4.5 cm long, ca. 2 cm in diameter, becoming purple at maturity.

Rarely collected trees of evergreen rain forest formations in the Caribbean lowlands of Costa Rica (La Selva and near Limón) and ranging into middle elevation (1000 to 2000 m) evergreen forests on the eastern slopes of the Andes in Peru. Hammel reports (1986) flowering at La Selva in January–February, with fruits maturing in September. The present circumscription of this name is very uncertain (see below).

Beilschmiedia sulcata is recognized by its relatively thin broad nearly glabrous leaves usually short-acuminate at the apex, raised minor venation on both leaf surfaces, nine 2-theous anthers, and ellipsoid fruits on slightly thickened pedicels. The following collections are tentatively placed here: *Hammel 11705, 11766* (DUKE), *Hartshorn 1519* (CR, F), *Little 20060* (US), and *Pittier 16140* (US). They are quite similar to both the original illustration and to a Ruiz and Pavón collection from Muña, Peru, bearing the original name at Field Museum. Hammel (1986) placed his collections under the name *B. mexicana* (Mez) Kostermans, but that species will probably prove to be a synonym of *B. pendula*. Both Kostermans and Bernardi included *B. ovalis* as a synonym under *B. sulcata*, but this appears to be incorrect (see the discussion under that species). The original illustration shows the anthers as 4-theous and a recent collection from Ecuador is also 4-theous. Unfortunately, flowering material has not been seen from Central America. Lack of collections and the variability found in other species of *Beilschmiedia* make the present circumscription of this species very uncertain.

Caryodaphnopsis Airy-Shaw

REFERENCES—A. J. G. H. Kostermans, A monograph of *Caryodaphnopsis*. Reinwardtia 9: 123–137. 1974. H. van der Werff & H. G. Richter, *Caryodaphnopsis* Airy-Shaw (Lauraceae), a genus new to the Neotropics. Syst. Bot. 10(2): 166–173. 1985.

Trees, branchlets terete or quadrangular. **Leaves** opposite or subopposite, petiolate, elliptic to ovate-elliptic, glabrous to very sparsely puberulent, often tripliveined. **Inflorescences** axillary or pseudoterminal, paniculate with opposite branches, bracts and bracteoles minute and caducous, pedicels slender. **Flowers** bisexual, floral tube short, perianth of 6 parts in 2 whorls of 3, strongly unequal, the outer whorl much shorter than the inner; **stamens** 9 in 3 series, anthers 4-theous (2-theous in the South American *C. inaequalis*) outer stamens introrse with the thecae in a horizontal row or arc, inner stamens with extrorse dehiscence and biglandular, 3 staminodes relatively large and stipitate, cordate-sagittate; **pistil** glabrous, style long and slender, stigma minute. **Fruits** subtended by an obconical or slender pedicel, perianth deciduous, a disc or cupule not developed; berry small and globose (in ours) to large and pyriform, green to yellowish green, glabrous, seed large.

A genus of about 14 species ranging from southern China and Indochina to the Philippines and Borneo in the Old World, and from Costa Rica to Ecuador and Peru in the upper Amazon Basin. This genus is distinguished by the opposite leaves, usually with three prominent veins from the base, and the flowers with strongly unequal tepals. Two of the Neotropical species were originally placed in *Persea*, but *Persea* does not have opposite leaves. Also, the flowers of *Caryodaphnopsis* differ from those of *Persea* in having shorter stamens and broader anthers, with the lower thecae usually lateral to the upper. Recent collections of *Caryodaphnopsis* show that the Neotropical species fall into two groups. One group includes species with pinnately veined (or subtripliveined) leaves and avocado-like fruits; the other group includes species with strongly tripliveined leaves and small, globose fruits. Our species belongs in this latter group.

Caryodaphnopsis burgeri Zamora & Poveda, Ann. Missouri Bot. Gard. 75: 1160. 1988. Figure 1.

Trees to 30 m tall and 80 cm d.b.h., leafy branchlets 1.3–6 mm thick, glabrous or very minutely (0.1 mm) appressed, puberulent in early stages, becoming dark in color; dichotomous branching sometimes present (from adjacent axillary branches at a node with an aborted apex). **Leaves** opposite or subopposite, petioles 7–12(–18) mm long, 1.3–2.4 mm thick, glabrous and dark, rounded or narrowly sulcate above; **leaf blades** 5–12(–16) cm long, 1.5–5(–8) cm broad, elliptic to elliptic-oblong or oblong, short-acuminate at the apex, the narrowed tip 5–12 mm long, acute to obtuse at the base, margin entire and with a thickened texture when dry, drying stiffly chartaceous, glabrous and grayish green to pinkish brown above, glabrescent and whitish green beneath (minutely appressed, puberulent on the veins beneath in young foliage), with 3 major primary veins extending from near the base to the apex (tripliveined), secondary veins difficult to see

and weakly subparallel between the primary veins. **Flower buds** ca. 5 mm long, flowers rotate and ca. 10 mm broad at anthesis, outer perianth whorl only 1 mm long, inner whorl ca. 5 mm long; outer **stamens** ca. 5 mm long with long slender filaments, outer anthers ca. 1.5 mm long, the lower thecae lateral to the upper, inner stamens 5 mm long, with glands attached to their filaments above their base, staminodes ca. 2 mm long, with triangular apex and hairy stipe ca. 1 mm long; **pistil** ca. 4 mm long, sparsely puberulent, ovary ellipsoid, style slender and 2.5 mm long, stigma bilobed. **Fruits** borne in short (2–4 cm) infructescences with only 1 or 2 fruits, pedicels ca. 5 mm long and 1 mm thick, receptacle not expanded; berry ca. 15 mm long and 13 mm in diameter, subglobose or globose-oblong, pale olive green and with a smooth surface when dry.

Trees of evergreen forest formations of the Pacific slope of central and southern Costa Rica from near sea level to 500 m elevation. Flowers and fruits were collected in March. The species is endemic to Costa Rica.

Caryodaphnopsis burgeri is unique among our native species of Lauraceae with its opposite or subopposite tripliveined leaves. The small rounded fruits lacking a cup or disc, the flowers with very short outer tepals, and the stamens with long filaments and with lower thecae lateral to the upper are also unusual. This species was first discovered by Luis Poveda in January 1984, and represented the first record for the genus in Central America. The type is *Zamora et al. 1208* (CR, the holotype, F).

Cassytha Linnaeus

Slender stemmed **herbaceous** plants, the stems with small haustoria attaching and obtaining nourishment from host plants, yellowish to orange or greenish. **Leaves** reduced to minute sessile scales, alternate in a spiral. Inflorescences solitary to several in the axils of scale leaves, spicate to racemose or capitate; flowers sessile or on short pedicels, subtended by a small bract and 2 bracteoles. **Flowers** bisexual and small, perianth of 2 whorls with 3 parts each, the outer whorl smaller and resembling the bracts, perianth persisting, floral tube shallow but developing to enclose the fruits; fertile **stamens** 9 in 3 series (whorls), 2-theous, the outer 6 (series I-II) with introrse dehiscence, the inner 3 with extrorse dehiscence and each biglandular, staminodia (series IV) present and sessile or stalked; pistil simple, stigma small and discoid. **Fruits** completely included in the enlarged and succulent floral tube (calyx tube or hypanthium) with a small opening at the apex with erect persisting perianth parts; testa membranous to coriaceous, cotyledons thick and becoming united (giving the impression of a carnosely endosperm).

A genus of about 20 species with all but one native to the Old World tropics; the largest num-

ber occur in Australia, while one species is pantropical. The plants are profoundly different from all other Lauraceae in habit and method of nutrition, but the flowers are typical of the family, resembling the flowers of *Cryptocarya* in particular. These plants bear a striking resemblance to another twining herbaceous parasite: *Cuscuta* of the Convolvulaceae. The slender yellow orange stems climbing over low herbaceous vegetation are very similar in the two genera but the flowers and fruits are very different.

Cassytha filiformis L., Sp. Pl. 35. 1753.

Herbaceous twining parasites to 1 or 2 m long, perennial, stems 0.3–3 mm thick (dry), minutely puberulent with thin straight hairs ca. 0.2 mm long or glabrous, yellowish to orange or olive green, cupulate or discoid haustoria ca. 1 mm broad and 0.5 mm high present on the stems. **Leaves** scalelike, 1–2 mm long, 1 mm broad at the base. **Inflorescences** solitary or paired, 1–5 cm long, spicate, puberulent or glabrous, the flowers sessile and subtended by 3 tepal-like bracts (1 bract and 2 bracteoles). **Flowers** ca. 2 mm long, greenish or white, outer perianth parts ca. 0.7 mm long, inner perianth 1.3–1.7 mm long and ca. 1.5 mm broad, thin and pellucid-punctate; outer **stamens** 0.9–1.1 mm long with short (0.3 mm) broad filaments, anther narrowly ovate to triangular and narrowed apically, inner stamens 1.2–1.4 mm long with narrowly triangular anthers and distally prolonged narrow connective, glands sessile, staminodia minute or not readily visible; **pistil** ovoid, ca. 1.3 mm long, ovary ca. 0.6 mm thick and gradually narrowed apically (the style not clearly differentiated), stigma slightly discoid. **Fruits** included in the expanded fleshy floral tube 5–6 mm long and 4–6 mm in diameter, urceolate but becoming globose in late stages, perianth persisting, greenish.

Twining parasitic plants in herbaceous vegetation and low shrubs in evergreen or partly deciduous formations from near sea level to 1000 m elevation. Flowering and fruiting collections have been made in all months of the year except December in southern Mexico and Central America. This species is now pantropical; it ranges from southernmost Florida (U.S.A.) and southern Mexico to the West Indies and South America.

Cassytha filiformis is recognized by its slender yellow to greenish twining stems with small haustoria that parasitize herbaceous and small woody plants. The 6-parted flowers, nine stamens with 2-theous anthers opening by flaps, and 1-seeded berries enclosed in a fleshy floral tube distinguish this species from the very similar species of *Cuscuta* (Convolvulaceae). No other genera of Lauraceae are either herbaceous or parasitic. This species was first collected in Costa Rica in January

1987 along Laguna Gandoca in easternmost Limón Province (Grayum et al. 8064, CR, MO).

Cassytha paradoxa Proctor, published in *Moscosoa* 2:20, 1983, from Honduras, Surinam, and Brazil, with solitary flowers, may prove to be a depauperate variant of *C. filiformis*.

Cinnamomum Schaeffer, nomen conservandum

Shrubs or trees, usually with aromatic bark and foliage. Leaves alternate or opposite, petiolate, usually coriaceous and tripliveined, less often pinnately veined. Inflorescences axillary or pseudoterminal, solitary or fasciculate, paniculate. Flowers bisexual (rarely unisexual and the female larger than the male), floral tube funnel-form and enlarging in fruits, perianth 6-parted in 2 whorls, the parts equal or subequal; fertile stamens 9 (rarely 6), usually 4-theous with the thecae superposed in an arc, with slender filaments usually equalling the anthers in length, 6 outer stamens dehiscent introrse and without glands, 3 inner stamens with stipitate glands and dehiscent extrorse, staminodes stipitate and ovate to sag-

ittate; pistil with sessile ovary and slender style, stigma discoid to peltate. Fruits usually ellipsoid, fruiting receptacle a cup with an entire margin or with persisting tepals or perianth-bases.

Cinnamomum is a genus with more than 200 species in Southeast Asia, Malaysia, Australia, and the Pacific Islands. The genus includes a number of important economic and ornamental trees. The bark of *C. verum* J. Presl (syn. *C. zeylanicum* Blume) provides the cinnamon of commerce, while *C. cassia* (Nees) Nees & Eberm. ex Blume is often used as a substitute. *Cinnamomum camphora* (L.) J. Presl has been the source of camphor. These trees resemble some of our native species of *Phoebe*, but they are not common in Central America where they are occasionally planted in parks and gardens. Specific descriptions are not provided but the following key should serve to differentiate the species likely to be found in cultivation.

Key to Commonly Cultivated Species of Cinnamomum

- 1a. Apical and lateral buds at first enclosed in large broad-based imbricate scales, leaves usually alternate, ovate-elliptic, to 14 cm long, often with pinnate venation; bark with the odor of camphor; trees to 25 m tall *C. camphora*
- 1b. Apical and lateral buds not enclosed by large scales; leaves conspicuously tripliveined and usually opposite; bark with odor of cinnamon; trees to 12 m tall 2a
- 2a. Leaves oblong to lanceolate and long acuminate to caudate-acuminate, to 14 cm long; panicles as long as the leaves *C. cassia*
- 2b. Leaves ovate to narrowly ovate-oblong, obtuse to acute, to 18 cm long; panicles longer than the leaves *C. verum*

Endlicheria Nees, nomen conservandum

Trees or shrubs, dioecious. Leaves alternate or rarely verticillate, laminae usually puberulent beneath, venation usually pinnate (rarely tripliveined or palmate). Inflorescences axillary or subterminal, few- to many-flowered, the female inflorescence usually smaller than the male and with shorter pedicels, bracts and bracteoles deciduous or persisting. Flowers small and unisexual, with a small floral tube, perianth 6-parted in 2 whorls and the whorls equal or subequal; male flowers with 9 fertile stamens in 3 series (the outer 2 series often appearing as a single whorl, rarely the inner whorl sterile and with 6 fertile stamens), all stamens 2-theous (the inner series 4-theous in *E. anomala*), the outer 2 series with introrse dehiscence, sessile or with filaments, the inner 3 stamens with extrorse dehiscence and biglandular at the base, staminodes absent, ovary slender (stipitiform) and nonfunctional; female flowers usually slightly smaller and with a broader floral tube than the male, stamens similar to those of the male but smaller and sterile, ovary included in the floral tube, style thick and

short or long, stigma discoid to 3-lobed. Fruit cups shallow and concave to deeply cupulate, perianth lobes deciduous or persisting, the rim often thin, simple; berry ovoid to ellipsoid, glabrous or rarely puberulent.

A Neotropical genus of about 40 species, nearly all South American. The unisexual flowers on dioecious plants, nine 2-theous stamens, lack of well-developed staminodes and cupulate fruiting receptacles distinguish this genus. *Endlicheria formosa* A. C. Smith has just been collected near Palmar Norte (Grayum et al. 9153 CR, MO), too late to be included in the keys and descriptions. The glabrous elliptic leaves are 12-35 × 4-10 cm with petioles 15-40 mm long, and the tertiary venation is raised on both surfaces. The thinly branched inflorescences are 10 cm long with minute (2 × 2 mm) flowers having erect tepals ca. 0.5 mm long; the ellipsoid fruits become 3 cm long.

The following species, known only from sterile and fruiting collections, is placed here provisionally.

Endlicheria sp.? Figure 9.

Trees to ca. 25 m tall and 70 cm d.b.h., leafy branchlets 1.2–3.5 mm thick, at first densely tomentulose with brownish or reddish brown ascending hairs 0.3–1 mm long. Leaves alternate and mostly in a single plane, petioles 3–5 mm long, 1–2.2 mm thick, densely brownish puberulent, with a narrow sulcus above; leaf blades (10–)12–23 cm long, 2.5–6 cm broad, narrowly elliptic-oblong or lanceolate, acuminate to long-acuminate at the apex, the tip 8–25 mm long, obtuse to acute at the base, margin entire, drying chartaceous and dark brownish or dark grayish brown, glabrous above and with the major veins impressed, conspicuously brownish puberulent beneath with straight slender ascending hairs 0.3–0.8 mm long over the veins and undersurface (but not obscuring the surface), with 10–14 major secondary veins on each side, the secondaries strongly loop-connected about 2–8 mm from the edge of the lamina. Inflorescences and flowers unknown. Fruits borne in a deeply (5 mm) cupulate receptacle 12–14 mm broad, ca. 8 mm long and abruptly expanded above the slightly thickened (3–4 mm) pedicel, becoming red; berry ovoid but flattened at the base, 17–20 mm long, ca. 13 mm in diameter, basal scar 5–7 mm broad, becoming purplish black.

Known only from above the Río Reventazón below the CATIE agricultural research institute near Turrialba, at about 600 m elevation on the Caribbean slope of central Costa Rica. Mature fruits were collected by Luis Poveda and Gerardo Salcedo (3795, CR, ♀) in January. Two sterile collections from the same area are *Holdridge 6590* (CR, NY) and *Poveda 3498* (CR).

Endlicheria sp.? is unique among our species of Lauraceae because of its thin, narrowly oblong, acuminate leaves, puberulent beneath, with usually more than 10 pairs of secondary veins strongly loop-connected near the margin and almost forming a submarginal or “collecting” vein 2–8 mm from the leaf edge. Further distinctions are the cup with broad base and thin simple margins, and the ovoid fruits flattened at the bottom and with a broad scar at the base. In fact, the dried fruits resemble an acorn (*Quercus*). While the generic placement of this species remains uncertain, the leaves and fruiting receptacles are reminiscent of a few South American species of *Endlicheria*; compare *E. multiflora* (Miq.) Mez, *E. sprucei* (Meissn.) Mez, and *E. verticillata* Mez. However, it is also possible that this species might belong in *Pleurothyrium*.

Licaria Aublet

REFERENCE—Holger Kurz, Fortpflanzungsbiologie einiger Gattungen neotropischer Lauraceen

und Revision der Gattung *Licaria* (Lauraceae). Ph.D. Thesis, Universität Hamburg, 251 pp. 1982.

Shrubs or trees, bisexual (but see below), glabrous or puberulent with simple transparent or brownish hairs, stems terete (in ours). Leaves alternate in a spiral (in ours) or rarely opposite, simple and often elliptic to lanceolate or oblong in shape, usually acuminate at the apex, acute to obtuse at the base, margins entire, drying chartaceous to coriaceous, upper surface glabrous, under-surface glabrous to hirsutulous, pinnately veined (in ours), domatia absent. Inflorescences paniculate with few to many flowers (rarely capitate), solitary in the axils of distal leaves or caducous scales. Flowers very small (in ours) or up to 8 mm long, bisexual (perhaps unisexual in an undescribed Costa Rican species), obovoid to globose with the tepals opening only near the top, glabrous or puberulent, outer perianth parts (tepals) often larger and overlapping the inner, floral tube short to long and surrounding the ovary; androecium of 3 inner fertile stamens (series III) which may be free or variously connate and forming a thick column around the slender style, with 0–6 small or flattened staminodes in the outer series but usually very difficult to see in ours, filaments usually not clearly differentiated in the fertile stamens, each fertile stamen with 2 thecae opening longitudinally or apically and extrorse (introrse in subgenus *Canella*), apex of the stamen (anther) usually broadly rounded, form of the stamens appears to vary considerably within some species, a fourth inner whorl of minute staminodes may be present in a few species, glands may be present at the abaxial base of the fertile stamens and free (6) or variously united (0–5); pistil slender, ovary glabrous (in ours) or sericeous, style slender, stigma simple and small. Fruits at first enclosed in the enlarged floral tube, fruiting receptacle forming a deep rounded (often hemispheric) cup enclosing the lower $\frac{1}{3}$ or $\frac{1}{2}$ of the fruits, the distal margin of the cup with 2(–3) usually distinct margins (occasionally poorly developed as in *L. sarapiquensis*), the outer rim associated with the perianth bases and the inner rim developed from the androecial whorls, outer surface often marked by lenticel-like warts and becoming reddish or bluish; berry ellipsoid to narrowly ovoid (rarely globose), smooth, cotyledons plano-convex, filling most of the seed and enclosing the minute plumule and radicle.

Licaria is a Neotropical genus of about 37 species in three subgenera (according to Kurz), ranging from Florida (U.S.A.) and Mexico through Central America and the West Indies to Bolivia and Brazil. The unusual androecium of only three stamens with two thecae each, and the deeply cupulate fruiting receptacle with two usually distinct margins on its rim make this a very well-characterized genus. The stamens are often united to form a staminal column in the center of the flower, surrounding the style. This column can be difficult to interpret. In some species the androecium opens by six very small apical valves that may be hard to see. In these instances the flower may appear to be abnormal or teratological. In addition, the fruit cups may fail to show the double margin,

especially in *L. sarapiquensis*. Foliage, also, seems to vary greatly within species, and it may be very difficult to be certain of an identification in the absence of mature flowers.

Acrodiclidium Nees, *Chanekia* Lundell, and *Misanteca* Schlecht. & Cham. are generic synonyms that have been used in Central America and Mexico.

We have followed Kurz's monograph, but differ in accepting *Licaria cufodontisii* as a valid species and not as a part of the more broadly defined *L. misantlae*. Hammel has discovered two new entities at La Selva since Kurz's thesis was written:

L. sarapiquensis and a single problematic collection, here called *Licaria* sp. A. The trees of this genus appear to be uncommon, and collections of our species are few in number. The paucity of material, variability of foliage, and the difficulty of dissecting the minute flowers contribute to making *Licaria* a poorly understood genus. This treatment should be considered provisional; we believe that there may be more species in Costa Rica than are recognized here. For a key based on fruits and leaves see dichotomy 64a in Key 2 at the beginning of the family.

Key to Species of *Licaria*

- 1a. Anthers opening by large (0.5 mm) longitudinal extrorse valves, stamens or staminal column often becoming slightly exerted beyond the perianth; 0–1400 m elevation 2a
- 1b. Anthers opening by smaller (0.1–0.4 mm) rounded apical valves, stamens not exerted at anthesis 3a
 - 2a. Leaves glabrous beneath, with 3–8 pairs of secondary veins *L. triandra*
 - 2b. Leaves usually minutely puberulent beneath, with 10–20 pairs of secondary veins *L. multinervis*
- 3a. Stamens clearly narrowed at the base and with erect globose or obovoid glands at their base, anther valves oblong and 0.2–0.4 mm long; flowers ca. 2 mm long; 0–700 m elevation 4a
- 3b. Stamens thick at the base, glands broad and flat or absent, anther valves 0.1–0.2 mm long, rounded; flowers 2–3 mm long 5a
 - 4a. Anthers apical and extrorse; pistil with a slender ovary; laminae lustrous above and often oblong *L. sarapiquensis*
 - 4b. Anthers apical and introrse; pistillode slender and without an ovary; laminae dull and elliptic *L. sp. A*
- 5a. Leaves usually 2–3 times longer than broad, often oblong and caudate-acuminate; 0–400 m elevation in southeastern Costa Rica *L. cufodontisii*
- 5b. Leaves usually 3–4 times longer than broad, often narrowly oblong, rarely caudate-acuminate 6a
- 6a. Leaves subcoriaceous; distal stems usually solid; often large trees of montane forest formations, 600–2800 m elevation *L. excelsa*
- 6b. Leaves drying chartaceous; small trees of evergreen forest formations 7a
- 7a. Distal stems hollow, leaves glabrous beneath; 500–1400 m on the Caribbean slope ... *L. brenesii*
- 7b. Distal stems solid, leaves minutely puberulent beneath; 10–500 m, Golfo Dulce area *L. pergamentacea*

Licaria brenesii W. Burger, sp. nov. Figure 3.

Arbor ca. 3 m alta, ramulis foliiferis 1.5–4 mm crassis, glabris, fistulosis. Folia alterna, petiolis 5–12 mm longis, 2–3 mm latis, laminis 16–30 cm longis et 4–8 cm latis, anguste oblongis vel anguste oblongo-ellipticis, apice saepe acuminato, subtus glabris vel leviter puberulis, nervis secundariis 6–11 paribus. Inflorescentiae paniculatae, 7–16 cm longae, pedunculis 3–8 cm longis. Flores 2–3 mm longi et 1.5–2.5 mm lati, extus glabri; stamina 3, crassa, conniventia, 0.5–1 mm longa, staminodiis nullis vel parvulis; gynoecium 1.2–1.6 mm longum, ova-

rio globoso, ca. 0.8 mm crasso. Fructus ignotus; cupula 2–2.5 cm lata, ca. 5 mm profunda.

Small or medium-sized trees, 3–7 m tall, leafy branchlets 1.5–4 mm thick, with prominent longitudinal ribs or obscurely ribbed, glabrous, becoming grayish and terete, the young stems usually hollow. Leaves alternate or occasionally opposite or whorled, petioles 5–12 mm long, 2–3 mm thick, dark in color, with 2 lateral ridges but sulcate only near the base; leaf blades 16–30 cm long, 4–8 cm broad, very narrowly oblong to narrowly oblong-elliptic, tapering gradually or abruptly to a long-acu-

minate apex (rarely acute), acute to obtuse or slightly rounded at the base, margin entire, drying chartaceous, glabrous above with the midvein slightly elevated, glabrous beneath or very slightly puberulent on the midvein, with 6–11 major secondary veins on each side, tertiary venation slightly raised beneath. **Inflorescences** solitary in the axils of distal leaves or occasionally borne in the axils of caducous scales on terminal shoots and forming compound inflorescences, 7–16 cm long, paniculate, few-branched and few-flowered, primary peduncle 3–8 cm long and ca. 1 mm thick, glabrous. **Flowers** 2–3 mm long and 1.5–2.5 mm broad, yellowish, urceolate in shape with a narrow (1 mm) opening at anthesis, drying dark and glabrous on the exterior, outer perianth parts broader than the inner; **stamens** 0.5–1 mm long, ca. 0.8 mm broad, strongly or weakly connivent, filament broad and thick (not differentiated), anthers rounded distally and the small (0.15 mm) valves opening distally or slightly extrorse near the apex of the stamen, staminodes and glands poorly developed or absent; **pistil** 1.2–1.6 mm long, ovary globose and ca. 0.8 mm in diameter, style slender, stigma occasionally subcapitate. **Fruits** borne in a cupulate receptacle 2–2.5 cm broad with a conspicuously wide-flaring (3 mm) outer margin, ca. 5 mm deep (but probably flattened in pressing), bright rose red; fruits unknown.

TYPE—Costa Rica, Alajuela Province, Cataratas de San Ramón, 26 February 1931, *A. M. Brenes 13523* (holotype, F 857810; negative, 61121; isotype, CR).

Understory trees of wet evergreen forest formations of the Caribbean slope, between 600 and 1400 m elevation. Flowers have been collected in February and a mature fruiting receptacle was collected in September. This species has also been collected from the upper Río Peñas Blancas valley (below the Monteverde reserve, *Burger et al. 10718*), and below Los Angeles de San Ramón (*Burger & Antonio 11170*) in Alajuela Province.

Licaria brenesii is recognized by its long narrow, essentially glabrous, thin-textured short-petiolate leaves, hollow stems, small flowers with partly united stamens and six minute valves opening near the top, and the fruiting receptacle with flared double-margin. The slender treelet habit, long narrow leaves, and hollow stems are very similar to those of *Ocotea paulii* and its relatives. An unusual collection, *Khan et al. 1983*, with stiff many-veined leaves, hollow stems, and anthers with small distal pores, may key out here but is presently placed with *L. multinervis*.

Licaria cufodontisii Kosterm., Recueil Trav. Bot. Néerl. 34: 602. 1937. Figure 16.

Shrubs or trees (2–)5–20 m tall, leafy branchlets 0.7–5 mm thick, essentially glabrous, grayish and terete,

sometimes with small (0.5 mm) grayish lenticels. **Leaves** alternate, petioles 5–12 mm long, 0.8–1.6 mm thick, usually sulcate above with 2 adaxial ridges, glabrous, usually drying dark; **leaf blades** (8–)10–18 cm long, 3–7 cm broad, elliptic-oblong to oblong or ovate-oblong, tapering abruptly to the acuminate or caudate-acuminate apex with a narrow tip 1–3 cm long, acute to obtuse at the base, margin entire or slightly undulate, drying stiffly chartaceous and usually dull grayish green or grayish brown, glabrous above and below, midvein prominent above, with 4–7 major secondary veins on each side. **Inflorescences** solitary and axillary or pseudoterminal, to 8 cm long, paniculate with few branches and few flowers, peduncle 1–3 cm long, 0.5–1 mm thick, glabrous or sparsely puberulent with minute (0.1–0.2 mm) appressed hairs, flowers usually in umbellate or cymose clusters at the ends of slender hairs, flowers usually in umbellate or cymose clusters at the ends of slender lateral branches, pedicels 2–5 mm long. **Flowers** 1.5–3 mm long, 2–2.8 mm broad, yellowish and glabrous on the outside, the outer tepals to 2 mm broad, imbricate, inner tepals smaller; **stamens** connivent, 0.7–1.3 mm long, 0.6–1 mm broad, oblong-cylindrical (not narrowed at the base) and thick, with short ascending hairs, the small (0.2 mm) thecae on the upper distal surface of the stamen, broad rounded glands present at the exterior (abaxial) base of the stamens, staminodes usually absent; **pistil** slender, 1–1.6 mm long, ovary ca. 0.7 mm long and 0.5 mm thick, stigma simple. **Fruits** borne in a cupule 10–15 mm long, 15–28 mm broad and 6–10 mm deep, conical to broadly cupulate, with or without lenticels on the surface, outer margin undulate, inner margin entire, becoming bright red; berry ellipsoid, 2–3 cm long, 1–2.2 cm thick, black or black with a bluish tint.

Trees of evergreen forest formations around Golfo Dulce and in the General Valley between sea level and 900 m elevation. Flowering material has been collected in April, June, September, and December, while fruiting material has been collected in February–March, September, and December. This taxon is endemic to the Pacific Slope, from the Reserva Biologica Carara southward to western Panama. However, it has also been interpreted as a subspecific element of *L. misantlae* (Brandege) Kostermans, and that species is said to range from central and southern Mexico to Colombia (see below).

Licaria cufodontisii is recognized by the very small flowers with thick connivent stamens and apical dehiscence, fruiting cups with double margins, and often oblong leaves with caudate-acuminate apices. Kurz (1983) placed this species under *L. misantlae* and discussed the distinctive traits of *L. cufodontisii*, and several other elements within *L. misantlae*. There is no doubt, based on stamen morphology, that these species are closely related, but we prefer to keep them separate. In addition to a disjunct geographical distribution, Costa Rican material has much larger leaves with

duller surfaces that tend to dry grayish. Leaves and fruits of this species may be confused with *Ocotea veraguensis*.

A collection received after this text (above) had been completed (*Haber et al. 4396*, CR, F, MO; from the Cordillera de Tilarán) looks very much like typical material of *Licaria misantlae* (sensu stricto), and indicates that this species is a part of the Costa Rican flora. The leaves are small (ca. 6 cm long and 2 cm broad) and the flowers fit Kurz's description for *L. misantlae*. In addition, recent collections from the Carara reserve in central Puntarenas Province (*Grayum et al. 7605*, CR, F, MO; *Hammel et al. 1428*, CR, F, MO) might be interpreted to be intermediate between *L. misantlae* and *L. cufodontisii*. A similar interpretation can be made of an earlier Brenes collection (12262, F, GH) from the Osa Peninsula. Thus it is quite probable that Kurz's interpretation is correct and *L. cufodontisii* must be synonymized under *L. misantlae*. In this event, the thicker larger leaves and restricted range of *L. cufodontisii* would support its recognition as a subspecies of *L. misantlae*.

Licaria excelsa Kosterm., Recueil Trav. Bot. Néerl. 34: 595. 1937. *Acrodiclidium excelsum* (Kosterm.) Lundell, Amer. Midl. Naturalist 19: 428. 1938. *Misanteca excelsa* (Kosterm.) Lundell, Wrightia 1: 147. 1946. *Licaria alata* Miranda, Ceiba 4: 128. 1954. Figure 16.

Trees 5–30 m tall, leafy branchlets 3–6 mm thick, usually glabrous or minutely appressed, puberulent in early stages, with numerous grayish lenticels 0.5–2 mm long. **Leaves** alternate, petioles 8–24 mm long, 2–3.5 mm thick, glabrous or minutely appressed puberulent, often deeply sulcate above, drying dark in color; **leaf blades** 7–20(–28) cm long, 3–7(–9) cm broad (Kurz, 1983, reports leaves to 40 cm long and 15 cm broad on petioles to 35 mm long), narrowly oblong to oblong-lanceolate, narrowly elliptic-oblong or elliptic-lanceolate, tapering gradually to a bluntly acute or short-acuminate apex, obtuse at the base, margin entire and slightly revolute (especially at the base), drying subcoriaceous to coriaceous, glabrous and slightly lustrous on both surfaces (sparsely puberulent beneath in early stages), midvein broad (3 mm) and slightly impressed above, with 5–10 major secondary veins on each side. **Inflorescences** axillary from distal leaves or apparently several from axils of caducous bracts, (5–)10–18(–22) cm long, primary peduncle 2–3 mm thick, distal parts with slender grayish or yellowish-brown hairs ca. 0.2 mm long, pedicels 1.5–4 mm long, densely puberulent. **Flowers** 2.5–3.5 mm long, 1.5–2.5 mm broad, obovoid, often puberulent beneath but glabrous distally, outer perianth parts broadly imbricate (almost valvate), 0.8 mm long and 1.5 mm broad, inner perianth parts 1 mm broad; **stamens** united

to form a thick column 0.7–1.2 mm high, each stamen ca. 1 mm broad and with an equally broad thick filament, the small circular valves dehiscing upwards and outward (at an angle of 45° abaxially), glands minute and free (6) or united (3), staminodes absent, floral tube slightly puberulent within; **pistil** ca. 1.8 mm long, ovary 0.6–1 mm thick, style ca. 0.5 mm long, stigma simple. **Fruits** borne in a cupulate or hemispheric receptacle, 1.3–2 cm long, 1.8–2.5 cm broad at the apex and 10–16 mm deep, the rim entire with inner and outer margins 1–2 mm distant and weakly developed, pinkish but drying dark with many conspicuous pale lenticels 0.5–2.5 mm long, fruiting pedicels to 15 mm long, 5 mm thick; berry ovoid-ellipsoid, to 3.5 cm long and 2.3 cm in diameter.

Trees of evergreen forests of the Pacific slope of southern Costa Rica and the adjacent Chiriquí highlands, from (600) 1100 to 2300 m elevation. Flowers have been collected in June, and fruits have been collected in January, March, and May in Costa Rica and Panama. The species ranges from southern Mexico to Panama.

Licaria excelsa is recognized by the very stiff narrow leaves with dark deeply sulcate petioles, the small flowers with a staminal column in which the small circular thecae open at an angle upwards and outwards, and the large fruiting cups with poorly defined double margin. The laminae are usually more than three times longer than broad. While the flowers appear to be distinctive, variability in leaf form and fruit development may make it very difficult to distinguish this species from *L. multinervis*. This species is poorly known; we have only five collections from Costa Rica. The following collections from the Caribbean slope with stiff narrowly oblong leaves and hollow stems with longitudinal ridges are placed here provisionally: *Hammel & Grayum 14111* (CR, MO), *Poveda et al. 3637* (CR).

Licaria multinervis H. Kurz, Mitt. Inst. Allg. Bot. Hamburg 23: in press. Figure 16.

Trees to 30 m tall, with trunks to 1 m d.b.h., leafy branchlets 1.3–6 mm thick, minutely (0.2 mm) puberulent with thin brownish or yellowish hairs, becoming glabrous and terete. **Leaves** alternate, petioles 4–12(–20) mm long, 1.2–2.5 mm thick, puberulent or glabrous, often drying dark; **leaf blades** 7–14(–22) cm long, 2–4(–5.5) cm broad, very narrowly oblong to narrowly elliptic-oblong or lanceolate, gradually tapering to an acute or short-acuminate apex, acute at the base, margin entire and often somewhat revolute, drying subcoriaceous, and lustrous above, glabrous above, lower surface with a covering of thin straight appressed ascending hairs 0.1–0.3 mm long and often difficult to see, midvein slightly impressed above, with (9–)12–20 (often obscure) secondary veins on each side, tertiary venation obscure above and

below. **Inflorescences** terminal or axillary or from leafless distal nodes, usually on the basal parts of new shoots, paniculate, ca. 5 cm long and with 50–100 flowers, peduncle ca. 1 mm thick and with many yellowish brown hairs, pedicels 1–2 mm long. **Flowers** ca. 2 mm long and 1.3 mm broad, obovoid to funnelform, the outer 3 tepals broadly ovate, ca. 0.8 mm long and 0.6 mm broad, puberulent, inner tepals much narrower, (0.4 mm) and thinner, erect at anthesis, floral tube sericeous within; **stamens** free or connate only at the short (0.4 mm) broad filaments, slender hairs present at the base, each anther ca. 0.6 mm long and 0.5 mm broad, ovoid with 2 large vertical thecae and extrorse dehiscence, slightly exerted, glands 2–6 but minute, staminodes absent; **pistil** ca. 1.4 mm long, ovary ca. 0.6 mm long and 0.3 mm thick, style thick, stigma slightly discoid. **Fruits** borne in a cupulate or hemispheric receptacle 10–14 mm long, 16–25 mm broad and 8 mm deep, abruptly expanded above the short (6 mm) thick (5 mm) pedicel, outer surface with pale lenticel-like spots 0.3–1 mm broad, rim of the cup 3 mm thick and with 2 margins but the margins not expanded and difficult to see when dry, cup minutely puberulent within; berry ovoid, ca. 15 mm long and 12 mm thick.

Trees of evergreen wet forest formations on the Caribbean slope and in the General Valley, between 500 and 1000 m elevation. Immature inflorescences were collected in September, flowers have been collected in May (*Léon 1104*, the designated type), and fruits were collected in February and October. The species is only known from four collections in central Costa Rica, near Tuis in the province of Cartago and near Volcán in southernmost San José Province.

Licaria multinervis is distinguished by its long narrow stiff leaves with dense but minute puberulence on the undersurfaces, and the thick cupulate fruiting receptacles with two weakly defined margins. Vegetatively, this species is very similar to *L. excelsa*, but that species has glabrous leaves and very different stamens. The almost free stamens with large longitudinally dehiscing extrorse anthers are more like those of *L. triandra* and may be slightly exerted at anthesis. This species is an important timber tree often called *quina*. We believe this species is a good one, but new collections from the Caribbean slope in Costa Rica have compounded the difficulties in defining the Costa Rican species of *Licaria*, and we suspect there are other new species. Variability of leaves and fruiting material within each species makes it very difficult to recognize and separate different species in the absence of flowers. The proper circumscription of all these species requires more and better collections.

Licaria pergamentacea W. Burger, sp. nov. Figure 16.

Arbor ca. 20 m alta, ramulis foliiferis 2–3 mm crassis, puberulis. Folia alterna, petiolis 8–14 mm longis, ca. 2 mm crassis, dense puberulis; laminis 24–26 cm longis, 5–6 cm latis, anguste oblongis, apice acuminato, papyraceis, supra glabris, infra costa minute puberula, nervis secundariis 8–10 paribus. Inflorescentiae paniculatae, 8–14 cm longae, pedunculis puberulis. Flores ca. 2 mm longi et 1.6 mm lati, extus puberuli, stamina 3, filamentis ca. 0.2 mm longis, antheris ca. 0.4 mm longis et 0.6 mm latis, staminodiis complanatis; gynoecium ca. 1.1 mm longum, ovario angusto. Fructus absens in typo.

Trees 12–20 m tall, leafy branchlets 2–3 mm thick, densely puberulent with brownish hairs 0.1–0.3 mm long, twigs solid. **Leaves** alternate, petioles 8–14 mm long, 2–3 mm thick, densely puberulent; **leaf blades** 22–26 cm long, 5–7.5 cm broad, narrowly oblong or narrowly elliptic-oblong, broadest at or near the middle, acuminate at the apex, acute to obtuse and slightly rounded at the base, drying chartaceous and brown, dull and glabrous above, tertiary venation slightly raised above (dry), glabrous beneath but with minute appressed hairs along the midvein, with 8–14 major secondary veins beneath, central secondaries arising at angles of 35°–50°, tertiary venation becoming raised beneath and forming a reticulum with areolae ca. 1 mm broad but not well defined. **Inflorescences** 8–14 cm long (but perhaps not fully mature), paniculate, peduncles ca. 3 cm long and 1 mm thick, densely and minutely puberulent with brownish hairs, lateral branches 2–3 cm long, pedicels 0.5–1 mm long. **Flowers** small and yellow, ca. 2 mm long and 1.6 mm broad, sparsely and minutely puberulent on the outside, inner tepals slightly smaller than the outer; functional **stamens** 3, loosely connivent with short (0.2 mm) broad filaments and broadly rounded anthers 0.4–0.8 mm long and 0.6 mm broad, valves opening apically or slightly extrorse, small flattened or glandlike structures present on the exterior (abaxial) side of the stamens; **pistil** ca. 1.1 mm long, ovary slender, style slender and 0.5 mm long, stigma simple. **Fruits** borne in a deep hemispheric double-margined cup 15–18 mm long and 16–20 mm broad; fruits only slightly longer than the cup and with broadly rounded apex (but not fully mature).

TYPE—Costa Rica. Puntarenas Province, hills above Palmar Norte de Osa, 22 Feb. 1951, *Paul H. Allen 5950* (holotype, F, 1439749; isotype, EAP).

Trees of lowland rain forest formations of the Golfo Dulce area and Osa Peninsula in southwestern Costa Rica, from near sea level to 500 m elevation. Flowers were collected in February (*Allen 5950*; *Burger et al. 12366*, CR, F, MO, NY), and an immature fruiting receptacle was collected in May (*Gómez-Laurito & Bermúdez 2711*, USJ). The species is known only from the three collections cited above.

Licaria pergamentacea is recognized by the thin narrowly oblong leaves on short puberulent petioles, the small flower with only three functional stamens dehiscing apically by small pores, and deep fruiting cup with double margin. The flowering and fruiting collections match each other very well, except that they differ somewhat in the number of secondary veins. The fruiting collection was made near Quebrada Zavala, Sierpe, near the Osa Peninsula. The thinner, pergamentaceous leaves are unusual in *Licaria*. This species was referred to as *Ocotea pergamentacea* Standl. & L. O. Wms. (an unpublished name) by Paul Allen (1956, p. 276).

Licaria sarapiquensis Hammel, J. Arnold Arbor. 67: 124. 1986. Figure 16.

Slender trees 5–20 m tall, trunks 5–20(–30) cm d.b.h., leafy branchlets 1.3–3 mm thick, glabrous, dark grayish, terete and smooth. **Leaves** alternate, petioles 4–12 mm long, 1–2 mm thick, usually sulcate above, glabrous and drying very dark in color; **leaf blades** 10–20 cm long, 3–7 cm broad, elliptic-oblong to oblong, narrowly elliptic or rarely lanceolate, tapering gradually or abruptly to a long (8–30 mm) acuminate apex, acute to obtuse at the base, margin entire and slightly revolute (dry), drying stiffly chartaceous and lustrous above (dark green in life), glabrous on both surfaces, with 3–5(–6) major secondary veins on each side, loop-connected near the margin, smaller veins forming a slightly raised reticulum on the lower surface (dry) with areolae 1–3 mm broad. **Inflorescences** axillary or extra-axillary, solitary and very slender, paniculate or racemose, 2.5–5 cm long, few-flowered, the flowers on lateral branches solitary, few or umbellate, primary peduncle ca. 0.5 mm thick (dry), glabrous, secondary peduncles to 2 cm long, pedicels 1–6 mm long. **Flowers** 1.5–2.5 mm long, ca. 1.5 mm broad, yellowish green and inconspicuous, campanulate, glabrous, perianth lobes ca. 1.2 mm long, the outer broadly imbricate; **stamens** 0.8–1.2 mm long, with filaments becoming 1 mm long and short (0.4 mm) oblate anthers 0.6–0.7 mm broad, the 2 thecae opening upward and outward (abaxially), each stamen with 2 stipitate glands and the stipes equalling the glands in length, the 6 outer stamens (series I & II) represented by ligulate staminodia, inner staminodia (series IV) absent; **pistil** 1.5–1.8 mm long, ovary equalling the length of the style, stigma slightly discoid. **Fruits** borne on a conical receptacle 6–12 mm long, 8–16 mm broad at the top and ca. 6 mm deep, margin entire but with a clearly differentiated internal ridge, fruiting pedicels 8–16 mm long and 1–2 mm thick, cups red at maturity; berry narrowly ovoid or ovoid-ellipsoid, 15–20 mm long and 7–10 mm in diameter, becoming bluish black.

Small trees of the very wet forests of the Caribbean slope and lowlands from near sea level to

about 800 m elevation, often found on ridges and steep slopes within the forest. Flowers have been collected in April–May, while fruits have been observed in August–November and collected in November, February, and March. This species is endemic to Costa Rica and only known from the following sites: La Selva (*Hammel 8663*, DUKE, the type; *10532, 12235*, DUKE, F; *Hartshorn 1588*, F), slopes below Volcán Barva (*Hammel 6923*), the Río Reventazón below Cairo (*Standley & Valerio 48784*, US), and near Turrialba (*Poveda et al. 3489*, CR, F) in the provinces of Heredia and Cartago. Provisionally placed here is *Gómez et al. 21143* (CR, MO) with unusual much-branched inflorescence and long-pedicellate (10 mm) flowers.

Licaria sarapiquensis is recognized by the lustrous leaves much darker above than below (in life), the lack of pubescence (except at the shoot apex), the slender little inflorescences, the inconspicuous flowers with only three stamens, and the conical fruit cup with double-margined rim. Crushed leaves and bark smell like *Sassafras* or sarsaparilla. *Quizarrá torita* has been reported as a common name. Dried material of this species resembles *Ocotea cernua*, *O. floribunda*, and *O. veraguensis*, and sterile material may be difficult to separate. Kurz (1983) cited a collection of this species (*Hartshorn 5249*, US) as *Licaria guatemalensis* Mez, but that is a species of northern Central America.

Licaria triandra (Sw.) Kosterm., Recueil Trav. Bot. Néerl. 34: 588. 1937. *Laurus triandra* Sw., Prodr. 65. 1788. *Misanteca triandra* (Sw.) Mez, Jahrb. Königl. Bot. Gart. Berlin 5: 103. 1889. *Acroclidium triandrum* (Sw.) Lundell, Contr. Univ. Michigan Herb. 7: 12. 1942. *Misanteca pittieri* Mez, Bull. Herb. Boissier, ser. 2, 3: 230. 1903. *L. pittieri* (Mez) C. K. Allen, J. Arnold Arbor. 26: 427. 1945. *Misanteca costaricensis* I. M. Johnston, Contr. Gray Herb. 70: 70. 1924. Figure 16.

Trees 10–15(–20) m tall, leafy branchlets 1.3–4(–6) mm thick, essentially glabrous and drying dark brown or grayish. **Leaves** alternate, petioles 4–15(–20) mm long, 1–2 mm thick, glabrous, flat or slightly sulcate above with 2 adaxial or lateral margins; **leaf blades** 5–16 cm long, 2–5(–7.5) cm broad, elliptic to elliptic-oblong or narrowly ovate, tapering gradually to abruptly to a short acuminate apex, the tip ca. 1 cm long, obtuse to acute at the base, margins entire or undulate, drying subcoriaceous and slightly lustrous above, often grayish brown,

glabrous above and below (minutely puberulent beneath in early stages), midvein slightly elevated above, with 3–8 major secondary veins on each side. **Inflorescences** solitary and axillary to distal leaves or terminal, paniculate and axillary to distal leaves or terminal, paniculate, small (6 cm), and few flowers (ca. 20) to racemose-paniculate with a long (16 cm) central rachis and alternating lateral panicles with up to ca. 200 flowers, minutely puberulent, pedicels 1–4 mm long and glabrous or minutely puberulent. **Flowers** 1.8–2.8 mm long, ca. 1.5 mm broad with the perianth parts erect at anthesis, yellowish, tepals glabrous (rarely puberulent) on the outside; **stamens** united in the lower half to form a short column surrounding the slender pistil, androecium 1.1–1.7 mm long and 1 mm in diameter, thecae free distally and becoming elevated above the perianth, dehiscent on the exterior (abaxial) side of the column, valves ca. 0.5 mm long, broad glands present at the abaxial base of the staminal column, the glands free and 2 per stamen or united and 1 per stamen, staminodes absent, hairs often present at the narrowed base of the stamens; **pistil** 1.5 mm long, ovary narrowly ellipsoid, ca. 0.7 mm long, stigma simple. **Fruits** borne in a cupulate or hemispheric receptacle, (6–)8–12(–15) mm long, 11–18(–25) mm broad, 5–9 mm deep, outer margin often conspicuous and entire or undulate, 1–3 mm broad, inner (distal) margin entire and 1–2 mm high, becoming red and often with small (1 mm) conspicuous lenticels on the outer surface; berry 1.5–2.8 cm long, 10–18 mm thick, ovoid to ovoid-ellipsoid, the lower $\frac{1}{3}$ or $\frac{1}{2}$ immersed within the cup, becoming dark purplish or black.

Trees of evergreen wet forest formations from near sea level to 1400 m elevation on the Caribbean side of Costa Rica and in the central highlands. Flowering material has been collected in April–May in Costa Rica, and fruits in January, April–July, and October. This species ranges from Florida (U.S.A.) and the West Indies through Mexico and Central America to Bolivia.

Licaria triandra is recognized by its stiff, essentially glabrous, and usually elliptic-oblong leaves, the very small flowers with three stamens united to form a tubular column around the slender style, the extrorse and exerted thecae, and the conspicuously double-rimmed fruiting cup. Foliage of this species varies greatly and can make identification difficult. Hammel's lowland collections from La Selva have laminae averaging 8 cm long and 3 cm broad, while the highland collections are considerably larger. In addition, the fruiting receptacles of the highland material is consistently larger than in lowland and West Indian collections. The highland collections are well characterized by the description and type of *L. pittieri* and, at first, it seemed best to recognize the highland material as a distinct species. However, Kurz (1982) interpreted *L. triandra* quite broadly, and the same pattern of larger-leaved highland collections, contrasting with smaller-leaved lowland collections,

is also found in Guatemala. Thus, we follow Kurz in submerging *L. pittieri*, though it may be worthy of subspecific rank. Kurz also included the following species as synonyms of *L. triandra*: *L. cervantesii* (H.B.K.) Kosterm., *L. limbosa* (Ruiz & Pavón) Kosterm., *L. reclinata* Lundell, and *L. tikalana* (Lundell) Lundell. It seems that *L. coriacea* (Lundell) Kosterm. also belongs here, and not under *L. misantlae* as suggested by Kurz.

Licaria sp. A.

A slender shrub 3 m tall, stem 3 cm d.b.h., leafy branchlets 0.6–2.5 mm thick, glabrous and grayish. **Leaves** alternate, petioles 5–15 mm, 0.6–1.3 mm thick, glabrous, sulcate above; **leaf blades** (4–)7–14 cm long, (1.3–)2–4 cm broad, narrowly elliptic to narrowly elliptic-oblong, tapering gradually to the acuminate apex, the narrow tip 0.6–2 cm long, acute at the base, margin undulate, drying chartaceous and grayish green, glabrous above and below, midvein slightly elevated above, with 5–9 major secondary veins, tertiary venation slightly elevated beneath. **Inflorescences** solitary and axillary, small (2 cm) and few-flowered, racemose but with a distal umbel of flowers, peduncle only 0.3 mm thick (dry), glabrous, pedicels to 3 mm long. **Flowers** apparently unisexual and the plants dioecious, female flowers not seen; male flowers ca. 2 mm long and 1.5 mm broad, obovoid and glabrous, perianth parts ca. 0.8 mm long; fertile **stamens** connivent, 0.7–1 mm tall, with a short thick filament and short (0.5 mm) broad (0.5 mm) anther, thecae apical and the valves with slightly introrse dehiscence, large glands and hairs present at the base of the stamens, staminodes not apparent; pistillode very slender, ca. 0.5 mm long. **Fruits** (based on *Zamora* 399) borne in a red cup 12 mm long and 20 mm broad with a prominent ridge around the distal margin; fruits ca. 20 mm long and 12 mm in diameter.

A small shrub in gallery forest at the edge of the Río Puerto Viejo near its confluence with the Río Sarapiquí at about 100 m elevation (*Hammel 10670*, DUKE, F). It was collected with flowers in early December, at the La Selva research site in the Caribbean lowland rain forest formation. The very slender pistil and the apical thecae that open inwardly (adaxially) are unusual in the genus. The small glabrous narrow and often long-acuminate leaves with undulate margins and lack of a strong aroma when crushed are further distinctions. It is possible that larger individuals of this species will prove to have bisexual flowers. (This is the first report of unisexual flowers in *Licaria*, and additional collections to verify this condition are greatly desired.) A second collection tentatively placed here (*Zamora* 399, CR) is a 10 m tree flowering in late November at Horquetas-Sarapiquí, at 400 m elevation.

Litsea Lamarck

Shrubs or small trees (in Central America), dioecious. **Leaves** alternate or rarely subopposite, laminae small and of 2 types in American species, elliptic and up to 14 cm long or ovate and orbicular to 8 cm long, usually coriaceous, pinnately veined (in ours) or tripliveined. **Inflorescences** solitary or fasciculate, in leaf axils or on short leafless shoots in a racemose arrangement, sessile or pedunculate, umbellate or capitate, at first enclosed in an involucre of 4–6 broadly imbricate bracts. **Flowers** pedicellate, unisexual, the floral tube short or absent, the perianth 6-parted (with 2 whorls of 3) or irregular, perianth parts (tepals) equal or subequal; **male flowers** usually with 9 or 12 stamens in 3 or 4 series (whorls), filaments well differentiated, anthers 4-theous and introrse (the inner series sometimes with lateral dehiscence), the innermost whorl of stamens usually with stipitate glands borne on the base of the slender filaments, a pistillode present or absent; **female flowers** with 9 or 12 staminodes in 3 or 4 series, the outer 2 series usually lacking glands and the inner series usually with stipitate glands, pistil with rounded ovary, stigma often discoid and lobed or subcapitate. **Fruits** borne on a slightly thickened pedicel or subtended by a small receptacular disc or cupule; berry usually globose and fleshy.

The genus is reported to contain around 400 species, and ranges from southern and eastern Asia (as far north as Korea and Japan) through Malaysia to Australia and New Zealand; in the New World it ranges from the southeastern United States and Mexico to Costa Rica. Only one species has been reported from Costa Rica and that species has not been collected there for over 50 years. The small trees with stiff aromatic little leaves, the globose inflorescence buds with their imbricate involucre and borne on a short peduncle, and the functionally unisexual flowers with 9 or 12 stamens/staminodes make these plants easy to recognize among our species of Lauraceae.

Litsea glaucescens H.B.K., Nov. gen. sp. 2: 133. 1817. *Tetranthera glaucescens* Spreng., Syst. veg. 2: 267. 1825. *L. neesiana* Hemsl., Biol. centr. amer., Bot. 3: 76. 1882. *L. guatemalensis* Mez, Jahrb. Königl. Bot. Gart. Berlin 5: 479. 1889. *L. flavescens* Bartlett, Proc. Amer. Acad. Arts 44: 599. 1909. *L. acuminatissima* Lundell, Contr. Univ. Michigan Herb. 4: 3. 1940. *L. glaucescens* var. *flavescens* (Bartlett) C. K. Allen, J. Arnold. Arbor. 26: 413. 1945. Figure 4.

Shrubs or small trees 1.5–6 m tall, dioecious (unisexual), leafy branchlets 1.3–3 mm thick, glabrous or with slender grayish ascending hairs, reddish brown to black, often with small dark lenticels, terete. **Leaves** alternate and well spaced along the stems, petioles (3–)5–16(–20)

mm long, ca. 1 mm thick, glabrous or puberulent, slightly sulcate above; **leaf blades** 3–8(–12) cm long, 1–3(–3.8) cm broad, narrowly elliptic to lanceolate or ovate-elliptic, tapering gradually to the acute or acuminate apex, obtuse or acute at the base, margin entire and often defined with a veinlike edge, drying very stiffly chartaceous to subcoriaceous, pale grayish to dark brown above, glabrous and slightly lustrous above with the midvein flat or slightly impressed, paler in color or glaucous beneath and glabrous or sparsely puberulent, with 4–8 major secondary veins on each side, the minor venation flat beneath but sometimes forming a slightly areolate surface on the glaucous underside. **Inflorescences** solitary in distal leaf axils or several on leafless short-shoots (and racemosely arranged), to 2.5 cm long, umbellate, peduncles 6–12(–15) mm long, ca. 0.5 mm thick, glabrous or puberulent, broadly imbricate bracts borne at the apex of the peduncle and forming an ovoid-globose bud 3–6 mm in diameter which encloses the immature umbel, bracts caducous, reddish brown, each umbel with 3–6 flowers, pedicels 1–3(–5) mm long. **Male flowers** ca. 4 mm long and 6 mm broad, with 6 narrow tepals ca. 3 mm long, outer stamens with anthers 1.3–1.7 mm long and ca. 0.6 mm broad, with slender filaments ca. 1.5 mm long; pistillode ca. 1.4 mm long, with ovoid ovary and slender style. **Female flowers** ca. 4 mm long and 4 mm broad, perianth with 6 or 4 tepals, staminodes usually 9 and ca. 1.2 mm long, flat; pistil ca. 2.3 mm long, ovary subglobose and 1.3 mm in diameter, style often crooked, stigma discoid and dark in color. **Fruits** subglobose, narrowed at the apex and base, 8–12 mm in diameter, fleshy; fruiting peduncles 3–5(–7) mm long and 1–2 mm thick, receptacle slightly expanded (2–4 mm broad) below the fruits and flat or saucer-like.

Small trees of evergreen but seasonally dry montane forest formations, between 1500 and 2000 m elevation on the Pacific slope of the western portion of the Cordillera de Talamanca (Candelaria, Sta. María de Dota, and Tarrazú) in Costa Rica. This species reaches 3000 m elevation in Guatemala, and flowers in November–April in Central America. Mature fruits have been collected in August in Costa Rica. This species ranges from eastern Mexico through Guatemala and Honduras to Costa Rica.

Litsea glaucescens is recognized by its small stature, small stiff usually glabrous leaves, umbellate inflorescences at first enclosed in broadly imbricate bracts at the apex of a short peduncle, and the unisexual flowers with both male and female parts on dioecious trees. The leaves have been used like bay (*Laurus*) leaves for flavoring food, especially soup and meat. It has been called *lentisco* in Costa Rica.

The Costa Rican specimens are distinguished from the more northern collections by their prominent marginal vein, yellowish venation, and the nonglaucous lower leaf surfaces. Caroline Allen (1945) recognized the Costa Rican material as va-

riety *flavescens*. The collections seen from Costa Rica are: *Oersted Lauraceae no. 10 (US)*, *Standley 42525 (F, US)*, *Tonduz 7796 (US)* and *11638*, also distributed as J. D. Smith's number *7352 (CR, F, GH, NY, US)*. We have seen no collections more recent than that made by Paul Standley in 1925, and it may be that the endemic Costa Rican variety of this species is now extinct.

Nectandra Rolander ex Rottboel

REFERENCE—J. G. Rohwer, *Prodromus einer Monographie der Gattung Ocotea Aubl. (Lauraceae)*, sensu lato. Mitt. Inst. Allg. Bot. Hamburg 20: 1–278. 1986.

Trees or shrubs, monoecious or rarely dioecious. **Leaves** alternate or rarely subopposite or opposite, petiolate, the laminae entire and pinnately veined, chartaceous to subcoriaceous, puberulent to glabrous, with or without domatia. **Inflorescences** usually solitary in axils of distal leaves, rarely pseudoterminal, usually paniculate, pedicels present. **Flowers** bisexual or rarely functionally unisexual, generally small (≤ 1 cm broad), white to yellowish or greenish, perianth tube well developed or absent but accrescent in fruits, perianth 6-parted in 2 whorls of 3 tepals each, the whorls equal or subequal, usually reflexed or rotate (spreading) at anthesis, tepals usually thick and often papillate-puberulent on the inner surface; fertile **stamens** 9 in 3 series, the 6 stamens of the outer whorls (often appearing as a single whorl) similar in size and shape and with introrse dehiscence, filaments short or absent (very rarely longer than the anthers), the anthers usually thick and papillate, reniform to ovate or laminate, the connective sometimes developed beyond the thecae or the anthers sometimes emarginate, thecae in a horizontal row or in an arc with the lower thecae lateral to the upper, opening by flaps attached at the top, the 3 stamens of the inner series (series III) usually with filaments and quadrate or rectangular anthers and each with 2 glands at the base, the upper 2 thecae usually dehiscing laterally or lateral-extrorse and the 2 lower usually extrorse, the inner whorl of staminodes (series IV) small and stipelike or absent; **pistil** with subglobose to ovoid or ellipsoid ovary, glabrous (puberulent in *N. reticulata* s.l.), style usually shorter than the ovary, stig-

ma usually discoid to peltate or capitate. **Fruits** borne in a cupulate receptacle with simple margin, perianth parts deciduous (rarely persisting on the margin), pedicel accrescent in fruits; berry a single-seeded berry, ellipsoid, subglobose, to oblong or obovoid.

A New World genus of 100–150 species ranging from Florida (U.S.A.) to Argentina and well represented in Mesoamerica and the West Indies, but with the great majority of species in South America. This genus has been submerged under *Ocotea* by Kostermans (1957) and Howard (1981). Such a taxonomic change creates many nomenclatural problems and clarifies little. Until we understand all the genera of Lauraceae much better, it seems best to continue using *Nectandra* in its traditional sense. Species in Costa Rica that have staminal characteristics intermediate between *Nectandra* and *Ocotea* are generally placed under *Ocotea* in this treatment. There may also be a Costa Rican species of *Nectandra* related to a few species of *Ocotea* formerly placed in *Phoebe*; see the discussion under *Nectandra belizensis*.

Some of the most difficult problems of species delimitation in the Costa Rican Lauraceae are found in *Nectandra*. Local differentiation within wide-ranging species or species groups and overall similarity of different lineages make species circumscription very tentative or even arbitrary in some groups of *Nectandra*. The following account attempts to recognize locally distinct populations with as little nomenclatural change as possible. Some of our “local species” are undoubtedly subspecies of more widely ranging species; but the circumscription of these widely ranging entities requires much more study and better sampling over their entire range before we can erect meaningful subspecies. Jens Rohwer is currently studying this genus, and many names and specific concepts are likely to be changed as a result of this new work.

Key to Species of Nectandra

- 1a. Outer stamens with the connective conspicuously to slightly expanded beyond the thecae, the connective minutely papillate or minutely puberulent, the stamens often flat and tepal-like . . . 2a
- 1b. Outer stamens with the connective not conspicuously prolonged distally 8a
 - 2a. Outer stamens with anthers more than 1.5 mm long, flat and tepal-like, sessile or with a narrow base; leaves and flowers densely puberulent 3a
 - 2b. Outer stamens with anthers less than 1.5 mm long, not tepal-like 4a
 - 3a. Outer stamens 2–3 mm long, thecae often superposed as in *Ocotea*, flowers 10–20 mm broad, peduncle much exceeding the length of the flowering rachis; growing in semi-deciduous forests *N. sinuata*

- 3b. Outer stamens 1.5–1.8 mm long, thecae in an arc, flowers 8–12 mm broad, peduncles usually equal in length to the flowering rachis of the panicle; growing in semi-deciduous and evergreen forests *N. reticulata*
- 4a. Outer stamens with the connective prolonged conspicuously beyond the thecae, the anther usually curved or obtuse at the apex 5a
- 4b. Outer stamens with the connective slightly prolonged beyond the thecae, apex of the anther usually flat or undulate; flowers 4–8 mm broad 7a
 - 5a. Leaves often drying pale grayish or yellowish green, with (4–)7–11 pairs of major secondary veins, leaf base often slightly revolute; flowers 6–12 mm broad; in deciduous and partly deciduous forests *N. globosa*
 - 5b. Leaves drying very pale brown to dark brown, with 3–7 pairs of major secondary veins 6a
 - 6a. Anthers 1–1.6 mm long, flowers to 12(–15) mm broad; leaves to 15 cm long, ovate-elliptic to elliptic-oblong, usually drying very pale brown; Pacific slope, 600–2400 m elevation *N. ramonensis*
 - 6b. Anthers 0.7–0.8 mm long, flowers ca. 8 mm broad; leaves to 20 cm long, usually narrowly elliptic and drying dark brown; evergreen forests, 0–1400 m *N. globosa* (in part)
- 7a. Leaves essentially glabrous and drying grayish, ovate to oblong or lanceolate; anthers ca. 0.7 mm long; evergreen and semi-deciduous forests *N. turbacensis*
- 7b. Leaves puberulent beneath and drying brownish, obovate to elliptic-oblong; anthers ca. 0.9 mm long; evergreen Caribbean lowlands *N. belizensis*
- 8a. Leaves conspicuously puberulent beneath with hairs more than 0.3 mm long, lower surface soft to the touch 9a
- 8b. Leaves glabrous or minutely puberulent beneath, pubescence not evident to the touch 10a
 - 9a. Leaves 12–40 cm long and obtuse at the base, oblong and drying dark brown, with 9–14 pairs of major secondary veins; flowers functionally unisexual *N. kunthiana*
 - 9b. Leaves 9–24 cm long and decurrent at the base, broadly elliptic to elliptic-obovate and drying pale brown, with 5–9 pairs of major secondary veins; flowers bisexual *N. cissiflora*
- 10a. Anthers 0.8–0.9 mm long and usually borne on well-developed (0.4 mm) filaments, flowers 6–8 mm broad; fruits ca. 20 mm in diameter; leaves often drying lustrous and with the tertiary venation prominent on the upper surface; 1400–2400 m elevation *N. cufodontisii*
- 10b. Anthers usually less than 0.8 mm long, often sessile, flower rarely becoming 8 mm broad (smaller); fruits rarely exceeding 15 mm in diameter; trees rarely found above 1500 m 11a
- 11a. Leaves silvery white beneath (in life) and conspicuously glaucous when dried, the leaf blades 10–28 cm long but with only 3–6 pairs of major secondary veins, long-acuminate at the apex; fruits ovoid-ellipsoid, to 25 mm long; rare trees of lowland evergreen forests *N. hypoleuca*
- 11b. Leaves never silvery white beneath and not conspicuously glaucous beneath when dried; fruits rarely 20 mm long 12a
- 12a. Leaves drying subcoriaceous, decurrent on the petiole and with the base often revolute, oblong-elliptic to lanceolate, with 3–5 pairs of major secondary veins arising from the proximal half of the midvein; flowers 3–5 mm broad; fruit cups to 12 mm broad; 0–1700 m elevation *N. membranacea*
- 12b. Leaves usually drying stiffly chartaceous, not decurrent or revolute at the base, major secondary veins arising throughout the length of the midvein; fruit cups ca. 6 mm broad 13a
- 13a. Leaves with the major secondary veins slightly loop-connected near the margin in the distal half of the lamina, tertiary venation usually slightly elevated on both surfaces when dry 14a
- 13b. Leaves with the major secondary veins not distally loop-connected near the margin 17a
 - 14a. Leaves 5–11 cm broad (in Costa Rica), major secondary veins usually weakly loop-connected; trees only known from the Caribbean lowlands in our area (but compare 16b, below) .. 15a
 - 14b. Leaves 5–15 cm long and 1–6 cm broad, major secondary veins usually directly loop-connected near the margin distally 16a
 - 15a. Petioles 10–25 mm long, leaves 8–17 cm long; twigs glabrous; tepals ca. 3 mm long *N. longipetiolata*

- 15b. Petioles 5–12 mm long, leaves 13–24 cm long; twigs minutely puberulent; tepals ca. 2 mm long *N. latifolia*
- 16a. Leaves narrowly elliptic or ovate; anthers to 0.7 mm broad; fruits usually globose in development, to 16 mm long; flowers appressed puberulent on the outside; 0–600(–900) m in Costa Rica, widely distributed *N. salicifolia*
- 16b. Leaves narrowly elliptic to lanceolate; anthers to 1 mm broad; fruits usually ellipsoid in development, to 20 mm long (dry); flowers sparsely puberulent on the outside; 600–1600 m elevation in central and western Costa Rica *N. salicina*
- 17a. Flower buds densely white puberulent; stems sparsely puberulent; leaves usually drying dull above and with the tertiary veins slightly elevated, narrowly ovate-elliptic to elliptic-oblong, with 6–10 pairs of major secondary veins *N. martinicensis*
- 17b. Flower buds yellowish puberulent; young stems densely puberulent; leaves usually drying dark, lustrous and flat on the upper surface with the tertiary venation little elevated, usually narrowly elliptic to lanceolate, with 4–7(–9) pairs of major secondary veins *N. nitida*

Nectandra austinii C. K. Allen, J. Arnold Arbor. 26: 374. 1945.

This species was typified by *A. Smith P 2226*. Two additional collections were cited: *A. Smith 240 and P 2114*. We have only seen Smith's 240 and that appears to be *Ocotea valeriana*. Rohwer (pers. comm.) believes that this species is part of the *Ocotea helicterifolia* complex, of which *O. valeriana* is a part. Whether that complex of species is better treated as a complex of smaller species or a single very variable species with many sub-specific elements cannot be determined at this time. See the discussion under *O. helicterifolia*.

Nectandra belizensis (Lundell) C. K. Allen, J. Arnold Arbor. 26: 400. 1945. *Phoebe belizensis* Lundell, Contr. Univ. Mich. Herb. 6: 20. 1941. *N. schippii* C. K. Allen, loc. cit. 373. 1945. Figure 8.

Trees ca. 10–16 m tall and ca. 20 cm d.b.h., leafy branchlets 2.5–4.5 mm thick, densely tomentulose with brownish or ferruginous hairs ca. 1 mm long, the longer hairs deciduous to expose very short (0.2 mm) grayish hairs, the stems becoming grayish and glabrescent. Leaves alternate and subverticillate, usually clustered at the ends of branchlets, petioles 4–8 mm long, 1.5–2 mm thick, densely tomentulose; leaf blades 9–16 cm long, 3.5–6 cm broad, elliptic-oblong to elliptic obovate, acute to acuminate at the apex (rarely obtuse), obtuse to cuneate at the base and slightly rounded at the petiole, margins entire or undulate, drying stiffly chartaceous and brownish, the upper surface with small dense hairs above the impressed primary and secondary veins but grayish and glabrous between the veins, darker brown and conspicuously puberulent beneath with slender hairs ca. 0.5 mm long, with 4–8 major secondary veins on each side, tertiary veins prominent beneath. Inflorescences solitary in distal leaf axils, from leafless nodes, or on a terminal

shoot with poorly developed leaves and made up of several panicles, each panicle (3–)6–12 cm long, few-flowered and racemose in outline, peduncle 2–6 cm long, 0.5–1.5 mm thick, densely velutinous, pedicels 4–8 mm long and ca. 0.3 mm thick (dry). Flowers ca. 3 mm long and 5–7 mm broad, white, tepals ca. 4.5 mm long and 3 mm broad, sericeous on the exterior and minutely papillate-puberulent within; outer stamens with filaments only 0.1–0.2 mm long, outer anthers ca. 0.9 mm long and 1.1 mm broad (in ours), broadly obovate with the connective slightly prolonged and papillate, thecae in an arc, staminodes very short (0.3 mm); pistil ca. 1.2 mm long with a short (0.3 mm) style and slightly discoid stigma. Fruits and fruiting receptacle unknown.

Trees of lowland rain forest formations along the Caribbean slope and coastal plain, from 20 to 400 m elevation. We have a single flowering collection (*Utley & Utley 4046*, DUKE, F) from Costa Rica, made in February at about 300 m elevation along the road between Río Naranjo and Canalete (road to Upala) in northern Alajuela Province. The only other collections are the types from Belize, with immature inflorescences in December and mature flowers in March.

Nectandra belizensis is recognized by its dense puberulence, narrow and often obovate short-petiolate leaves, and long-pedunculate racemose panicles. The leaves clustered near the ends of branchlets and the laminae slightly rounded at the petioles, usually with acuminate apices, also help to identify the species. The broad stamens with the connective papillate and slightly expanded distally resemble those found in some elements of the *Ocotea helicterifolia* complex. These and other similarities with that complex probably reflect the real relationships of this species. Costa Rican material has leaves more narrowly obovate in form than either the type of *N. belizensis* (*Gentle 3304*, F) or the type of *N. schippii* (*Schipp 856*, GH, NY).

Nectandra cissiflora Nees, Syst. laur. 296. 1836.
N. paulii C. K. Allen, J. Arnold Arbor. 26: 400.
1945. Figure 11.

Trees to 30 m tall, trunks ca. 30 cm d.b.h., leafy branchlets 2.5–6 mm thick, densely puberulent in early stages with slender ascending hairs 0.1–0.3 mm long, with longitudinal ridges from beneath the leaf bases but becoming terete. **Leaves** alternate and somewhat clustered distally, petioles 11–28 mm long, 1.3–3.5 mm thick, velutinous-tomentulose, the adaxial ridges forming a sulcus above; **leaf blades** 9–21(–24) cm long, 4–8(–9) cm broad, broadly elliptic to elliptic-oblong, oblanceolate or elliptic-obovate, abruptly narrowed or rounded to the bluntly obtuse to short-acuminate apex, tapering gradually to the acute or obtuse base and strongly decurrent on the petiole, margin entire and revolute (especially near the base), drying stiffly chartaceous to subcoriaceous and grayish green to pale brown, densely puberulent on the midvein above with slender appressed or spreading hairs ca. 0.2 mm long, becoming (sub)glabrous in age, the lower surface minutely puberulent with slender inconspicuous hairs, with 6–9(–11) major secondary veins on each side, the secondary veins slightly impressed above and prominent beneath. **Inflorescences** axillary to leaves (occasionally pseudoterminal), 12–25 cm long, many flowered panicles with branches in the distal half, peduncle to 11 cm long, 1.8–3 mm thick, densely and minutely velutinous, pedicels 1–5 mm long (to 12 mm in fruits). **Flowers** 4–6 mm broad, white, densely puberulent on the outside, tepals 1.3–2 mm long, 0.9–1.5 mm broad, broadly rotate at anthesis, densely papillate-puberulent within; outer **stamens** subsessile with anther 0.4–0.6 mm long and 0.6–0.9 mm broad, thecae in a single row or arcuate, connective papillate distally, inner stamens with anthers broader than long and with conspicuous glands, staminodes small (0.5 mm) and somewhat broadened and flattened distally; **pistil** ca. 1.3 mm long, ovary globose and 0.9–1.1 mm in diameter, style very short (0.2–0.3 mm), stigma simple and flat. **Fruits** borne in a flat, saucer-like or shallow cupulate receptacle, abruptly expanded above the thickened (3 mm) pedicel, 10–12 mm broad and 1–3 mm deep, green; berry globose or subglobose, 1.3–2 cm in diameter, dark green becoming black.

Rarely collected trees of wet evergreen or partly deciduous forest formations, between 50 and 1200 m elevation on both the Caribbean and Pacific slope in Costa Rica. Flowering is in January–March with fruit set in April–June. In Costa Rica the species is only known from La Selva (*Hammel 11168*, DUKE, 11665, DUKE, F), the General Valley near San Isidro (*Skutch 2605*, US, the type of *N. paulii*) and Las Alturas de Coto Brus (*Burger et al. 12187*, CR). The species ranges from Mexico to Peru and Brazil.

Nectandra cissiflora is recognized by the larger, minutely puberulent, stiff leaves with usually more than six pairs of secondary veins, decurrent leaf base, small subsessile anthers with thecae in a hor-

izontal row, ovary with very short style, and globose fruits subtended by a very shallow cup. This species is similar to *Ocotea* sp. aff. *caracasana* and *Ocotea glaucosericea* in general appearance (C. K. Allen used fruits of the latter species in describing *N. paulii*). Even in forests that have been carefully studied, these trees are rarely collected. Hammel (1986) states that they grow on ridge tops.

Nectandra cufodontisii (O. C. Schmidt) C. K. Allen, J. Arnold Arbor. 26: 393. 1945. *Ocotea cufodontisii* O. C. Schmidt, Arch. Bot. (Forli) 11: 50. 1935. *O. seibertii* C. K. Allen, loc. cit. 336. 1945. Figure 12.

Trees 8–35 m tall, often with a well-developed spreading crown, leafy branchlets 2–5 mm thick, at first with minute (0.3 mm) slender appressed-ascending hairs but quickly glabrescent. **Leaves** alternate, petioles 8–21 mm long, 1.2–2.3 mm thick, flat or slightly sulcate above with lateral margins continuous with the lamina margins, very minutely puberulent; leaf blades (5–)6–15(–21) cm long, (2–)3–7(–9) cm broad, narrowly elliptic to ovate-elliptic, acute to short-acuminate at the apex, obtuse to rounded at the base and decurrent on the petiole, margins entire and with a veinlike revolute edge, drying subcoriaceous and the midvein yellow orange above, smooth and lustrous (rarely dull) above, essentially glabrous beneath but sometimes with longer whitish hairs in the basal vein-axils (domatia), with 4–7 major secondary veins on each side, central secondaries arising at angles of 20°–40°, tertiary veins slightly raised on the upper surface. **Inflorescences** axillary to distal leaves, 5–15(–25) cm long, peduncle to 10 cm long, reddish in life and drying dark, lateral branches short (1–3 cm) or long and the panicle narrow or broad, glabrous or minutely appressed puberulent, pedicels 1.5–4.5 mm long. **Flowers** ca. 3 mm long and 6–8 mm broad, sweet-scented and cream-white to yellowish green, floral tube short and funnellform, tepals ca. 2.5 mm long and 1.5 mm broad, papillate-puberulent within; **androecium** 2–2.5 mm broad, outer stamens broadly ovate, 0.8–0.9 mm long on filaments ca. 0.4 mm long, thecae in an arcuate configuration or somewhat superposed, inner stamens biglandular, small staminodes often present; **pistil** 1.7–2.1 mm long, ovary ellipsoid to ovoid, style 0.8–1 mm long, stigma simple. **Fruits** borne in a flat or cupulate receptacle 8–11 mm broad, 0–3 mm deep, abruptly expanded above the thickened pedicel, a very short (1–2 mm) broad stipe often developed beneath the fruits, cup red at maturity; berry (13–)20–40 mm long and 10–20 mm in diameter when dry (said to become 5 cm long and globose), green becoming blue black or purple.

Distinctive trees of montane cloud forest formations, from 1400 to 2600 m elevation. Flowering in May–August; fruits have been collected in January–September. The species ranges along the Caribbean side of the Meseta Central, from Palmira and Poás eastward through the Cordillera

de Talamanca to the Chiriquí highlands in Panama, and it has recently been found in the Cordillera Central de Nicaragua.

Nectandra cufodontisii is distinguished by the dried leaves usually lustrous and with the minor venation slightly raised on the upper surface to produce a characteristic texture, and the montane habitat. The inflorescences are bright orange in life and the leaves often dry an orange brown color. The stamens are usually more like those characteristic of *Nectandra*, with the thecae forming an arcuate pattern, but superposed (*Ocotea*-like) thecae can be found in many collections. The short flat cup beneath the large round fruits is another unusual feature of this species. The outer part of the fruiting receptacle (cup) may break off, producing a smaller (7 mm) flat base as in the type collection (*Cufodontis* 315, F). Common names are *quizarrá* and *yema de huevo*.

Nectandra davidsoniana C. K. Allen, J. Arnold Arbor. 26: 369. 1945.

This small-leaved species of the cloud forests in the Chiriquí highlands in Panama resembles *N. salicina* but has *Ocotea*-like stamens. The correct disposition of this species is uncertain at this point; it appears to be endemic in western Panama. See the discussion under *Ocotea viridiflora*.

Nectandra globosa (Aubl.) Mez, Jahrb. Königl. Bot. Gart. Berlin 5: 415. 1889. *Laurus globosa* Aubl., Hist. pl. Guiane 1: 364. 1775. See also Lourteig in Phytologia 63: 153–154. 1987. Figure 18.

Trees 4–15(–25) m tall, leafy branchlets 2–7 mm thick, at first grayish or yellowish puberulent with a covering of very minute (0.05–0.1 mm) thin appressed hairs that may be difficult to see, becoming terete. **Leaves** alternate, petioles 6–18 mm long, 1–2 mm thick, slightly flattened or sulcate above; **leaf blades** (7–)11–24(–30) cm long, (2–)3–8(–10) cm broad, ovate lanceolate to elliptic-lanceolate, narrowly elliptic or narrowly elliptic-oblong, tapering gradually to the long-acuminate (acute) apex, acute to obtuse at the base, margin entire and often revolute just above the petiole, drying stiffly chartaceous to subcoriaceous and often yellowish or grayish, dull, flat and glabrous above with the tertiary venation obscure, usually with a fine tomentum of minute (0.1 mm) hairs beneath, with (4–)7–11 arcuate ascending major secondary veins on each side and very prominent beneath, tertiary veins subparallel between the secondaries and usually obscure, domatia of tufted hairs often present in the vein axils beneath. **Inflorescences** axillary to distal leaves or pseudoterminal, 8–15(–20) cm long, broadly paniculate, peduncle ca. 1.5 mm thick and minutely puber-

ulent, usually equal to the length of the distal flowering rachis, pedicels 1–7 mm long, minutely puberulent. **Flowers** white or cream colored, puberulent, 5–7 mm long, 6–9(–12) mm broad, tepals 3–5 mm long, densely papillate within, inner tepals often narrower and more obovate than the outer; outer **stamens** sessile or subsessile, outer anthers 0.5–1.4 mm long and 0.8–1.4 mm broad, the 4 thecae in a horizontal row at the base of the distally expanded thick and minutely papillate connective, distal part of the connective usually more than half the length of the anther, staminodes present or absent, to 1 mm long and acute at the apex; **pistil** 1.3–1.7 mm long, globose or turbinate, the style very short (0.4 mm) or absent, stigma simple or slightly discoid. **Fruits** borne on a short (1–4 mm) flat or slightly cupulate receptacle 0.5–3 mm deep, 5–8 mm broad at the apex, margin entire; berry becoming globose and ca. 1 cm in diameter (dry), perhaps ovoid-ellipsoid in some populations (fruits are rarely collected), becoming black.

Trees of deciduous and partly deciduous forest formations, from near sea level to 700 m elevation along the Pacific slope of Costa Rica. Flowering material has been collected in December–March. Fruits have been collected in February–April (and in June at Turrialba where it has been planted). This species ranges from Mexico to Bolivia and Brazil.

Nectandra globosa is recognized by its large stiff leaves usually broadest below the middle and with the margin often curled under just above the petiole, the minute puberulence on many parts, the large flowers (for *Nectandra*) with tepal-like stamens, and the restriction to forests with a dry season of several months. (The distal development of the anther connective is an unusual feature among Costa Rican species but typical for many *Nectandra* species of other areas.) There are some specimens in Costa Rica that may be interpreted as intermediate between *N. globosa* and *N. ramonensis* of higher elevations. Both of these species have the anther connective expanded distally. Present evidence seems to indicate that the two species are well separated ecologically, with only occasional and problematic intermediates. Rohwer has recently annotated material (at F & MO) as *Nectandra caucana* (Meissn.) Mez, and this may become the accepted name for the material placed here.

In the earlier part of this study *Nectandra glabrescens* Benthham was thought to differ from *N. globosa* by the thinner dark brown leaves with obscure minor venation (when dried), and a preference for moister forest habitats (cf. dichotomy 6b in the key to *Nectandra* species; and fig. 18, second from the top). It now appears that these differences are not significant. Also, the syntypes

from Mexico and Nicaragua may not represent the same species (Rohwer, pers. comm.).

Nectandra hypoleuca Hammel, J. Arnold Arbor. 67: 126. 1986. Figure 18.

Trees 5–15 m tall, trunks 10–35 cm d.b.h. with dark brown bark, leafy branchlets 2–5 mm thick, very minutely (0.1 mm) papillate-puberulent. Leaves alternate, petioles 5–15 mm long, sulcate above, dark brown; leaf blades 10–28 cm long, 4–11 cm broad, elliptic to broadly elliptic, elliptic-oblong or narrowly elliptic, tapering gradually to the long-acuminate apex, the tip often 2 cm long, tapering gradually to the acute base, drying stiffly chartaceous and dull grayish above, glabrous above and below but with minute appressed hairs along the midvein and tufts of hairs (domatia) in some vein axils beneath, conspicuously glaucous beneath when dry, with 3–6 major secondary veins on each side, tertiary veins obscure and occasionally subparallel. Inflorescences axillary to distal leaves (sometimes pseudoterminal with distal leaves failing to develop and forming larger compound inflorescences), 4–18 cm long, peduncles 3–15 mm long, branches of the primary rachis becoming shorter distally, somewhat distant (5–15 mm) and forming an open panicle, ultimate flower clusters with 3–10 flowers, pedicels ca. 2 mm long, minutely puberulent. Flowers 2–2.5 mm long and 4–6 mm broad, perianth white or greenish white, tepals 2–2.5 mm long, minutely papillate-puberulent within; outer stamens subsessile, outer anthers 0.3–0.4 mm long and 0.6–0.7 mm broad, distinctly broader than long and with the thecae in 1 plane with the outer opening laterally, inner stamens with narrower thecae, staminodes ca. 0.4 mm long and clavate; pistil 1–1.5 mm long, ovary 0.7 mm broad, style narrow, stigma simple or slightly lobed. Fruits borne in a shallow or conical cup 5–8 mm long, 7–12 mm broad and 2–4 mm deep, enclosing only the base of the fruits, pedicel and cup red; berry 16–25 mm long, 12–16 mm thick, ovoid to broadly ellipsoid, becoming purple.

Trees of the wet evergreen forests of the Caribbean lowlands and perhaps in the Golfo Dulce area. Flowering collections have been made in May–August and October–November; fruits have been collected in September–October. At present, this species is known from the La Selva site where it is found in old secondary woods and alluvial forest along the Río Puerto Viejo at about 100 m elevation in the province of Heredia, and it may occur on the Osa Peninsula (see below).

Nectandra hypoleuca is recognized in life by its gray green leaves which are strikingly silvery white or glaucous on the undersurfaces, according to Hammel (1986). The leaves almost glabrous, with occasional tufted domatia, grayish and smooth above, tapering gradually to both apex and base (but not decurrent), long-acuminate tip, and the small flowers on somewhat distant branches of an

open panicle help distinguish dried specimens. An unusual collection (*Knapp & Mallet 2208*, CR, MO) from Parque Nacional Corcovado has foliage exactly like that of *N. hypoleuca* but the small (0.7 mm) anthers have only two valves! Two sterile collections (*A. Gentry 48524, 48567*, MO) from this same locality probably also represent this population; all three are placed here tentatively.

Nectandra kunthiana (Nees) Kosterm., Meded. Bot. Mus. Utrecht 25: 19. 1936. *Acrodiclidium kunthianum* Nees, Syst. laur. 269. 1936. *Ocotea kunthiana* (Nees) Mez, Jahrb. Königl. Bot. Gart. Berlin 5: 291. 1889. *Ocotea cooperi* C. K. Allen, J. Arnold Arbor. 26: 335. 1945. *Rhodostemonodaphne kunthianum* (Nees) Rohwer, Mitt. Inst. Allg. Bot. Hamburg 20: 84. 1986. Figure 7.

Trees to 25 m tall, dioecious, leafy branchlets 2.5–7 mm thick, sparsely to densely puberulent with dark gray or brown hairs to 0.3 mm long. Leaves alternate, petioles 8–37 mm long, 2–4 mm thick, somewhat sulcate above, minutely puberulent; leaf blades 12–32(–40) cm long, 6–12(–16) cm broad, elliptic to elliptic-oblong, tapering gradually to a long (1–4 cm) acuminate apex, obtuse at the base, margin entire or somewhat undulate, drying subcoriaceous, becoming glabrous and lustrous above, puberulent beneath with stiff slender hairs 0.1–0.5 mm long, with 9–14 major veins on each side, the central secondaries arising at angle of 40°–60°, major veins impressed above, tertiary veins often subparallel and slightly raised above. Inflorescences 11–22 cm long, axillary or pseudoterminal, thyriform panicles with the flowers somewhat clustered on the lateral branches, peduncles 4–9 cm long, ca. 2 mm thick, densely and minutely puberulent. Flowers unisexual but with organs of both sexes, urceolate and with a well-developed floral tube; male perianth campanulate, 4–5 mm broad, outer anthers subsessile, 0.6 mm long and 0.6–0.9 mm broad, thecae in a line or arc, staminodia absent, pistillode linear; female flowers more urceolate, ca. 4 mm long and 3 mm broad, anthers smaller than in the male and with inconspicuous valves, pistil 2.5 mm long, slender, style short, stigma discoid. Fruits borne in a cup ca. 16 mm long and 16 mm broad, campanulate and 6–10 mm deep, fruit stalk 6–20 mm long, margin of cup entire or slightly lobed, becoming orange red; berry 2.5–4 cm long, ca. 1.5 cm thick, oblong-ellipsoid, the lower third enclosed within the cup, glabrous, becoming black.

Infrequently collected trees of wet evergreen forest formations, between 50 and 900 m elevation on the Caribbean slope and foothills, and in the General Valley in Costa Rica. Flowering material has been collected in January–March, and fruits have been collected in July–August. The species ranges from Costa Rica and Panama to the Guianas and Ecuador, and may extend to Bolivia.

Nectandra kunthiana has distinctive foliage that dries dark in color, laminae that are often quite large and with a narrow acuminate tip, numerous secondary veins, and often with the subparallel veins raised on the leaves' lustrous upper surface. The densely puberulent inflorescences, functionally unisexual flowers, and the deep cups are further distinctions. A local name is *quizarrá negra*.

Rohwer and Kubitzki (1985) erected the genus *Rhodostemonodaphne* to replace *Synandrodaphne* Meissn., and they distinguish this genus from *Nectandra* by its dioecious habit, inner surface of the tepals hairy rather than papillate, and thecae along the upper edge of the anther. While transfer to a segregate genus may be justified, we continue the traditional placement of this species in *Nectandra* for the sake of convenience.

Nectandra latifolia (H.B.K.) Mez, Jahrb. Königl. Bot. Gart. Berlin 5: 454. 1889. *Ocotea latifolia* H.B.K., Nov. Gen. Sp. 2: 165. 1817. *N. purpurea* auct. Figure 17.

Small or medium-sized trees 5–17 m tall, 15–20(–40) cm d.b.h., leafy branchlets 1.5–4.5 mm thick, minutely (0.1–0.2 mm) appressed puberulent with thin ascending brownish hairs, becoming (sub)glabrous and dark grayish brown. Leaves alternate, petioles 5–12 mm long, 1.5–2 mm thick, with 2 adaxial ridges continuous with the lamina margin and usually forming a slight sulcus above, minutely appressed, puberulent; leaf blades 13–24 cm long, 5–11 cm broad, elliptic-oblong to narrowly ovate-elliptic or broadly oblong, short to longer acuminate or caudate-acuminate at the apex, tip 0.5–2 cm long, acute to obtuse (rarely rounded and subtruncate) at the base, shortly decurrent on the petiole, margin entire or slightly undulate (dry), drying stiffly chartaceous, the upper surface glabrous, lustrous, and with the minor venation often slightly raised, lower surface glabrous and with the minor venation slightly raised, with (4–)5–8 major secondary veins on each side, the distal secondaries often loop-connected near the margins, pit domatia with a few hairs often present in the proximal and central vein axils on the lower surface. Inflorescences axillary to distal leaves or pseudoterminal, 6–17 cm long, paniculate with spreading lateral branches, peduncle 1–6 cm long, reddish, lateral branchlets grayish puberulent, pedicels 1–2 mm long. Flowers ca. 3 mm long, 4–5 mm broad, white at anthesis and becoming orange, tepals (1–)1.3–2 mm long, densely papillate-puberulent within; outer anthers 0.4–0.6 mm long and 0.5–0.9 mm broad, on short (0.2 mm) filaments, lower thecae lateral to the upper or occasionally superposed, inner stamens ca. 1 mm long with filaments 0.6 mm long, staminodes slender with a narrow or thickened apex, 0.4–0.7 mm long; pistil 1–1.6 mm long, ovary ca. 0.7 mm in diameter, style ca. 0.4 mm long, stigma discoid. Fruits not seen from Costa Rica and the following based on Barro Colorado Island (Panama) collections: fruiting receptacle short (3–7 mm) and conical, only 2–3 mm deep and 6–10 mm broad at the

apex, becoming red; berry globose-ellipsoid, 14–18 mm long and 10–14 mm in diameter when dry.

Trees of evergreen lowland rain forest and partly deciduous forests, but only known from La Selva at 50 to 150 m elevation at the edge of the Caribbean coastal plain in Costa Rica. Flowering in May–June in Costa Rica; flowering in December–July in Central Panama with two peaks: December–March and May–July. This species is said to range from Nicaragua to Colombia, Ecuador, Peru, and Bolivia (but see below).

Nectandra latifolia is recognized by the relatively larger (in ours), almost glabrous leaves, lustrous above and with the minor venation usually slightly elevated on both surfaces (dry), secondary veins loop-connected distally, the sparsely puberulent domatia, the many-flowered panicles with small flowers, very small stamens, and the slender staminodes. Costa Rican material is quite different from the smaller-leaved material from Barro Colorado Island (which resembles *N. salicifolia* in some ways), and it may be an error to base our fruiting description on the Panamanian material. Specimens from La Selva are intermediate in leaf size between the Barro Colorado Island collections, and the much larger-leaved *N. lundellii* C. K. Allen from the Caribbean side of Honduras, Guatemala, and Belize. Also, there may be trees intermediate between our lowland representatives of this species and *N. cufodontisii* in the General Valley and Las Alturas de Coto Brus (cf. Burger *et al.* 12183, CR, F, determined as *N. cufodontisii*).

Costa Rican collections have been called *Nectandra purpurea* (Ruiz & Pavón) Mez based on *Laurus purpurea* Ruiz & Pavón, in *Laurografia Peruviana* t. 7. A Ruiz and Pavón collection at Field Museum, with foliage much like that in the original illustration, has stamens with a more *Ocotea*-like form than in material from Panama and Costa Rica. Thus, *N. latifolia*, both in the sense of the collections from Panama and those from La Selva, appears to be more closely related to *N. salicifolia* than to *N. purpurea*. This species was mistakenly called *N. purpurascens* in the *Flora of Barro Colorado Island* (Croat, 1978).

Nectandra longipetiolata van der Werff, sp. nov.
Figure 13.

Arbor ad 10 m alta. Folia alterna, chartacea, 9–17 × 5–8 cm, glabra, elliptica vel ovato-elliptica, basi obtusa, apice acuta vel breviter acuminata; costa nervique (4–8) super immersi, subtus elevati; reticulatio elevata. Pe-

tioli glabri, 10–25 mm longi. Inflorescentiae ad 4 cm longae, parviflorae. Flores extus minute puberuli vel papillati, intus dense papillati; tepala ca. 3.5 mm longa, patentia vel reflexa per anthesim; stamina 9, omnia 4-locellata, 6 exterioribus filamentis brevissimis, locellis introrsis; 3 interioribus locellis lateralibus vel laterali-extrorsis; staminodia 3; ovarium ovoideum, glabrum. Fructus ellipsoideus, ad 2 × 1.4 cm; cupula parva, patelliformis.

Small trees 4–10 m tall, leafy branchlets 1.2–3 mm thick, glabrous and reddish brown. **Leaves** alternate, petioles (8–)10–25 mm long, 0.9–1.7 mm thick, glabrous; **leaf blades** (7.5–)9–17 cm long, (4–)5–8 cm broad, ovate-elliptic to elliptic or slightly oblong, tapering to a short and bluntly acuminate apex, obtuse at the base, drying stiffly chartaceous, slightly lustrous on the upper surface with the secondary and tertiary venation distinctly raised when dry and grayish green to olive green, drying paler grayish green or yellowish beneath, with 4–8 major secondary veins on each side, central secondaries arising at angles of 40°–60°, minor venation prominent beneath but not forming a raised reticulum, pit domatia with a few hairs sometimes present in the axils of the basal secondaries beneath. **Inflorescences** ca. 4 cm long (only one seen), a racemose panicle with few (ca. 25) flowers, axillary to a distal leaf, glabrous. **Flowers** ca. 6 mm broad at anthesis, perianth parts ca. 3.5 mm long and 2 mm broad, sparsely puberulent on the exterior and minutely papillate puberulent on the interior (adaxial) surfaces; **outer stamens** ca. 0.9 mm long with anthers 0.7 mm long and 0.8 mm broad, the thecae in a horizontal plane or very low arc, staminodes prominent, ca. 0.8 mm long with a short stipe and broad (0.6 mm) apex; **pistil** ca. 1.4 mm long, ovary 1 mm in diameter, style short (0.4 mm) and poorly defined, stigma slightly thickened. **Fruits** borne on a short (2–6 mm) cup 6–7 mm broad at the apex, conical or abruptly expanded, puberulent within, rose red; berry broadly ellipsoid or slightly obovoid, 15–20 mm long and 11–14 mm in diameter, green.

TYPE—Costa Rica, Prov. Limón, Hitoy Cerere Reserve, 31 July 1985, *M. Grayum & B. Hammel 5769* (holotype, MO; isotype, CR).

Understory trees of ridges in evergreen rain forest of the Caribbean lowlands near Manzanillo de Talamanca and the Hitoy Cerere Reserve, between 50 and 200 m elevation. Known from only three collections (*Grayum et al. 4381, 4396, 5769*, all CR, MO), from the Caribbean lowlands of southeastern Costa Rica.

Nectandra longipetiolata is distinguished by its completely glabrous leaves drying grayish to yellowish green, distinctive venation on the dried leaf surfaces, anther form, and small fruiting cups. At first glance *N. longipetiolata* does not seem to be a *Nectandra*, because of the long petioles (for a *Nectandra*), the weakly extended secondary veins which do not come close to the lamina margin, and the raised minor venation on both leaf surfaces. However, flowers and fruits leave no doubt

that this species belongs to the *N. salicifolia* species group, characterized by relatively well-developed staminodia, inner stamens with lateral or lateral-extrorse dehiscence and the small, saucer-like cupule. Within the *N. salicifolia* group, *N. longipetiolata* stands apart by its long petioles, glabrous twigs and leaves, almost glabrous flowers, upper surface of the leaves not drying dark, the broad leaves with an obtuse base, and the small inflorescences.

Nectandra martinicensis Mez, Mitt. Bot. Vereins Kreis Freiburg 47–48: 421. 1888, Jahrb. Königl. Bot. Gart. Berlin 5: 459. 1889. *N. woodsoniana* C. K. Allen, J. Arnold Arbor. 26: 394. 1945. Figure 17.

Small to medium-sized trees 5–15(–25) m tall, leafy internodes 0.5–4 cm long, 1.5–4.5 mm thick, minutely grayish tomentulose but quickly becoming (sub)glabrous, grayish or brown and minutely longitudinally striate. **Leaves** alternate, petioles 6–13 mm long, 1–2 mm thick, with 2 adaxial ridges and sulcate or flat above; **leaf blades** 12–28 cm long, 4–8.5 cm wide, elliptic-oblong to narrowly elliptic or narrowly ovate-elliptic, tapering gradually to an acuminate apex, the tip 0.5–1.5 cm long, acute to obtuse at the base, drying chartaceous and dull grayish green or darker and slightly lustrous above, glabrous or with slender appressed hairs 0.2–0.4 mm long on the upper surface, glabrous or with minute slender hairs beneath, with 6–10 major secondary veins on each side, pit domatia or tufted hairs often present in the axils of proximal veins beneath, the minor venation often slightly raised above (dry). **Inflorescences** solitary in distal leaf axils or pseudoterminal, 8–15(–20) cm long, paniculate with open distal branching and the peduncle about half the length (3–8 cm) of the rachis, peduncle 1.5–2 mm thick, reddish brown or yellowish, minutely puberulent, pedicels 0.5–4 mm long. **Flowers** 3–4 mm long and 5–8 mm broad, white and showy at anthesis, tepals ca. 2.5 mm long, puberulent on the outside and densely papillate-puberulent on the inner surfaces; **androecium** ca. 2.5 mm in diameter, outer stamens subsessile or with short (0.4 mm) filaments, outer anthers 0.4–0.6 mm long and 0.7–0.9 mm broad, subreniform to rectangular, the lower thecae lateral to the upper or all in a single plane, anthers emarginate or not, inner stamens ca. 1 mm long with filaments 0.4–0.5 mm long, staminodes slender or with a broadened apex, ca. 0.5 mm long; **pistil** 1.2–1.7 mm long, style 0.3–0.5 mm long, stigma discoid. **Fruits** borne on a flat disclike receptacle 2–4 mm long and 6 mm broad; berry ellipsoid, 15–18 mm long and 10 mm in diameter.

Trees of evergreen forests or partly deciduous forests of the Pacific slope in Costa Rica, from near sea level in Panama to 1300 m in the central highlands of Costa Rica. Costa Rican collections are primarily from the eastern part of the Meseta Central and the western part of the General Valley

in the province of San José. Flowering collections have been made in March–July; fruits have been collected in October–November and January. The species range is poorly understood because of the difficulty of separating closely related species.

Nectandra martinicensis is recognized by the larger sparsely puberulent chartaceous laminae with as many as 10 pairs of major secondary veins, the larger open many-flowered inflorescences with whitish puberulent buds, and short outer stamens with thecae often in a single row. Specimens of this species may be difficult to separate from unusual individuals of the *N. salicifolia*-*N. latifolia* species group. Moreover, there may be intermediates with material placed in *N. nitida*, which has narrow leaves that are usually very lustrous and often dry dark on the upper surface. Despite the name, this species does not grow in Martinique. Howard (1981) discusses the problems associated with the name of this species and, because he does not accept *Nectandra* as a genus, he places this taxon under the name *Ocotea tabascensis* (Lundell) Howard, since Mez had already described an *Ocotea martinicensis*. We follow the interpretation of Bernardi (1967, pp. 69–72).

Nectandra membranacea (Sw.) Griseb., Fl. Brit. W. I. 282. 1860. *Laurus membranacea* Sw., Prodr. 65. 1788. *N. skutchii* C. K. Allen, J. Arnold Arbor. 26: 396. 1945. *N. standleyi* C. K. Allen, loc. cit. 1945. Figure 17.

Shrubs and small to medium-sized trees, 4–18 m tall, leafy branchlets 1.5–7 mm thick, at first minutely (0.1 mm) appressed puberulent, becoming (sub)glabrous and dark in color, terete. **Leaves** alternate, petioles 5–20 mm long, flat or slightly sulcate above, densely and very minutely puberulent in early stages, lateral margins continuous with the decurrent lamina margins; **leaf blades** 8–24(–30) cm long, 4–7(–13) cm broad, oblong-elliptic to lanceolate, ovate-lanceolate, narrowly ovate or oblong, broadest at or below the middle, usually tapering gradually to a short or long-acuminate apex, acute to obtuse at the base, margin entire and decurrent on the petiole, margin usually revolute near the base of the lamina, drying subcoriaceous and dull grayish or brown above, the major veins flat or impressed above and the tertiary venation obscure, very minutely (0.1 mm) puberulent or appearing glabrous, with 3–5 major secondary veins on each side and arising at angles of 20°–40°, usually with the most distal secondaries arising from the middle of the lamina, tertiary veins subparallel and perpendicular to the midvein (often perpendicular to the secondaries in larger leaves), domatia absent. **Inflorescences** pseudoterminal or axillary to distal leaves, 4–14(–20) cm long, paniculate, peduncles to 8 cm long, minutely appressed puberulent with yellowish or brownish hairs, pedicels 1.5–4 mm long. **Flowers** 3.5–5.5 mm broad,

yellowish green in life, tepals 1.5–2.5 mm long, ca. 1 mm wide, densely papillate-puberulent within; outer **anthers** 0.3–0.5 mm long and 0.6–0.8 mm broad, on short filaments, staminodes (0.2–)0.4–0.7 mm long, slender and with a slightly triangular tip; **pistil** 1.1–1.6 mm long, ovary 1 mm thick, glabrous, style 0.7–1 mm long, stigma simple. **Fruit** cup (8–)10–12 mm broad, very shallow (1–3 mm), mostly conical in form, ca. 10 mm long, apparently remaining green; berry 12–15 mm long, globose to ovoid (rarely ellipsoid), green becoming black.

Shrubs or trees often encountered along forest edges and in more open sites or secondary woods in wet evergreen forest formations, from 50 to 1700 m elevation along the Caribbean slopes of Costa Rica and in the highland forests; not known from the Pacific slope below 600 m elevation. Flowering collections have been made in May–December with an apparent peak in July–August. Fruits have been collected in December–April, but appear to mature mostly in March–April. The species ranges from Mexico and the West Indies to Peru and Brazil.

Nectandra membranacea is recognized by the narrow leaves with relatively few major secondary veins arising from the proximal half of the leaf blade and strongly arcuate-ascending. The decurrent leaf base and revolute margin (near the base), minute puberulence, small globose-ovoid fruits, and restriction to moister evergreen forests further characterize this species. *Nectandra gentlei* Lundell with narrower, usually lanceolate, leaves is probably no more than a variety of this species. A number of collections from the Caribbean slope with leaves drying orange brown and venation not so arcuate-ascending are tentatively placed here (*Gómez-Laurito 11262, 11272*, both at CR, USJ; *Grayum et al. 8060*, CR, MO).

Nectandra nitida Mez, Jahrb. Königl. Bot. Gart. Berlin 5: 461. 1889. *N. perdubia* Lundell, Lloydia 4: 47. 1941. Figure 17.

Trees (rarely shrubs) (3–)5–20 m tall, 4–30(–90) cm d.b.h., leafy branchlets 1.7–5 mm thick, densely puberulent with minute (0.1–0.4 mm) yellowish brown or grayish appressed-ascending hairs, longitudinally ridged but becoming terete, glabrescent and grayish. **Leaves** alternate, petioles 4–10 mm long, 1–2 mm thick, densely brownish puberulent, sulcate or flat above; **leaf blades** 10–23(–30) cm long, 3–6(–7) cm broad, lanceolate to narrowly elliptic, elliptic-oblong, narrowly oblong or narrowly ovate-elliptic, tapering gradually to an acuminate tip (rarely acute or caudate-acuminate), the tip to 3 cm long, obtuse to acute at the base, the margin entire, drying stiffly chartaceous to subcoriaceous, usually dark and lustrous above, usually sparsely appressed-

puberulent above and becoming glabrescent, sparsely appressed-puberulent beneath with thin ascending hairs (rarely glabrous), with (3-)4-7(-9) major secondary veins on each side, the central secondaries arising at angles of 25°-45° and strongly ascending (rarely loop-connected distally), with pits and tufted hairs in the axils of the major veins beneath (not always present). **Inflorescences** axillary to distal leaves or pseudoterminal, sometimes appearing to be several per axil when the peduncle is very short, to 15 cm long, paniculate and widely branching to racemose in form, peduncles 3-50 mm long, puberulent, pedicels 1-4 mm long. **Flowers** 5-7 mm broad, white, tepals 2-2.3 mm long, ca. 1.3 mm broad, puberulent on the outside and densely papillate within; **outer stamens** 0.6-0.8 mm long with filaments 0.2-0.3 mm long, **outer anthers** ca. 0.3 mm long and 0.5 mm broad, rectangular to reniform, the thecae in 1 plane or arcuate, connective flat or emarginate distally, **inner stamens** with quadrangular anthers and large glands, **staminodes** minute or small (0.6 mm), often with a sagittate apex; **pistil** 1-1.3 mm long, ovary rounded and ca. 0.7 mm thick, style ca. 0.3 mm long, stigma discoid. **Fruits** borne on a short (2-4 mm) conical or slightly cupulate receptacle 4-6 mm broad at the apex and only 1-2 mm deep, margin entire, becoming red; berry (7-)8-12 mm long and (6-)7-10 mm in diameter (dry), globose or subglobose, becoming dark green.

Small or medium-sized trees often found at forest edges and in secondary formations, from sea level to 1300 m elevation in evergreen and partly deciduous formations. The primary flowering period for this species in Mexico and Guatemala is March-June, and fruiting range is September-February. The species ranges from middle Mexico through Belize and Guatemala to Costa Rica and adjacent Panama (but see below).

Nectandra nitida is recognized by its narrow leaves usually gradually narrowed at both apex and base, the glossy upper leaf surfaces that dry dark, the densely puberulent young stems, the small broad anthers on short filaments, and the small globose fruits on short-conical or shallow cupulate receptacles. This species has been little collected in Costa Rica, and it is difficult to separate from *N. martinicensis* and *N. salicifolia* in our area; in fact, there may be intergradation between *N. nitida* and *N. martinicensis* in our highlands, and intergradation with *N. salicifolia* in our lowlands. While difficult to recognize and separate in Costa Rica, this species seems more easily identified and much more common in Guatemala and southern Mexico.

Nectandra ramonensis Standley, Publ. Field Mus. Nat. Hist. Bot. Ser. 18: 453. 1937. Figure 18.

Trees 5-15 m tall, leafy branchlets (0-)5-35 mm long, 1-4 mm thick, densely appressed puberulent with short

(0.2 mm) grayish or pale brown hairs, older twigs glabrescent, a reddish brown inner bark sometimes becoming exposed by flaking off of outer bark. **Leaves** alternate or subopposite, petioles 4-12(-17) mm long, 1-1.8 mm thick, minutely puberulent, with lateral margins only near the lamina base, terete near the base and rarely sulcate above; **leaf blades** (4-)7-15 cm long, 2.5-6(-7) cm broad, elliptic-oblong, oblong or ovate-oblong, gradually tapering to an acute or acuminate (less often obtuse) apex, obtuse or acute at the decurrent base, margin entire and often slightly revolute just above the petiole, drying stiffly chartaceous and often pale brown or grayish green above, the upper surface glabrous or sparsely and minutely puberulent and with a dull flat surface (rarely slightly lustrous), sericeous beneath in early stages with thin appressed hairs or very sparsely and minutely puberulent, with (3-)4-6(-7) major secondary veins on each side, domatia of tufted hairs often present in vein axils beneath. **Inflorescences** axillary to distal leaves, 5-12 cm long, paniculate, few flowered, primary peduncle to 9 cm long and much longer than the flowering rachis, 0.5-1 mm thick and densely puberulent, flowers often in umbellate clusters of cymes, pedicels 2-11 mm long. **Flowers** to 5 mm long and 12(-15) mm broad, white, minutely puberulent, tepals ca. 5 mm long and 3 mm broad, minutely papillate on the inner surfaces; **outer stamens** with broad subsessile anthers 1-1.6 mm long and 1.2-1.8 mm broad, the 4 thecae in a horizontal line or slight arc at the base of the thick distally expanded connective, small (0.4-0.9 mm) staminodia with obtuse apices usually present, floral tube shallow (ca. 1 mm); **pistil** 1.2-2 mm long, style very short (0.5 mm) or not well differentiated on the conical apex of the ovary. **Fruits** rarely collected, borne in a cup 5-12 mm long, 8-10 mm broad and 3-6 mm deep, with entire margin; berry 1-1.5 cm long and 8-10 mm in diameter, ellipsoid.

Trees of evergreen montane forest formations, between 600 and 1400 m elevation; apparently confined to the Pacific slope of the central highlands and Cordillera de Talamanca. Flowering material has been collected mostly in February near San Ramón, but in December-April elsewhere. Fruits have been collected in March-April. The species is known from the area of San Ramón, Alajuela, a few collections in the central highlands, the easternmost highlands of Puntarenas Province and eastward to the province of Coclé, Panama.

Nectandra ramonensis is characterized by the relatively small pale brown leaves with dull flat upper surface, lamina base often revolute, few-flowered inflorescences on long peduncles, large flowers, unusual stamens, and restricted habitat. This species is closely related to *N. globosa*, and appears to be a montane derivative of that species. Collections that may be intermediate between the two species have been made near San Ramón; see the discussion under *N. globosa*. While a subspecific rank may be suggested for this taxon, some populations are strikingly distinctive. This is especially true of the collections made in and around

the Chiriquí highlands, with their short elliptic-oblong leaves (with domatia beneath) and the tendency for the inflorescences to have an umbel-like configuration of terminal cymes.

Nectandra reticulata (Ruiz & Pavón) Mez, Jahrb.

Königl. Bot. Gart. Berlin 5: 404. 1889. *Laurus reticulata* Ruiz & Pavón, Laurografia Peruviána t. 3, ?1802. *Ocotea mollis* H.B.K., Nov. Gen. Sp. 2: 164. 1817. *N. mollis* (H.B.K.) Nees, Syst. Laur. 287. 1836. Figure 7.

Trees to 28(–40) m tall, trunks to 75 cm d.b.h., usually dark gray and smooth, leafy branchlets 2–8 m thick, densely puberulent with short (0.1–0.5) brownish hairs. Leaves alternate and usually in 4 ranks, petioles 8–23 mm long, 2–3.5 mm thick, densely puberulent; **leaf blades** 10–25(–36) cm long, 4–11(–14) cm broad, ovate-lanceolate to ovate-elliptic or elliptic-oblong, usually broadest below the middle and tapering gradually to the long-acuminate apex, obtuse to acute at the base, margin entire and with a vein along the edge, the margin often revolute near the petiole with expanded auriculate flaps 4–16 mm long forming enclosed spaces on both sides of the lamina base beneath, drying stiffly chartaceous, grayish puberulent on the veins above and smooth to the touch, brownish tomentulose beneath with slender crooked hairs ca. 0.5 mm long, with 6–16 major secondary veins on each side, tertiary venation subparallel and prominent beneath. **Inflorescences** 6–18 cm long, axillary to distal leaves, panicate with few or many clusters of closely approximate flowers on prominent lateral branches, peduncle 3–10 cm long, 1.5–2 mm thick, densely puberulent, lateral branches 3–5 cm long. **Flowers** 4–8 mm long and 8–12 mm broad, white at anthesis but becoming reddish brown, tepals 4–5.5 mm long, densely papillate-puberulent within; outer **stamens** broad and flat, 1.5–1.7 mm long, thecae in a plane or in a partly superposed arc, connective usually developed distally beyond the thecae, staminodia slender or absent; **pistil** 2.5–3.5 mm long, stigma discoid. **Fruits** not seen from Central America (the following from high altitude collections in the Andes): fruiting receptacles obconic, 6–12 mm long and 10–16 mm broad, shallow and saucer-like or deeper (2–4 mm) and more cupulate; berry 10–20 mm long, ovoid-oblong, abruptly rounded at the apex.

Trees of both evergreen rain forests and evergreen formations with a pronounced dry season, on both the Caribbean and Pacific sides of Costa Rica, from near sea level to 1200 (?1600) m elevation. Flowers have been collected in October–February and April. The species ranges from southern Mexico through Central America to Peru and southern Brazil.

Nectandra reticulata is recognized by its narrowly ovate (almost lanceolate) leaves with long-acuminate apices and dense brownish puberulence

beneath. This species often has flaplike auriculate developments on the underside of the lamina near the petiole. These are bent under to form partly enclosed spaces, but not all leaves or specimens have this development. The lack of mature fruiting collections in Central America is unusual for a species that is fairly often collected. The early stages of fruit development seem to have the drupe completely enclosed within the urceolate hypanthium.

Nectandra salicifolia (H.B.K.) Nees, Syst. Laur. 302.

1836. *Ocotea salicifolia* H.B.K., Nov. Gen. Sp. 2: 166. 1817. Figure 17.

Shrubs and small trees 4–12 (rarely to 25) m tall, leafy branchlets 1.5–4 mm thick, minutely (0.1–0.2 mm) appressed puberulent with thin ascending hairs, becoming (sub)glabrous and brownish to gray. **Leaves** alternate, petioles 3–8(–14) mm long, ca. 1 mm thick, usually sulcate above; **leaf blades** 6–15 cm long, 1.5–6 cm broad, narrowly elliptic, elliptic-lanceolate or elliptic-oblong to ovate-elliptic, tapering gradually or abruptly to an acuminate (rarely acute) apex, the tip 4–16 mm long, acute to obtuse at the base and slightly decurrent on the petiole, margin entire, drying stiffly chartaceous to subcoriaceous and often darker above than below when dried, glabrous above and usually lustrous, glabrous beneath except for the tufted hairs (domatia) in the axils of proximal secondary veins in some collections, with 4–7 major secondary veins on each side, the secondaries usually weakly loop-connected near the margin in the distal half of the lamina, minor venation raised on both surfaces when dry. **Inflorescences** solitary in the axils of distal leaves or pseudoterminal (sometimes appearing to be several in the axil due to a very short peduncle), broadly panicate and many-flowered or rarely racemose to umbellate in few-flowered panicles, 4–11(–17) cm long, primary peduncle (2)–6–60 mm long, reddish to whitish and sparsely to densely puberulent with slender minute (0.1 mm) hairs, pedicels 2–3(–4) mm long. **Flowers** white, 3–4 mm long, 5–6(–8) mm broad, tepals 2.5–3.8 mm long and 1.2–1.7 mm broad, spreading or reflexed at anthesis, puberulent on the outside and papillate within; outer **stamens** subsessile or the filaments to 0.3 mm long, outer anthers 0.4–0.6 mm long, 0.5–0.7 mm broad, rectangular to reniform and convex to emarginate distally, the thecae in a single plane or the lower lateral to the upper in an arc, inner stamens ca. 0.8 mm long and with large glands, staminodes 0.4–0.8 mm long and slender or slightly thickened apically (sometimes absent or minute); **pistil** 1–1.7 mm long, ovary 0.6–1 mm in diameter (rarely puberulent), style 0.3–0.6 mm long, stigma discoid or simple. **Fruits** borne on a short-conical or saucer-like receptacle 3–5 mm long, (5)–8–10 mm broad and 1–3 mm deep, the margin entire or slightly undulate, becoming reddish or purple; berry 1–1.6 cm long and 1–1.5 cm in diameter, subglobose to ellipsoid-oblong, becoming black (red?).

Shrubs and small trees of evergreen and partly deciduous forest formations, between sea level and

600 (900) m elevation in the Caribbean lowlands, the General Valley and the Golfo Dulce region in Costa Rica. Flowering material has been collected in January–August in Costa Rica and January–June in Guatemala; mature fruits have been collected in August–November in Central America. This species (in a wide sense) ranges from north-eastern Mexico through Central America to Costa Rica and Panama.

Nectandra salicifolia is recognized by the relatively small, stiff, essentially glabrous leaves with the minor venation raised on both surfaces and the upper surface usually lustrous when dried. The usual presence of tufted domatia and the weakly loop-connected secondary veins are associated with small puberulent flowers with very small anthers, short styles, small shallow fruiting receptacles, and usually subglobose fruits. These characters vary greatly and can make some populations appear quite different from others. Collections from southwestern Costa Rica tend to have more caudate-acuminate leaves with conspicuous “drip tips,” while material from the Caribbean slope is often narrowly elliptic. *Nectandra salicina* appears to be a highland derivative of *N. salicifolia*, and there appear to be collections intermediate between the two in the Cordillera de Guanacaste; see the discussion under *N. salicina*. *Nectandra savannarum* (Standl. & Steyerl.) C. K. Allen of Guatemala and Belize is probably an unusual form of *N. salicifolia* with small umbellate inflorescences and small ovate leaves with prominent basal secondary veins. Trees referred to as *N. salicifolia* in Paul Allen’s book (1956) are actually *N. turbacensis*. Some material placed here was earlier identified as *N. coriacea* (Sw.) Griseb., which is probably restricted to the West Indies and Yucatan peninsula (Rohwer, pers. comm.).

Nectandra salicina C. K. Allen, J. Arnold Arbor. 26: 385. 1945. *N. smithii* C. K. Allen, loc. cit. 370. 1945. Figure 4.

Trees 5–10 m tall, leafy branchlets 1–4(–5) mm thick, at first minutely puberulent with appressed yellowish brown hairs, becoming glabrous, smooth, and grayish. **Leaves** alternate and often densely clustered at the ends of branches, petioles 4–12 mm long, ca. 1 mm thick, flat or slightly sulcate above and with lateral margins; **leaf blades** 5–9(–14) cm long, 1–3(–4) cm broad, narrowly elliptic to lanceolate or elliptic-oblong, tapering gradually to the acuminate apex, the narrowed tip 0.5–2 cm long, tapering gradually to the attenuate base, margin entire or undulate, drying stiffly chartaceous or subcoriaceous and often greenish brown, glabrous and lustrous

above with the tertiary veins slightly raised, glabrous or very sparsely puberulent beneath, rarely with tufts of hairs (domatia) in the vein axils, with (3–)4–6(–7) major secondary veins on each side, the tertiary venation always forming a raised but irregular reticulum on the upper surface of the dried leaf. **Inflorescences** axillary or extra-axillary (nodes with undeveloped leaves?), to 12 cm long, paniculate but with few lateral branches, peduncles (2–)4–8 cm long, minutely puberulent, pedicels ca. 4 mm long and articulate in the middle. **Flowers** ca. 3.5 mm long and 6–7 mm broad, yellowish white, densely and minutely puberulent, tepals 2.5–3 mm long, densely papillate-puberulent within; **androecium** ca. 3 mm in diameter, outer stamens with short (0.2 mm) filaments, outer anthers 0.5–0.8 mm long and 0.7–1 mm broad, thecae usually in an arc with the lower lateral to the upper, inner stamens narrow, staminodes to 1 mm long or absent; **pistil** 1–1.8 mm long, ovary globose, 0.7–1.1 mm in diameter, style narrow, stigma discoid or simple. **Fruits** borne in a conical or broadly campanulate and very shallow (1–2 mm) cup, 5–10 mm long above the thickened pedicel and 4–11 mm broad at the top, margin entire or undulate, becoming red; berry 10–18 mm long and 7–16 mm thick (dry), ellipsoid during development but becoming globose at full maturity.

Trees of evergreen forests on both the Caribbean and Pacific slopes, from about 600 to 1700 m elevation. Flowering collections have been made in January–May and July–August; fruits have been collected in March–November. The species, as here defined, ranges from the westernmost parts of the Cordillera de Guanacaste through the Cordillera de Tilarán to the eastern part of the central volcanic highlands (near Turrialba, Cartago).

Nectandra salicina is recognized by its small lustrous narrowly elliptic and acuminate leaves with the tertiary venation usually prominent on both surfaces. The small few-flowered inflorescences with reddish rachises and puberulent little flowers, and the ellipsoid to globose fruits borne in shallow cups also distinguish this species. The wood and leaves are said to be sweet-smelling. *Nectandra salicina* appears to intergrade with very similar smaller-leaved specimens of *N. salicifolia* at lower elevations, and it would appear that it should really be called a subspecies of *N. salicifolia*. However, *N. salicifolia* encompasses much geographic variation in the lowlands, and its relationship with material called *N. latifolia* is not clear. Until these matters are clarified, we prefer to think of these taxa as species; see the discussion under *N. latifolia*. Specimens intermediate between typical *N. salicina* and *N. salicifolia* have been collected at lower elevations (about 400 to 900 m) in the Cordillera de Guanacaste, but they lack fruits, which are generally larger in *N. salicina*.

Nectandra smithii was based on *Austin Smith*

H. 541 (AA,F) from near Zarcero at 1600 m elevation. The leaves resemble those of some collections of *N. salicifolia* but are more elliptic-oblong, and a few of the leaves have distinctive slightly rounded caudate-acuminate tips. *Brenes 6825* (F) was cited in the description of *N. smithii* and seems to be intermediate between the type collection and typical material of *N. salicina*; it is for this reason that *N. smithii* appears to be an unusual variant of *N. salicina*. Rohwer (p. 81, 1986) points out that the flowers have some *Ocotea*-like characteristics, both as regards pubescence and thecae arrangement in the outer anthers. This suggests that the type may be of hybrid origin; however, these characteristics are also sometimes seen in *N. salicina*.

***Nectandra sinuata* Mez, Jahrb. Königl. Bot. Gart. Berlin 5: 402. 1889. Figure 7.**

Small or medium-sized trees to 20 m tall, trunk to 1 m d.b.h., leafy branchlets 2–8 mm thick, densely villous-tomentulose with slender yellowish brown or grayish hairs ca. 0.5 mm long. Leaves alternate, petioles 8–32(–40) mm long, 1–4 mm thick, densely puberulent and obscurely sulcate above; leaf blades 10–22(–30) cm long, 3.5–12(–19) cm broad, oblong-elliptic to slightly obovate or oblong-obovate, usually abruptly narrowed to the obtuse or short-acuminate apex, usually abruptly narrowed to the obtuse or truncated base (rarely acute), the larger leaves often rounded and subcordate at the base, laminae drying stiffly chartaceous, sparsely puberulent above and densely tomentulose to sericeous beneath with slender straight or curved hairs 0.3–1 mm long, with 10–12 major secondary veins on each side, the central secondaries arising at angles of 40°–75°. Inflorescences axillary to distal leaves, to 30 cm long, open panicles puberulent in all parts, peduncle to 16 cm long (often more than half the length of the inflorescence), ca. 2 mm thick, pedicels 5–12 mm long. Flowers ca. 10 mm long, 10–20 mm broad, tepals 5–8 mm long and ca. 4 mm broad (dry), pale rose, pink or white (reddish brown when dry), densely tomentulose on the outside and papillate-puberulent within; androecium ca. 5 mm in diameter, outer anthers 2–3 mm long on short (0.5 mm) thick filaments, connective often expanded and the stamen tepal-like in form, thecae in an arc or sometimes superposed, staminodes absent; pistil 2–3 mm long, style ca. 1 mm long with lobed disclike stigma. Fruit cups ca. 20 mm long and 16 mm broad, entire or lobed at the margin, ca. 5 mm deep; berry 2–2.5 cm long and 1–1.8 cm thick, ellipsoid-oblong, sparsely to densely sericeous in the lower fourth, glabrous above except at the apex, becoming black.

Trees of evergreen and partly deciduous forest formations of the central highlands and Pacific slope in Costa Rica, between 300 and 1500 m elevation. (A few collections have been made on the Caribbean slope near Turrialba, but these may

have been planted.) Flowering collections have been made in January–April in Costa Rica, and fruits have been collected in April–June. The species ranges from southern Mexico along the Pacific side of Central America to the western part of the Cordillera de Talamanca (near Sta. María de Dota).

Nectandra sinuata is distinguished by the dense puberulence of its long-peduncled inflorescences and lower leaf surfaces, the large densely puberulent flowers, and the ellipsoid fruits with appressed hairs near the base. The oblong leaves abruptly narrowed at both apex and base, preference for a seasonally dry habitat, and frequent pink flowers further characterize this species. The tepal-like anthers are unusual and sometimes have the valves in a superposed *Ocotea*-like arrangement. Rohwer (pers. comm.) has suggested transferring this species to *Ocotea*.

***Nectandra turbacensis* (H.B.K.) Nees, Hufeland. ill. 14. 1833; Syst. laur. 316. 1836. *Ocotea turbacensis* H.B.K., Nov. Gen. Sp. 2: 162. 1817. *N. concinna* Nees, Syst. laur. 322. 1836. *N. nervosa* Mez & J. D. Smith ex Mez, Bull. Herb. Boissier, ser. 2, 3: 235. 1903. Figure 18.**

Trees to 20(30) m tall, to 80 cm d.b.h., leafy branchlets 1.5–5 mm thick, glabrous or sparsely puberulent with thin minute (0.2 mm) appressed ascending hairs, becoming dark and smooth. Leaves alternate, petioles 5–12 mm long, 0.7–1.2 mm thick, usually glabrous and dark, flat or slightly sulcate between the adaxial ridges; leaf blades 5–17 cm long, 2–4.5(–6) cm broad, lanceolate to narrowly ovate or narrowly oblong, tapering gradually to the acute or acuminate apex, acute (rarely obtuse) at the base, margin entire or undulate, stiffly chartaceous and often grayish green above, glabrous above and below, the midvein and minor venation slightly raised above, with (3)–5–7 major secondary veins on each side (rarely with a basal pair of secondaries strongly ascending and almost tripliveined, as in *Allen 5710*), ciliate pit domatia often present in proximal vein axils beneath. Inflorescences in the axils of distal leaves or pseudoterminal, to 17 cm long, paniculate with spreading lateral branches, peduncle (0.5)–2–6 cm long, 0.5–1.5 mm thick, glabrous (rarely sparsely and minutely puberulent), pedicels 1–4 mm long. Flowers ca. 3 mm long and 5–8 mm broad, white, sparsely puberulent on the outside, tepals 2.2–3 mm long, 2–2.6 mm broad, densely papillate-puberulent within; androecium 3 mm in diameter, outer stamens subsessile, outer anthers 0.6–0.7 mm long, 0.8–1.1 mm broad, thecae in a horizontal row, the connective slightly expanded distally and papillate, inner stamens 0.9–1.4 mm long, staminodes minute or absent; pistil 1.5–2 mm long, ovary 1–1.4 mm in diameter, style short (ca. 0.8 mm) and thick, stigma discoid. Fruits borne on a short (4–10 mm) cupulate receptacle 8–12 mm broad at the apex and (2)–3–4 mm deep, margin entire and often with

2 concentric ridges, greenish or bluish; berry 10–14 mm long and 7–10 mm thick (dry), oblong-ellipsoid, becoming black.

Trees usually found in secondary associations in evergreen and partly deciduous forest formations, from near sea level to 1200(1700) m. Flowers have been collected in September–March (May) in Costa Rica; fruiting is said to occur in March–April in southwestern Costa Rica (P. H. Allen, 1956). The species ranges from Veracruz, Mexico, to Colombia, Venezuela, Peru, and Bolivia.

Nectandra turbacensis is recognized by the glabrous leaves that dry dull grayish with smooth surfaces and obscure minor venation (as in the type) or with the minor venation slightly raised on a darker background (as in the populations of southwestern Costa Rica). The outer sessile anthers with their slightly prolonged (but truncated or obtuse) and papillate connective and their thecae in a single plane are distinctive. The entire fruit cup enclosing about 1/4 of the fruit and a general lack of puberulence (except for distal parts of the inflorescence and perianth) further distinguish this species. The veins are not loop-connected near the margin, and the flowers and stamens are larger than in *N. salicifolia* and its allies.

Trees with long narrow leaves and prominent minor venation have been called *N. panamensis* Mez, and are characteristic of southwestern Costa Rica and western Panama in the Pacific lowlands. It may be that the populations of the Pacific lowlands deserve subspecific recognition. The species is rarely collected in Central America and appears to be restricted to the Caribbean lowlands in northern Central America. A population with abnormal flowers was sampled by Standley and Valerio (45469, 45906, 45909, 46192, all us) near Tilarán in 1926.

Ocotea Aublet

REFERENCE—J. G. Rohwer, Prodrum einer Monographie der Gattung *Ocotea* Aubl. (Lauraceae), sensu lato. Mitt. Inst. Allg. Bot. Hamburg 20: 1–278. 1986.

Trees or shrubs, bisexual or rarely unisexual (dioecious), glabrous to densely puberulent. **Leaves** alternate, rarely subopposite or verticillate, petiolate or sessile but narrowed near the base, the **leaf blades** entire, chartaceous to coriaceous when dry, with pinnate venation (rarely with strongly developed basal secondaries and subtripliveined), with or without domatia. **Inflores-**

cences usually solitary and axillary to distal leaves, sometimes pseudoterminal, lacking a subtending involucre of bracts, paniculate or occasionally few-flowered and racemose, pedicels usually well developed, bracts and bracteoles usually deciduous. **Flowers** bisexual or unisexual, (male flowers usually with a pistillode and female flowers with staminodes when unisexual), generally small (2–5 mm long), white to yellowish or green, the floral tube (hypanthium) well developed, small or absent but always accrescent in fruits, perianth 6-parted with 2 whorls of 3 tepals each, imbricate, equal or subequal, the tepals thick to thin and glabrous to densely puberulent; fertile **stamens** 9 in 3 series, the outer 2 series (often appearing as a single whorl) similar in size and shape and with introrse dehiscence, filaments present or absent, anthers variously shaped but usually as broad as long or longer than broad (flat and triangular to laminar or tepal-like in some species), the connective rarely prolonged beyond the thecae, each anther with 4 thecae arranged in 2 planes (superposed) or with the lower thecae slightly lateral to the upper (this character can vary within the same flower in a few species and makes differentiation from *Nectandra* difficult), opening by flaps attached at the top, the inner 3 stamens also 4-thealous, usually with longer filaments and narrower anthers that open extrorsely or with the upper thecae opening laterally and the lower extrorse, each inner stamen with 2 conspicuous sessile (rarely stipitate) glands at the base of the filament (6 glands per flower), the glands thick and bluntly rounded or angular, an inner whorl of staminodes (series IV) usually absent or poorly developed (less than 0.6 mm long); **pistil** with globose, ovoid, or turbinate ovary, usually slightly narrowed at the base, rarely puberulent, style slender or thick, stigma simple to discoid or capitate (rarely 2- or 3-lobed). **Fruits** borne on a flattened discoid to cupulate or hemispheric receptacle, perianth usually deciduous and the cup with a single-margined edge (with a double margined rim in *O. dendrodaphne*, *O. veraguensis* and some flat disclike receptacles), the margin sometimes undulate (rarely 6-lobed), pedicel thickened in fruits and erect or pendulous; fruits a single-seeded berry, ovoid to ellipsoid, oblong or globose, usually narrowed and slightly flattened at the base, abruptly rounded at the apex, style or stigma rarely persisting.

A genus of perhaps 300 to 400 species centered in the American tropics, with a few species in Africa and a group of species in Madagascar. In Costa Rica there appear to be a few species intermediate between *Ocotea* and *Nectandra*, and between *Ocotea* and *Phoebe*. The usual lack of three well-developed staminodes help distinguish *Ocotea* from our species of *Phoebe*. The character of superposed (2-ranked) thecae valves, which separates *Ocotea* from *Nectandra*, displays considerable variation with some intermediate states among a few species. While it is easy to say that these relatively rare intermediate states invalidate current generic concepts, there does not seem to be any way of developing better generic concepts at this time. Lumping these genera together produces nomenclatural confusion with no increased understand-

ing of how the species should be arranged. The present grouping of species in *Ocotea* appears to form a central assemblage from which other lineages may have been derived (cf. Rohwer & Kubitzki, 1985; Rohwer, 1986). For example, one population of *O. insularis* appears to be in the process of losing the upper thecae in each anther, and this may have been how *Aiouea costaricensis* originated (see the discussion under these species and under *Aiouea*, *Nectandra*, and *Phoebe*).

Ocotea is recognized by the 6-parted flowers with equal or subequal tepals, the nine stamens with four superposed valves in each, the three inner

stamens with two conspicuous glands, the absence or poor development of staminodes, and the receptacle forming a cup or disc in fruits. There is great morphological variation within our species. The stamens range from sessile lamina-like structures to those with well-developed slender filaments and clearly differentiated anthers. Comparison with other genera and with related species within *Ocotea* suggests that laminar stamens are not a primitive condition in Lauraceae (cf. Rohwer & Kubitzki, 1985). Likewise, the fruiting receptacle ranges from a small disc to a deep hemispheric cup.

Key to Species of *Ocotea* in Costa Rica

- 1a. Distal branchlets hollow and often harboring small ants; leaves usually more than 15 cm long and narrowly oblong to elliptic-oblong or narrowly obovate, always glabrous beneath; small trees of wet evergreen forest understory 2a
- 1b. Distal branchlets solid, the center with wood or pith and not consistently hollow 6a
 - 2a. Flowers 4–6 mm long; anthers 2–3 mm long, flat and tepal-like; fruit cups ca. 15 mm broad and 3–7 mm deep; leaves drying grayish green and subcoriaceous, usually elliptic-oblong; 0–1500 m elevation *O. dendrodaphne*
 - 2b. Flowers 2–3 mm long; anthers to 1 mm long and not tepal-like; fruit cups 6–12 mm broad and only 1–2 mm deep 3a
 - 3a. Leaves usually drying chartaceous and usually very dark in color; 0–1000 m elevation ... 4a
 - 3b. Leaves usually drying subcoriaceous and grayish green to orange brown or dull brown ... 5a
 - 4a. Leaves becoming 30–50 cm long, often narrowly obovate; flowers essentially glabrous, outer filaments glabrous; fruits 20–35 mm long *O. atirrensensis*
 - 4b. Leaves not exceeding 30 cm in length, usually narrowly elliptic-oblong; flowers minutely puberulent, filaments minutely puberulent; fruits 12–20 mm long *O. wedeliana*
 - 5a. Distal stems strongly angled with 3–5 prominent longitudinal ridges; leaves to 40(–55) cm long, often narrowly obovate; fruit cups often with persisting perianth bases; 0–1100 m ... *O. nicaraguensis*
 - 5b. Distal stems without prominent ridges, not strongly angled in cross section; leaves 10–30 cm long, often narrowly oblong; fruit cups with entire margins; 600–2300 m elevation *O. paulii*
- 6a. Leaves usually becoming more than 30 cm long, obovate and gradually narrowed to the base, drying stiffly chartaceous 7a
- 6b. Leaves rarely more than 30 cm in length (sprout shoots from nonflowering basal branches may be larger) 9a
 - 7a. Leaves to 50 cm long and 25 cm broad, glabrous beneath; flowers 3 mm long and 3 mm broad, outer anthers ca. 0.6 mm long; Golfo Dulce area *O. rivularis*
 - 7b. Leaves to 40 cm long, conspicuously puberulent beneath; flowers 5–7 mm long and 6–10 mm broad; Caribbean slope and lowlands 8a
 - 8a. Leaves often narrowly obovate, to 16 cm broad; inflorescence rachis sparsely hirsute; outer anthers 1.2–1.4 mm long; ca. 1400 m elevation *O. lentii*
 - 8b. Leaves often broadly obovate, to 22 cm broad; inflorescence rachis densely yellowish puberulent; outer anthers 1–1.2 mm long; 0–900 m *O. valeriodes*

- 9a. Leaves densely puberulent beneath with longer (0.3–1 mm) hairs, the hairs spreading or appressed, puberulence on the lower surface soft or slightly rough to the touch 10a
- 9b. Leaves glabrous to sparsely puberulent beneath (lower surface), the hairs small (0.05–0.2 mm) or inconspicuous and difficult to see with a 10X hand lens, puberulence of the lower leaf surface not discernable to the touch 25a
- 10a. Lower leaf surface sericeous with lustrous silvery or reddish hairs, the leaves drying stiffly coriaceous and decurrent on a very short petiole; flowers 4–7 mm long and densely puberulent; only from above 2000 m *O. calophylla*
- 10b. Lower leaf surfaces not densely sericeous with lustrous silvery or reddish hairs; petioles well developed 11a
- 11a. Largest leaves rarely more than 10 cm long 12a
- 11b. Largest leaves usually more than 13 cm long 15a
- 12a. Flowers glabrous to sparsely puberulent, often with well-developed staminodes; lamina base not decurrent on the petiole, leaves usually drying chartaceous 13a
- 12b. Flowers minutely and densely puberulent, staminodes absent; lamina base decurrent on the petiole, leaves often drying subcoriaceous 14a
- 13a. Fruit cups 10–15 mm broad; pubescence on the lower leaf surfaces brownish and slightly rough to the touch; 1000–3200 m elevation *O. pittieri*
- 13b. Fruit cups ca. 6 mm broad; pubescence on the lower leaf surfaces grayish and soft to the touch; 1400–2300 m elevation *O. mollicella*
- 14a. Leaves usually elliptic and 1.5–4 cm broad, with an acute apex; flowers 3–4 mm long, outer anthers 0.6–0.9 mm long; western highlands, 1400–1600 m . *O. monteverdensis*
- 14b. Leaves usually oblong and 1.5–6 cm broad, with an obtuse apex; flowers 4–5 mm long, outer anthers ca. 1 mm long; central and eastern highlands, 1700–3000 m elevation *O. austinii*
- 15a. Base of the leaf blades decurrent on the petiole and the petiole often poorly defined, margin of the lamina often revolute near the petiole 16a
- 15b. Base of the leaf blade not consistently decurrent on the petiole 19a
- 16a. Leaves usually narrowly elliptic to oblong, 1.5–6 cm broad; montane species rarely encountered below 1200 m elevation 14a
- 16b. Leaves often obovate or slightly obovate, 3–11 cm broad; rarely found above 1100 m 17a
- 17a. Petioles clearly differentiated from the narrowed lamina base, leaves drying stiffly chartaceous, with 4–8 pairs of major secondary veins; fruit cups 10–16 mm broad *O. hartshorniana*
- 17b. Petioles not clearly differentiated from the narrowed lamina base, leaves drying subcoriaceous, with 9–12 pairs of major secondary veins; fruit cups 5–12 mm broad 18a
- 18a. Fruit cups flat and saucer-like, without dentate lobes *O. stenoneura*
- 18b. Fruit cups deeply cupulate and with persisting perianth lobes *O. dentata*
- 19a. Leaves broadly obovate to broadly elliptic, usually rounded or abruptly narrowed at the apex, usually drying dark brown above, densely puberulent beneath; outer anthers 0.7–1.5 mm long; Caribbean slope and central cordilleras 20a
- 19b. Leaves rarely obovate or broadly elliptic, not rounded at the apex, rarely drying dark brown, sparsely puberulent beneath 25a
- 20a. Trees of montane formations, (800–)1000–2500 m elevation; leaves often drying subcoriaceous, oblong to broadly elliptic, obovate or suborbicular; flowers 6–15 mm broad 21a
- 20b. Trees not known from above 800 m elevation in Costa Rica; laminae usually drying stiffly chartaceous, usually obovate to oblong or pandurate; flowers 4–12 mm broad 23a
- 21a. Flowers glabrous on the outside, outer anthers sessile or with very short filaments; fruits borne in a deep (5–8 mm) cup 10–18 mm broad . *O. valeriana*

- 21b. Flowers densely puberulent on the outside, outer anthers with prominent filaments 22a
- 22a. Leaves usually elliptic to oblong, 3–9 cm broad; flowers 6–8 mm broad; fruits in a shallow entire cup; 1500–2500 m elevation *O. pseudopalmana*
- 22b. Leaves usually broadly elliptic to suborbicular, 6–14 cm broad; flowers ca. 12 mm broad; fruits in a deep lobed cup; 800–1400 m *O. gomezii*
- 23a. Leaves 10–22 cm broad, obovate to pandurate, on short thick (3–6 mm) petioles; inflorescences apparently erect; perianth sparsely puberulent *O. valeroides*
- 23b. Leaves 4–14 cm broad, petioles rarely more than 3 mm thick 24a
- 24a. Leaves often obovate to pandurate; inflorescences pendant with long thin peduncles, flowers often borne on umbellate lateral branches; perianth usually glabrous on the outside and drying dark *O. helicterifolia*
- 24b. Leaves obovate to broadly oblong; inflorescences usually erect and broadly paniculate with racemose or branched lateral branches; perianth puberulent on the outside and drying brownish *O. mollifolia*
- 25a. Distal branchlets strongly winged (alate) with narrow longitudinal wings 2–3 mm high, the stems 3–5-angled in cross section; leaves narrowly oblong to narrowly obovate and coriaceous, with 9–14 pairs of major secondary veins; Pacific slope below 1000 m elevation *O. aurantiodora*
- 25b. Distal branches without conspicuous longitudinal wings, the stems sometimes bluntly angled in cross section but not with 2–3 mm high ridges 26a
- 26a. Leaf base usually decurrent on the petiole, the leaf base and petiole often poorly differentiated, lamina margin often revolute near the petiole, the leaves petiolate to sessile 27a
- 26b. Leaf base not usually decurrent on the petiole, lamina acute to obtuse or rounded at the base and usually clearly differentiated from the petioles, the leaves never sessile or subsessile 36a
- 27a. Leaf base broadly revolute (auriculate) and forming 2 broad flaps on the underside, petiole little developed and the leaves subsessile, broadly obovate and often coriaceous; (700–)1100–2300 m elevation *O. endresiana*
- 27b. Leaf base flat or revolute but not forming broad flaps beneath, never auriculate and usually petiolate 28a
- 28a. Mature leaves usually with slender appressed ascending hairs parallel with the secondary veins over the lower surface; trees often with prop roots at the base of the trunk 29a
- 28b. Mature leaves glabrous or variously puberulent but not with slender appressed hairs paralleling the secondary veins on the lower surfaces; trees without prop roots(?) 31a
- 29a. Leaves elliptic to oblanceolate or obovate, 2–5 cm broad, leaf base usually long-decurrent (to 5 cm long), with 5–9 pairs of major secondary veins; fruits ellipsoid; Pacific slope at 600–1400 m (if higher elevation cf. *O. whitei*) *O. skutchii*
- 29b. Leaves broadly obovate, 4.5–11 cm broad, long- or short-decurrent at the base, with 7–12 pairs of major secondary veins; fruits globose to ovoid and 2–4 cm long .. 30a
- 30a. Fruits ellipsoid to ovoid, 3–4 cm long in large deep (12 mm) cups; leaves drying smooth and dull above with the minor venation obscure; Caribbean lowlands *O. sp. aff. caracasana*
- 30b. Fruits globose to oblong, 2–3 cm long, often in conical cups with reflexed edges; leaves drying with a lustrous sheen and the minor venation raised above; 1500–2500 m elevation *O. glaucosericea*
- 31a. Leaves often rounded at the apex or bluntly obtuse (rarely acute to short-acuminate in smaller leaves), often obovate, (2–)5–9(–12) cm broad, drying coriaceous or subcoriaceous and often yellowish brown to pale reddish brown; fruit cups 6–9 mm broad and often with persisting perianth bases on the edge, fruits ellipsoid, 1–2 cm long; 0–2000 m *O. insularis*
- 31b. Leaves bluntly acute to acuminate at the apex, sometimes bluntly obtuse but never rounded, often oblanceolate to narrowly elliptic-obovate or oblong, 1.5–5(–6) cm broad; fruit cups without persisting perianth 32a
- 32a. Flowers 2–5 mm long, functionally unisexual; fruits subglobose, 6–16 mm in diameter; leaves drying grayish green or yellowish green, elliptic-oblong to obovate 33a
- 32b. Flowers 1.5–3 mm long, bisexual; fruits globose or oblong, but never with a persisting style;

- leaves often drying very dark in Costa Rica but variable in *O. whitei*, often oblanceolate to very narrowly elliptical 34a
- 33a. Fruits with a persisting style base at the top and borne on a thick flat double-rimmed disclike receptacle 6–10 mm broad, berry 10–16 mm in diameter; leaves often obovate and drying grayish; 0–1900 m *O. floribunda*
- 33b. Fruits without a persisting style base, receptacle 4–8 mm broad, berry 6–8 mm in diameter (dried); leaves often elliptic-oblong and drying yellowish; 0–500 m *O. puberula*
- 34a. Fruits 15–38 mm long and 11–18 mm thick (dry), ellipsoid and borne in cupulate receptacles 8–14 mm broad; leaves often narrowly elliptic; 1300–2500 m elevation *O. whitei*
- 34b. Fruits rarely exceeding 15 mm in length, globose to oblong, subtended by shallow receptacles 4–6 mm broad; leaves usually oblanceolate to narrowly elliptic-obovate 35a
- 35a. Flowers 2–3 mm long, outer anthers ca. 0.6 mm long; fruits globose, 5–8 mm in diameter (dry); leaves without domatia; Caribbean lowlands *O. sp. aff. O. bijuga*
- 35b. Flowers 1.5–2.5 mm long, outer anthers ca. 1 mm long; fruits oblong, 9–18 mm long and 7–9 mm in diameter; pit domatia often present on leaf undersurfaces; (0–)600–1000 m ...
..... *O. oblonga*
- 36a. Leaves drying very dark (almost black) and thin-chartaceous; fruiting receptacle gradually expanding (obconic) to the 1 cm broad apex, concave or slightly cupulate, fruits 2–3 cm long and 1–2 cm thick; flowers glabrous and small 37a
- 36b. Leaves drying grayish to dark brown, stiffly chartaceous to coriaceous if drying very dark .. 38a
- 37a. Flowers 1.5–3 mm long, outer anthers ca. 0.7 mm long and the connective not expanded; leaves elliptic to elliptic-oblong, with 4–7 pairs of major secondary veins, glabrous; 0–1700 m elevation *O. tenera*
- 37b. Flowers 3–5 mm long, outer anthers ca. 1 mm long and with the connective expanded distally; leaves ovate to broadly elliptic, with 3–5 pairs of major secondary veins, sparsely puberulent; 900–2000 m *O. brenesii*
- 38a. Minor venation raised on the lower leaf surface and forming a reticulum of small areolae 0.3–1 mm broad, the areolae often with subequal sides; the leaves often drying yellowish green or grayish green, glabrous or glabrescent on the lower surface 39a
- 38b. Minor venation not raised and not forming a definite reticulum on the lower (abaxial) leaf surfaces, areolae very irregular if present; glabrous to puberulent beneath 43a
- 39a. Leaves gradually narrowed to the base, usually narrowly obovate and drying grayish green, domatia lacking; fruits globose with short persisting style at the apex and subtended by a small (6–10 mm) flat disclike receptacle; 0–1900 m elevation *O. floribunda*
- 39b. Leaves abruptly narrowed at the base (obtuse to acute), pit domatia present; fruiting receptacles cupulate, 8–14 mm broad and 2–5 mm deep; fruits mostly ellipsoid, 2–3 cm long and the style not persisting 40a
- 40a. Leaves broadly obovate and large (14–30 cm × 7–18 cm), rounded to bluntly obtuse at the apex, drying yellowish brown and subcoriaceous; fruit cup with an irregular margin; flowers unknown; 500–1000 m elevation *O. sp. A aff. O. laetevirens*
- 40b. Leaves never broadly obovate and not more than 10 cm broad, usually acuminate at the apex; flowers 2–4 mm long, anthers 0.7–1 mm long; fruit cups with an entire margin . 41a
- 41a. Leaves usually drying yellowish green and often subcoriaceous, often broadly elliptic, reticulum of minor venation poorly defined; fruit cup 10–16 mm broad, 3–5 mm deep
..... *O. laetevirens*
- 41b. Leaves usually drying stiffly chartaceous; fruit cups only 2–3 mm deep 42a
- 42a. Leaves usually drying grayish green and with a reticulum of small (0.5 mm) areolae beneath; fruit cup 8–14 mm broad with flaring edges; inflorescences usually paniculate; 0–2100 m elevation *O. meziana*
- 42b. Leaves usually drying yellowish brown and lustrous above, reticulation of veins not forming small areolae beneath; fruit cup ca. 10 mm broad and with persisting lobes; inflorescences often umbellate or racemose; Pacific Highlands, 1600–2000 m *O. viridiflora*

- 43a. Flowers to 7 mm long and 5–10 mm broad, outer anthers 1.5–2.5 mm long and usually flattened 44a
- 43b. Flowers to 5 mm long, outer anthers less than 1 mm long; evergreen forests, 0–1800 m elevation 45a
- 44a. Flowers minutely puberulent; leaves drying grayish, with 5–8 pairs of major secondary veins; deciduous and partly deciduous forest formations, 0–1600 m *O. veraguensis*
- 44b. Flowers glabrous; leaves drying dark brown with 3–6 pairs of major secondary veins; evergreen forests, 1600–2200 m *O. holdridgeiana*
- 45a. Flowers 2–2.5 mm long, glabrous and drying black; leaves usually oblong and caudate-acuminate at the apex, drying grayish and chartaceous, glabrous or very sparsely puberulent; fruit cups ca. 1 cm broad; 0–300(–800) m elevation *O. cernua*
- 45b. Flowers 2–5 mm long and minutely puberulent; leaves never caudate-acuminate, often drying grayish green and subcoriaceous; fruit cups 5–8 mm broad, dark and with pale lenticels; 0–1800 m 46a
- 46a. Leaves usually glabrous beneath, the major veins not impressed above, often elliptic-oblong; distal branchlets strongly 2- or 3-angled in cross section; flowers unisexual *O. leucoxydon*
- 46b. Leaves usually puberulent beneath, the major veins impressed above and the leaves somewhat bullate, usually broadly elliptic to slightly obovate; distal branchlets with longitudinal ridges but not strongly angled in cross section; flowers not known in Costa Rica *O. babosa*

Ocotea atirrensis Mez & J. D. Smith, Bot. Jahrb. Syst. 30, Beibl. 67: 18. 1901. *O. pedalisfolia* Mez, loc. cit. 19. 1901. Figure 2.

Shrubs or small and slender trees to 5(–8) m tall, leafy branchlets 3–6 mm thick, glabrous and smooth, strongly ridged or terete, distal stems hollow and often inhabited by small ants. **Leaves** alternate, petioles 6–18 mm long, 1.5–3.5 mm thick, with adaxial margins forming a deep sulcus above and partly overlapping; **leaf blades** 12–35(–55) cm long, 5–13(–22) cm broad, narrowly obovate to oblong-obovate or oblanceolate, usually abruptly narrowed and caudate-acuminate at the apex, the tip often 1–3 cm long and 2–4 mm broad, gradually narrowed to the acute or obtuse base, margin entire and slightly undulate, drying chartaceous and dark gray, glabrous above and below, with 7–12 major secondary veins on each side, venation usually flat above and more prominent beneath, the tertiary veins often subparallel between the secondaries. **Inflorescences** axillary to distal leaves (rarely pseudoterminal), 10–18 cm long (to 30 cm in fruits), paniculate with distal branches much shorter than the basal branches, glabrous, peduncles 1–6 cm long, becoming pendulous, pedicels 1–3 mm long. **Flowers** buds ca. 2 mm long and 2 mm broad, yellow, glabrous or with a few hairs on the outside, tepals ca. 1.5 mm long and 1.2 mm broad near the base, ovate; outer **anthers** ca. 0.6 mm long, narrow with superposed and slightly overlapping thecae, filaments 0.1–0.5 mm long, staminodes absent; **pistil** ca. 2 mm long, style ca. 1 mm long, stigma simple or slightly discoid. **Fruits** borne on a receptacle 8–12 mm long, 6–10 mm broad and 1–3 mm deep, urceolate (but solid) to oblong and warty, bright red; fruits 2–3.5 cm long, 1–2 cm thick (dry), oblong-ellipsoid to narrowly ovoid, narrowed at the base, becoming black.

Usually found as understory treelets in evergreen wet forest formations, from near sea level

to 1100 m elevation. Most flowering collections have been made in January–April, with a few in August–October. Mature fruits have been collected in January–April and July–December. The species is to be expected in southeastern Nicaragua and has been collected along the Caribbean side of Costa Rica, in the General Valley, Osa Peninsula, and adjacent Panama.

Ocotea atirrensis is distinguished by the large thin obovate leaves with caudate-acuminate tips, lack of puberulence, hollow distal stems, small stature in the understory of usually lowland wet forests, small flowers, and unusual fruiting receptacle (a deep cup is not developed). This species is closely related to *O. paulii* and *O. wedeliana* but is distinguished by the large thin obovate leaves with caudate tips, tertiary veins more often parallel, and different habitats. This species is similar to *O. nicaraguensis*, but that species has thicker leaves that do not dry dark and are not caudate-acuminate at the apex and its stems are more prominently ridged. Some collections between 400 and 1000 m elevation on the Caribbean slope have smaller, narrower, stiffer leaves that do not dry so dark and resemble *O. paulii*. Whether this is just clinal variation or reflects intergradation and gene flow with *O. paulii* should be investigated. See the discussion under *Aiouea vexatrix* by van der Werff in Ann. Missouri Bot. Gard. 75: 405. 1988.

Ocotea aurantiadora (Ruiz & Pavón) Mez, Jahrb. Königl. Bot. Gart. Berlin 5: 295. 1889. *Laurus*

aurantiodora Ruiz & Pavón, Laurografia Peruviana t. 15, ?1802. *Mespilodaphne aurantiodora* Meissn. in DC., Prodr. 15 (1): 101. 1864.

Small trees to 12 m tall and ca. 25 cm d.b.h., leafy branchlets 6–14 mm thick, puberulent with short (0.4 mm) thin ascending brownish hairs, becoming glabrescent and dark in color, distal stems strongly angled with prominent (ca. 1 mm) longitudinal ridges, usually with 5 ridges (or wings) in cross section. **Leaves** alternate, petioles ca. 10 mm long and 3 mm thick, flat above or the 2 adaxial ridges forming a shallow sulcus; **leaf blades** 13–35 cm long, 4–10 cm broad, very narrowly obovate to oblanceolate or oblong-elliptic, usually tapering gradually to a short acuminate apex, tapering gradually to the cuneate or decurrent base, margin slightly revolute, drying subcoriaceous, glabrous above with the slightly raised minor venation forming a reticulum of small areolae (0.5–1 mm broad), lower surface with slender appressed straight yellowish hairs 0.2–0.7 mm long and usually parallel with the secondary veins, with 9–14 major secondary veins on each side and arising at angles of 45°–50°. **Inflorescences** axillary to distal leaves, 10–22 cm long, becoming 30 cm long in fruits, peduncles 3–9 cm long and 2–4 mm thick, sparsely puberulent and with longitudinal ridges, pedicels ca. 1 mm long. **Flowers** apparently unisexual, ca. 2 mm long and 3 mm broad, yellowish white and minutely puberulent, tepals 1.5–2 mm long and 1.5 mm broad; **outer stamens** with short (0.4 mm) filaments and narrow anthers ca. 0.8 mm long with superposed thecae, inner stamens ca. 1.5 mm long, glands closely appressed and resembling an annular disc, staminodes absent; **pistil/pistillode** ca. 1.8 mm long, stigma disclike. **Fruits** borne in a receptacle ca. 6 mm long and 8 mm broad, rounded and cupulate in form, the opening ca. 5 mm in diameter and 3–4 mm deep, margin rounded and entire; berry ca. 8 mm long and 5–6 mm thick, oblong and bluntly rounded at both ends.

Trees of evergreen and partly deciduous forest formations, at elevations from 200 to 900 m. A single flowering collection has been made in July in Costa Rica, and fruiting material has been collected in January–April. This species is known from southern Nicaragua, and from the General Valley in southern Costa Rica. The species ranges from southern Nicaragua and Costa Rica to Peru and the Amazon Basin.

Ocotea aurantiodora is recognized by its thick, strongly winged stems, long, stiff, narrowly oblong or obovate leaves with slender appressed hairs beneath, small functionally unisexual flowers, and small oblong fruits half immersed in a thick rounded cup. This species is similar to *O. nicaraguensis*, but lacks the hollow ant-inhabited stems, and the flowers and fruits are very different. This very distinctive species has been interpreted by Rohwer (1986) to include *O. longifolia* H.B.K., *O. grandifolia* (Nees) Mez, and *O. opifera* Martius, among others. However, in his monograph, Rohwer (1986)

considered the Ruiz and Pavón names *nomina nuda* because only their illustrations were published. He has since changed his mind and we agree that the Ruiz and Pavón names, based on very fine illustrations, should be considered as effectively published. The text for these illustrations was published in Anal. Inst. Bot. Cavanilles 13: 21. 1954.

Ocotea austinii C. K. Allen, J. Arnold Arbor. 26: 350. 1945. *O. irazuensis* Lundell, Wrightia 5: 339. 1977. Figure 5.

Trees to 25 m tall and 65 cm d.b.h., leafy branchlets 1.8–5 mm thick, very minutely puberulent with brownish hairs in early stages, becoming (sub)glabrous, dark grayish and longitudinally ridged. **Leaves** alternate and usually clustered at the ends of branchlets, petioles 5–20 mm long, 1.5–3 mm broad, flat or sulcate above, lateral margins continuous with the lamina margins; **leaf blades** 3–12(–16) cm long, 1.5–4(–6) cm broad, oblong to elliptic-oblong, abruptly narrowed at the short-acute or obtuse apex, obtuse at the base with the margin revolute and decurrent on the petiole, drying subcoriaceous, upper surfaces usually lustrous and often with the tertiary venation forming a raised reticulum, densely subsericeous beneath with slender straight appressed yellowish or brownish hairs 0.2–0.5 mm long and oriented parallel with the major veins, becoming glabrescent, with (5–)6–9(–11) major veins on each side, the central secondaries arising at angles of 40°–60°. **Inflorescences** axillary to distal leaves, 6–15 cm long, paniculate, peduncles 2.5–7 cm long, 1–3 mm thick, minutely puberulent with slender appressed yellowish brown hairs, flowers in short-stalked clusters, pedicels 1–3 mm long. **Flowers** 4–5 mm broad, densely and minutely puberulent on the outside, perianth-lobes 2.5–3 mm long, 2 mm broad; **outer stamens** with anthers ca. 1 mm long and 1 mm broad, the thecae superposed or the lower slightly lateral to the upper, filaments ca. 0.5 mm long, inner anthers narrow, staminodes absent; **pistil** ca. 2.5 mm long, glabrous, style to 1 mm long and slender, stigma discoid or simple. **Fruits** borne in an obconic cup ca. 12 mm long, 10–15 mm broad and 1–5 mm deep; berry 2–3.5 cm long, 1–2.5 cm in diameter, ellipsoid to ovoid, becoming purple.

Trees of higher montane wet evergreen forest formations, from 1700 to 3000 m elevation, ranging from the northern edge of the Meseta Central (near Palmira, Alajuela) through the central volcanic chain to the western part of the Cordillera de Talamanca (near Empalme and Sta. María de Dota, San José). Both flowers and fruits have been collected in May–June, August, and December–March. This species is endemic to central Costa Rica but has closely related taxa in the Cordillera de Tilarán and the Chiriquí highlands of Panama.

Ocotea austinii is characterized by its high-al-

titude habitat, small stiff oblong leaves with lustrous upper surfaces and reticulate tertiary venation, the decurrent and revolute lamina base, silky yellowish or orange brown pubescence on younger parts and young leaves beneath, and the small puberulent flowers. This species is very closely related to *O. whitei* which usually has oblanceolate leaves, and varies from densely sericeous to almost glabrous (see the discussion under *O. whitei*). *Ocotea austinii* appears to be part of a group of species including *O. sp. aff. caracasana*, *O. glaucosericea*, *O. whitei*, and *O. skutchii*. A Costa Rican name is *ira rosa*.

Ocotea babosa C. K. Allen, Mem. New York Bot. Gard. 15: 82. 1966, *sensu lato*. Figure 8.

Trees 15–35 m tall, to 1 m d.b.h., bark gray or marbled, leafy branchlets 2–6 mm thick, puberulent with crooked or straight brownish tomentulose hairs 0.2–0.5 mm long, soon becoming (sub)glabrous and grayish or black. Leaves alternate, petioles 8–22(–30) mm long, 1.5–2.3 mm thick, minutely puberulent or glabrescent, sulcate above; leaf blades 14–26 cm long, 8–12.5 cm broad, broadly elliptic to ovate-elliptic or slightly obovate, acute to short-acuminate at the apex, obtuse at the base, margin often somewhat undulate, drying stiffly chartaceous to subcoriaceous, minutely puberulent on the veins above but glabrescent between the veins, lustrous and somewhat bullate between major veins above, hirsutulous or tomentulose with spreading slender straight brownish hairs to 0.5 mm long beneath, with 4–7 major secondary veins on each side, central secondaries arising at angles of 35°–55° and loop-connected near the margin distally, secondary veins slightly impressed above and very prominent beneath, tertiary venation prominent beneath. Inflorescences axillary to distal leaves, 7–10 cm long and few-flowered, becoming 10–12 cm long in fruits. Flowers said to be 3.5–4.5 mm and campanulate, tepals ca. 2.5 mm long; outer stamens ca. 1 mm long and the outer anthers slightly longer than their filaments, staminodes absent; pistil ca. 2.5 mm long, ovary ellipsoid to obovoid, stigma papillate. Fruits borne on a campanulate-cylindrical pedicel gradually or abruptly expanded to the flat or saucer-like receptacle, 4–10 mm long and ca. 6 mm broad, only 1–2 mm deep, margin often 6-lobed with persisting perianth bases or entire, pedicel often with lenticels and verrucous; berry globose 7–10 mm in diameter (dried), dark green at maturity, drying black and lustrous.

Trees of lowland evergreen forest formations in Costa Rica. The species appears to flower in December–February in Costa Rica; fruits have been collected in April and June. This species is known from the La Selva area (Heredia) at about 100 m elevation and Pejibaye (Cartago) at 500 m, both on the Caribbean slope of Costa Rica. The species

(in a wide sense) ranges from Costa Rica to Venezuela.

Ocotea babosa is recognized by the distinctive leaves with prominent venation and distinctive pubescence beneath. The major veins are impressed above and often give a broadly bullate appearance to the upper surface. The small inflorescences and small globose fruits on slightly expanded receptacles, often with persisting perianth bases, also distinguish this species. Herbarium material resembles some species of *Persea*. In Costa Rica, this species is only known from the following fruiting collections: *Hammel & Trainer 10871*, *Hammel 11530*, and *McDowell 854* (all DUKE), from La Selva; and *Stork 2807* (F), from Pejibaye (Pejivalle). While it is not unusual for a species to have a lower altitudinal range in isthmian Central America than in continental South America, the difference in altitudinal range of the Costa Rican collections and those from northern South America (at 1800–2200 m) is greater than normally seen, and there are differences in fruit dimensions and upper leaf surfaces. Thus, C. K. Allen's name *O. babosa* (1966) may prove to be incorrect for our material. We are following Hammel's usage (1986).

Ocotea sp. aff. O. bijuga (Rottb.) Bernardi, Candollea 22: 59. 1967. *Nectandra bijuga* Rottboel, Pl. Surinam. Rar. 12. 1776. Figure 11.

Trees to 30 m tall and 70 cm d.b.h., trunks whitish to pale gray, leafy branchlets, 1.3–5 mm thick, minutely (0.1 mm) and sparsely appressed puberulent or glabrous, dark brown and longitudinally ridged, becoming terete and grayish. Leaves alternate, petioles 5–15 mm long, 1–2 mm broad, sparsely and minutely puberulent, flat or sulcate above; leaf blades 6–15 cm long, 1.5–5 cm broad, narrowly elliptic-obovate to oblanceolate or narrowly oblong, tapering to an obtuse or bluntly short-acuminate apex, tapering gradually to the acute or attenuate base and decurrent on the petiole, margin entire and often slightly revolute (especially near the base), drying stiffly chartaceous to subcoriaceous, glabrous and dull or slightly lustrous above when dry with the minor venation obscure, glabrous or very sparsely appressed-puberulent beneath, with 5–9 major secondary veins on each side, central secondaries arising at angles of 35°–50°. Inflorescences axillary to distal leaves or extra-axillary, 6–15 cm long, paniculate with short (2 cm) lateral branches, peduncle 2–5 cm long, ca. 1.3 mm thick, glabrous or minutely puberulent, drying dark, pedicels 0–2 mm long. Flowers 2–3 mm long, ca. 4 mm broad, very minutely appressed puberulent on the outside, tepals 1.2–1.7 mm long and ca. 1.2 mm broad, pellucid punctate; outer stamens with short (0.5 mm) puberulent filaments, outer anthers ca. 0.6 mm long and equally broad, thecae superposed, inner stamens 1.4 mm long with large (0.5

mm) glands, staminodes absent; **pistil** ca. 2 mm long, style narrow and equalling the length of the ovary, stigma simple or discoid. **Fruit** cup poorly developed, funnel-form in life (fide Hammel) but drying flat or saucer-shaped and about 5 mm broad, abruptly expanded above the slightly thickened (1.5 mm) pedicel, red; berry globose, 5–8 mm in diameter when dry (to 12 mm in life), green to greenish purple.

Trees of ridge tops in primary evergreen lowland Caribbean rain forest in Costa Rica. Flowering is in October, and fruiting material has been collected in February and April. Costa Rican material is only known from La Selva. The species with which our material is provisionally placed occurs in Colombia, Venezuela, and Brazil (see below).

Ocotea sp. aff. *O. bijuga* is recognized by its glabrous narrowly elliptic to oblanceolate leaves with decurrent leaf base and the small globose fruits borne on a small flat or slightly concave receptacle. The leaves tend to dry a dark olive green above and brownish beneath. The association of this material with Bernardi's concept of *O. bijuga*, including *O. florulenta* (Meissner) Mez, should be considered tentative. Rohwer (pers. comm.) believes that *O. bijuga* is part of the *Ocotea cernua* complex. Also, *Ocotea bijuga* is said to be dioecious, while ours appear to have bisexual flowers; this also suggests that *O. bijuga* may not be closely related to the Costa Rican material placed here. The form and texture of the leaves are very similar to Costa Rican material of *O. oblonga* and the westernmost populations of *O. whitei* (at Monteverde), but those species have very different fruits, and prefer higher-elevation habitats. At present this taxon is known from only five collections in Costa Rica: *Folsom 9112* (DUKE); *Hammel 10229* (DUKE), *11663* (F, DUKE); *Hartshorn 1585* (F, CR); and *Ocampo 3646* (CR).

Ocotea brenesii Standl., Field Mus. Nat. Hist., Bot. Ser. 18: 454. 1937. *Nectandra brenesii* (Standl.) C. K. Allen, J. Arnold Arbor. 26: 370. 1945. Figure 13.

Small to large trees, 6–28 m tall, trunks to 2 m broad at the base, leafy branchlets 1–3.5 mm thick, appressed puberulent at first with minute (0.2 mm) straight yellowish hairs, quickly becoming (sub)glabrous and dark in color, terete. **Leaves** alternate, petioles 6–13 mm long, ca. 1 mm thick, minutely appressed puberulent or glabrescent, with a narrow adaxial sulcus; **leaf blades** 6–12(–15) cm long, 2.5–6(–8) cm broad, ovate to ovate-elliptic or broadly elliptic to ovate-oblong, short-acuminate to long-acuminate at the apex, acute to obtuse or rounded at the base, drying thin chartaceous and very

dark in color, often lustrous above, appressed puberulent on both surfaces but glabrescent with the minute (0.1–0.3 mm) thin straight hairs persisting on the larger veins, with 3–5 major secondaries on each side, central secondaries arising at angles of 35°–60°. **Inflorescences** axillary to distal leaves, to 10 cm long, flowers few in an open racemose panicle, peduncles to 5 cm long and 0.5 mm thick (dry), puberulent with straight appressed ascending hairs, pedicels ca. 3 mm long. **Flowers** 3–5 mm long, 5–10 mm broad, yellowish or white, perianth glabrous or papillate-puberulent on the outer surfaces, tepals ca. 2 mm broad, glabrous within; outer **stamens** subsessile or on short (0.3–0.4 mm) filaments, outer anthers ca. 1 mm long, ovate with superposed thecae, the connective slightly developed beyond the theca, inner stamens with narrowly oblong anthers, staminodes absent, the floral tube with straight lustrous hairs; **pistil** 1.5–1.7 mm long, glabrous, ovary ovoid or angular, style ca. 0.8 mm long, stigma slightly discoid. **Fruits** borne on fruiting receptacles gradually expanded from the thickened pedicel and conic, ca. 10 mm long and 8 mm broad; berry poorly known, apparently to 24 mm long and 16 mm in diameter, ovoid-oblong (based on *A. Smith 517, 4102*, F).

Trees of evergreen montane forest formations, between 900 and 2000 m elevation in central Costa Rica. Flowering collections have been made in February–May; mature fruits were collected in April. This species is endemic and known only from the northern region of the central highlands, from near the Reserva Forestal de San Ramón to the area between Poás and Barva (Barba) volcanoes in Alajuela Province.

Ocotea brenesii is distinguished by its relatively broad leaves with few secondary veins that dry thin in texture and very dark in color, rather large flowers on open racemose panicles, and its restricted habitat. It resembles *O. tenera* but that species is glabrous in all its parts, has smaller flowers, and narrower leaves. *Ocotea brenesii* resembles the type of *Ocotea pittieri* (Tonduz 11893, US); see the discussion under that species. *Ocotea holdridgeana* with larger flowers and stiffer leaves may also be related to *O. brenesii*.

Ocotea brenesii has been placed into synonymy under *O. heydeana* (Mez & J. D. Smith) Bernardi, by Bernardi (1967, p. 93) and by Rohwer (1986, p. 63). Collections of *O. heydeana* in having stiffly chartaceous leaves that usually turn olive green when dried, and possess four to six pairs of major secondary veins; also flowers and floral parts are larger than in *O. brenesii*. Nevertheless, these species are closely related. *Ocotea heydeana* (often referred to as *Nectandra heydeana*) ranges from Honduras to Chiapas at elevations of 700 to 1600 m.

Ocotea calophylla Mez, Jahrb. Königl. Bot. Gart. Berlin 5: 298. 1889. *Pleurothyrium velutinum* Meissn. in DC., Prodr. 15, pt. 1: 170. 1864, not *O. velutina* Martius. *O. fulvescens* Standl. & L. O. Williams, Ceiba 1: 237. 1951. Figure 5.

Trees to 20 m tall, leafy branchlets 5–12 mm thick, densely sericeous with reddish brown hairs in early stages but the hairs becoming dark gray and matted. Leaves alternate and sessile, petioles short (0–10 mm) and poorly differentiated from the cuneate lamina base; leaf blades 10–19 cm long, 4–6 cm broad, narrowly elliptic to elliptic-oblong, obtuse at the apex, attenuate at the base with the margin revolute but not decurrent on the stem, drying subcoriaceous, densely and minutely appressed puberulent above but becoming dull grayish and the pubescence obscure, very densely and conspicuously sericeous beneath with lustrous reddish brown or silvery brown appressed ascending hairs, with 10–13 major secondary veins on each side, the central secondaries arising at angles of 40°–70°, tertiary venation obscure. Inflorescences to 25 cm long, axillary to distal leaves, flowers crowded in a compact panicle with lateral branches ca. 3 cm long, peduncles about half the length of the inflorescence (4–12 cm) and 4–5 mm thick, reddish brown puberulent. Flowers 4–7 mm long and 6–10 mm broad, densely puberulent or tomentulose on the outside, outer tepals ca. 4 mm long and 3 mm broad; outer anthers 1.6–1.8 mm long on slender glabrous filaments of nearly equal length, thecae superposed but the upper introrse and the lower latrorse (in the outer series), staminodes present and small; pistil slender, to 4.5 mm long, style 1–3 mm long. Fruit cups ca. 1 cm broad and 3 mm deep (immature?); berry ca. 20 mm long and 17 mm in diameter, globose-ellipsoid.

Trees of wet evergreen montane forest formations, between 2600 and 3000 m elevation. Flowers have been collected in January–February, and fruiting inflorescences have been collected in September in Costa Rica. This species is also known from Colombia and Venezuela at elevations from 2000 to 3100 m.

Ocotea calophylla is one of Costa Rica's most distinctive species of *Ocotea*; the thick leaves with dense lustrous pubescence beneath are unique among Costa Rica's Lauraceae, and resemble some Sapotaceae. The sessile leaves with revolute lamina base, thick stems, reddish brown inflorescence, and high montane habitat further distinguish this species. We have only seen the following collections: *Lems 5352* (F, NY); *León 2166* (CR, US, the type of *O. fulvescens*); and *Madriz 12* (CR, F). The local names are reported as *ira zoncho* and *yema huevo*. Many South American specimens of this species have dull reddish pubescence, but some do have the lustrous hairs that makes our Costa Rican material so striking. The leaves of this species are folded in an unusual way in bud, leaving a

diagonal line across the upper left of the lamina and a short line on the right side near the base (viewing the lamina undersurface with the apex up and the base down). *Ocotea guianensis* Aublet of lowland formations in South America has similar lustrous pubescence, and the same pattern of folding in leaf veneration, and must be related. Closely related Andean species are *O. micans* Mez and *O. sericea* H.B.K.

Ocotea sp. aff. *caracasana* (Nees) Mez, Jahrb. Königl. Bot. Gart. Berlin 5: 292. 1889. *Oreodaphne caracasana* Nees, Linnaea 21: 522. 1849. Figure 10.

Trees to 30 m tall and 60 cm d.b.h., occasionally with prop roots from near the base, dioecious or apparently bisexual in ours, leafy branchlets 2.5–8 mm thick, appressed puberulent with minute (0.1–0.4 mm) slender ascending pale yellowish to golden hairs, often with longitudinal ridges but becoming terete and grayish. Leaves alternate, petioles 0–15 mm long but poorly defined, with lateral margins continuous with the decurrent lamina base, minutely appressed puberulent, narrowed portion of the lamina base 1–4 cm long; leaf blades 12–20(–24) cm long, 4.5–8(–11) cm broad, elliptic-obovate to obovate, oblong-obovate or oblanceolate, abruptly narrowed or rounded to a short-acuminate or obtuse apex tapering gradually to the cuneate and decurrent base, margin usually revolute near the base, drying subcoriaceous to coriaceous, glabrous above or minutely appressed puberulent on the flat or impressed midvein near the base, usually dull above and slightly glaucous beneath, minutely and often obscurely puberulent beneath with thin straight appressed yellowish hairs 0.1–0.3 mm long and usually parallel with the secondary veins or glabrescent, with (6–)7–12 major secondary veins on each side, central secondaries arising at angles of 35°–50°, tertiary venation subparallel and slightly raised beneath. Inflorescences axillary to distal leaves or distal leafless nodes, 7–12 cm long, panicles broadly paniculate, many-flowered, peduncles 2–8 cm long, 2–3 mm thick, densely puberulent and silvery to reddish brown in color, pedicels 0–4 mm long. Flowers 3.5–5 mm long, 4–6 mm broad, campanulate, densely puberulent on the outside, tepals 1.5–2.8 mm long, 1.3–2.3 mm broad; outer stamens on short (0.4 mm) broad glabrous filaments, outer anthers 0.5–1 mm long, usually narrower than long, thecae superposed but occasionally quite variable, inner stamens 1.3–2 mm long, often with large glands, staminodes to 1.1 mm long and variable or absent; pistil 1.6–2.5 mm long, the slender style 1–1.5 mm long, stigma discoid or simple. Fruits borne in a large hemispherical cup 18–28 mm broad and 8–15 mm deep, margin often with teethlike projections from the persisting perianth; berry 3–4 cm long and 2–2.5 cm in diameter, ovoid.

Trees of evergreen rain forest formations in the Caribbean lowlands of Costa Rica. Flowers and fruits were both collected in May. This taxon may

be endemic to Costa Rica if it proves to be different from true *O. caracasana*, which occurs in Colombia, Venezuela, and the Guianas.

Ocotea sp. aff. *caracasana* is recognized by the larger slightly obovate leaves, abruptly short-acuminate at the apex and decurrent and revolute at the base. The large fruits and the stiff leaves with characteristic appressed hairs are also helpful in recognizing this species and its relatives. The puberulent flowers were described as unisexual but the Costa Rican material appears to be bisexual. Our material is derived from only a single tree at La Selva (Hammel p. 225, 1986: *Hammel 12450*, DUKE, F). The Hammel collection differs from the type photo (Karsten 32, F) in its lack of the elongate racemiform inflorescences, its secondary veins arising at a narrower angle, and its revolute lamina base being not as long. But there are also many similarities between the Costa Rican material and the type collection. This species, whatever its final name, is related to *O. glaucosericea* and *O. skutchii* of Costa Rica's highland forests; see the discussions under those species. While the foliage of these species resembles that of *O. insularis* and its allies, the fruits, parallel-appressed hairs, and prop roots indicate that they may not be closely related.

***Ocotea cernua* (Nees) Mez, Jahrb. Königl. Bot. Gart. Berlin 5: 377. 1889. *Oreodaphne cernua* Nees, Syst. laur. 424. 1836. Figure 14.**

Shrubs or small to medium-sized trees 5–10(–20) m tall, dioecious (unisexual), leafy branchlets 1.2–3 mm thick, apical buds slightly puberulent but stems essentially glabrous, terete or slightly ridged. **Leaves** alternate, approximate but not congested distally, petioles 6–20 mm long, ca. 1 mm thick, glabrous and with a shallow adaxial sulcus; **leaf blades** 6–14(–18) cm long, 3–6(–8) cm broad, oblong to elliptic-oblong, caudate acuminate or short- to long-acuminate at the apex, often with a narrow (ca. 3 mm) tip to 2 cm long, acute to obtuse at the base, margin often undulate, drying chartaceous to stiffly chartaceous, grayish and glabrous above, glabrous or sparsely puberulent along the major veins beneath, the primary veins flat above, with 3–6 major secondary veins on each side, central secondaries arising at angles of 30°–70°. **Inflorescences** axillary or extra-axillary on distal twigs (sometimes pseudoterminal and stemlike), 3.5–15 cm long, paniculate and usually with racemose lateral branches or small and raceme-like, glabrous or with very few appressed hairs, often drying very dark (both flowers and inflorescence), peduncle to 5 cm long, ca. 0.5 mm thick, pedicels 1–4 mm long, slender. **Flowers** unisexual, drying dark, glabrous on the exterior; male flowers ca. 2.2 mm long and 3–4 mm broad, campanulate, tepals 1.2–1.8 mm long, outer anthers 0.6–0.8 mm long, slightly narrower than long, subsessile, thecae superposed, a pistilode present or absent; **female flowers**

ca. 2.5 mm long and urceolate, with a deep tube, tepals 1–1.8 mm long and minutely papillate near the tips, nonfunctional anthers ca. 0.5 mm long, pistil ca. 1.5 mm long, stigma subsessile on the narrow apex of the ovary. **Fruits** borne in a cup 6–8 mm long and 9–12 mm broad, 4–5 mm deep, margin entire, thickened part of the pedicel 5–10 mm long, becoming red and enclosing the lower ½ of the fruits; berry 1.5–2 cm long, ovoid, becoming black (rare in herbaria).

Small trees of lowland evergreen forest formations on both the Caribbean and southern Pacific slopes, below 900 m elevation in Costa Rica. Flowering occurs in February–May, and fruits have been collected in August–November in Costa Rica. The species ranges from southern Mexico and the West Indies through Central America to South America.

Ocotea cernua is distinguished by its elliptic-oblong leaves that nearly always dry grayish or yellowish and often have a caudate-acuminate apex, and the slender inflorescences that are racemiform or open panicles with racemose lateral branches. The lack of puberulence on almost all parts, the ebracteate inflorescences, and the small unisexual flowers that usually dry black are additional features of this unusual species. *Ocotea cernua*, *O. meziana*, and *O. tenera* are very similar in the field but differ in their dried appearance (cf. Hammel, 1986). *Licaria cufodontisii* and *L. sarapiquensis* are also similar to *O. cernua*, especially in the appearance of leafy twigs and inflorescences.

***Ocotea dendrodaphne* Mez, Jahrb. Königl. Bot. Gart. Berlin 5: 238. 1889. *O. quisara* Mez & J. D. Smith, Bot. Gaz. 33: 259. 1902. *O. ovan-densis* Lundell, Contr. Univ. Mich. Herb. 6: 16. 1941. Figure 3.**

Shrubs or small treelets to 6 m tall, leafy branchlets 3–7 mm thick, minutely (0.1–0.3 mm) appressed puberulent with straight ascending hairs in early stages, soon becoming glabrous and pale gray, lenticellate and ridged but becoming terete in age, distal stems hollow and often with small ants. **Leaves** alternate, petioles 6–36 mm long, 1.5–3 mm thick, sulcate above, drying dark in color; **leaf blades** 14–36 cm long, 5–14 cm broad, elliptic to narrowly elliptic-oblong, widest at or slightly below the middle, acute or short to long acuminate at the apex (occasionally rounded/obtuse), acute to obtuse at the base, drying very stiffly chartaceous to subcoriaceous and grayish green, glabrous and slightly lustrous on both surfaces, with 5–10 major secondary veins on each side, the central secondaries arising at angles of 40°–70° tertiary venation slightly raised and reticulate beneath. **Inflorescences** to 15 cm long, borne close together at the branchlet tips in the axils of what appear to be leaf scars (perhaps early caducous leaf scales), paniculate

in form with basal branches larger than the distal, primary peduncle to 5 cm long, very minutely puberulent in early stages. **Flowers** 4–6 mm long, to 8 mm broad, white and sweet-scented, tepals to 5 mm long, densely and minutely papillate-puberulent; outer **anthers** 2–3 mm long, broadly flattened and somewhat tepal-like, ovate-triangular to lanceolate in outline with the thecae often on the basal half of the inner face, minutely puberulent, filaments very short (0.5 mm) and stout, staminodes not seen; **pistil** 1.9–2.4 mm long, style 1.1–1.5 mm long, slender, stigma slightly discoid. **Fruit** cups 8–10 mm long, ca. 15 mm broad and 3–7 mm deep, enclosing the basal ¼ of the fruits, conical to cupulate in form, often with a second ridge around the rim; berry 15–25 mm long, 10–12 mm thick, bluntly rounded at the apex, narrowly ovoid to oblong, black at maturity.

Understory plants of wet evergreen forest formations, between sea level and 1500 m elevation, along the Caribbean slopes and in the central highlands. Flowering collections have been made in January–June, October, and December; fruiting occurs throughout the year, but most collections have been made in July–October in Costa Rica. The species ranges from central Mexico to central Panama.

Ocotea dendrodaphne is recognized by its hollow stems often inhabited by ants, the large glabrous elliptic-oblong leaves that dry very stiff and gray-green, the large flowers with tepaloid stamens, and distinctive deep cups. This species is often found on slopes and ridges. Two unusual features of this species are the way in which the inflorescences originate from leafless nodes, and the frequently inflated distal branchlet-tips with longitudinal slitlike openings into the hollow stems. The latter are associated with ants. The large flowers with broadly flattened outer stamens and the fruit cups with ridged rims (resembling *Licaria*, but not always developed) indicate a relationship with *O. veraguensis*. However, specimens may be more easily confused with *O. paulii* and its allies, which also have hollow stems, similar leaves, and are treelets of wet forest understory.

Ocotea dentata van der Werff, sp. nov. Figure 20

Arbor ad 25 m. Ramuli juniores angulares, adpresse pubescentes, vetustiores teretes glabrescentesque. Folia obovata, 20–35 × 8–12 cm, apice rotundata vel breviter acuminata, basi decurrente et reflexa, supra praeter costam nervosque leviter pubescentes laevia glabraque, subtus sparse pubescentia, pilis brevibus et plerumque erectis; costa, nervis elevata, venatione reticulata et parum elevata; nervis 9–12. Petioli sulcati, 0.5–1.5 cm longi. Inflorescentiae pubescentes, in axillis foliorum vel bracteatum deciduarum, foliis breviores vel aequales, ram-

ificatione divaricata. Flores fragrantis, hermaphroditis; tepala magnitudine aequalia, ca. 1.5 mm longa, ovata, omnia intus glabra, 3 exterioribus extus dense puberulis sed 3 interioribus minus puberulis; stamina 9, 4-locellata, 6 exterioribus ca. 1.1 mm longis, antheris glabris, ca. 0.6 mm longis, thecis introrsis, filamentis ca. 0.5 mm longis, prope apicem pilis minutis munitis; 3 interioribus ca. 1.2 mm longis, antheris glabris, thecis inferioribus extrorsis, thecis superioribus lateralibus, filamentis ca. 0.5 mm longis, 2 glandulis munitis; pagina interiore filamentorum prope apicem pubescentia densa munita; staminodia nulla. Ovarium ovoideum, glabrum, in sicco 0.5 mm longum, stylo ca. 1 mm longo, glabro. Fructus viridis, ellipsoideus, 10 × 6 mm; cupula tepalis persistentibus munita.

Trees to 25 m tall, leafy branchlets 2.5–8 mm thick, angular when young but becoming terete, at first appressed puberulent but glabrescent in age. **Leaves** alternate, petioles difficult to delimit because of the decurrent lamina-base, 5–15 mm long, 2.5–7 mm broad and sulcate above; **leaf blade** (15–)20–35 cm long, (5–)8–12 cm broad, obovate to elliptic-obovate or elliptic-oblong, usually broadest at or above the middle, abruptly narrowed and often rounded at the obtuse to short-acuminate apex, tapering to the cuneate and decurrent base, margin somewhat revolute near the base and decurrent on the petiole, drying stiffly chartaceous to subcoriaceous, glabrous above or with some hairs above the major veins, lower surface usually sparsely puberulent with erect or spreading hairs 0.2–0.5 mm long, with 9–12 major secondary veins on each side, central secondaries arising at angles of 30°–50°. **Inflorescences** axillary to distal leaves or deciduous bracts, solitary, 12–25 cm long, robust and many-flowered panicles, peduncle 3–12 cm long, 1.7–3.5 mm thick and with grayish or brownish puberulence, pedicels to 2 mm long, flowers in cymose groups. **Flowers** 3–5 mm long and 4–5 mm broad, yellowish green, tepals 1.5–2.5 mm long, subequal, outer tepals densely puberulent on the outer surfaces, glabrous within; outer **stamens** with short (0.2–0.4 mm) filaments, outer anthers 0.5–0.8 mm long and equally broad or narrower, thecae superposed or the lower slightly lateral, inner stamens 1.2–1.4 mm long, with a tuft of hairs below the anthers, staminodes absent; **pistil** 1.5–2.6 mm long, ovary ovoid, style 1–1.5 mm long, slender, stigma slightly discoid. **Fruits** borne on a short (8–10 mm) cupulate receptacle 5–12 mm broad, the margin usually with persisting perianth bases; berry ellipsoid or oblong, 10 mm long and 6 mm in diameter (in the type) but perhaps becoming 3 cm long and 2 cm in diameter.

TYPE—Costa Rica, Prov. Limón, Reserva Biológica Hitoy Cerere, 100–125 m, 29 Aug. 1985, *L. D. Gómez & G. Herrera* 23653 (holotype, MO; isotypes, CR, F). **Additional Collections**: Nicaragua, Dept. Matagalpa, *Neill 1715*, *Stevens & Riviera 20899*, Dept. Zelaya, *Araquistain 3165*, *Grijalva 264*, *Stevens 8005*, *12444* (all MO); Costa Rica, Prov. Alajuela, *Haber 5557*, *6178* (MO); *Hartshorn 1543* (CR, F); Panama Prov. Bocas del Toro, *Lao 94*, *von Wedel 720*, *1382* (all MO).

Trees of evergreen rain forest formations, from near sea level to 1000 m elevation. Flowers have been collected in August and October–December; young fruits have been collected in February, mature fruits in March. This species ranges along the Caribbean slope and lowlands, from Nicaragua to Panama, and in the evergreen forests of the southern Pacific slope in Costa Rica.

Ocotea dentata is recognized by the larger stiff puberulent obovate leaves with decurrent and revolute leaf bases, and the fruit cups often with persisting perianth parts. This species is closely related to *O. insularis* (in a wide sense). The pubescence helps separate this species from *O. insularis*, *O. ira*, and *O. rivularis*. The dense pubescence of the flowers, and the cupules with persistent tepals (hence the dentate appearance and specific name) are also distinctive. Earlier, some of the material placed here was identified as *O. stenoneura*. Unfortunately, *Ocotea stenoneura* is very poorly understood at present, but it has very different fruits (q.v.). Additional material was used to amplify the English description beyond the measurements cited for the type in the Latin description.

***Ocotea endresiana* Mez, Jahrb. Königl. Bot. Gart. Berlin 5: 257. 1889. Figure 10.**

Trees to 25 m tall, leafy branchlets 2–6 mm thick, glabrous or minutely appressed puberulent at first, with prominent ridges but soon becoming terete, dark brown to dark gray. Leaves alternate, petioles poorly defined or absent, narrowed portion of the lamina base 0–2(–3) cm long, flat above, with strongly revolute margins; leaf blades 6–17 cm long, 3–9 cm broad (25 × 18 cm in sprout shoots), obovate to elliptic-obovate, obtuse to abruptly rounded at the apex, tapering gradually to the decurrent base, revolute with the margin curled under near the base, drying subcoriaceous or coriaceous, glabrous and often lustrous above, glabrous or minutely (0.1–0.2 mm) puberulent beneath, rarely with longer tufts of hairs (domatia) in the vein axils and along the midvein beneath, with 5–9 major secondary veins on each side, central secondaries arising at angles of 40°–60°, tertiary venation slightly raised on both surfaces but usually obscure, often subparallel between the secondaries, major veins often reddish in early stages. Inflorescences axillary to distal leaves or apparently terminal, to 17 cm long, broadly paniculate but few-branched, peduncle to 6 cm long, 2–3 mm thick, glabrous and drying dark brown to black, pedicels ca. 2 mm long. Flowers 2.5–5 mm long, 3–6 mm broad, yellowish, glabrous to densely and minutely puberulent on the outer surfaces, minutely papillate-puberulent within, tepals ca. 2.5 mm long; outer stamens with short (0.5 mm) filaments, outer anthers 0.5–0.8(–1.1) mm long and equally broad or narrower,

staminodes absent (rarely present?); pistil 1.5–2 mm long, style narrow and usually equalling the ovary in length, stigma simple or discoid. Fruits borne in cupulate receptacles 8–15 mm long and 7–10 mm broad, rim entire and the surfaces smooth, becoming red; berry 15–18 mm long, 8–10 mm thick (dried), oblong-ellipsoid or elliptic-cylindrical.

Trees of montane evergreen forest formations, between (700) 1100 and 2300 m elevation, along the Caribbean slope and continental divide. Flowering material has been collected in August–October and February; mature fruits have been collected in February–March and June. The species ranges from the Cordillera de Tilarán (Monteverde area), along the northern and eastern edge of the central highlands, to the area of Cartago and Volcán Turrialba. This taxon of doubtful status is endemic to Costa Rica and adjacent Panama (see below).

Ocotea endresiana is recognized by the stiff bluntly obovate leaves, with decurrent leaf bases which have broadly revolute margins on the underside of a poorly defined petiole/leaf base. The long narrow fruits in smooth entire-rimmed cups only 1 cm broad also distinguishes this species. It appears to be common only north of San Ramón and near Vara Blanca de Sarapiquí. The very restricted range is an argument for considering these plants no more than a subspecific element of *O. insularis* in a wide sense. However, the leaf bases are very distinctive, as are the fruiting stages. See the discussion under *O. insularis*. *Ocotea endresiana* has sometimes been confused with *O. skutchii*, which also has long-decurrent leaf bases but different flowers, and a characteristically fine indumentum on the undersides of the leaves. We have not seen the type and are following earlier usage in the application of this name.

***Ocotea floribunda* (Sw.) Mez, Jahrb. Königl. Bot. Gart. Berlin 5: 325. 1889. *Laurus floribunda* Sw., Prodr. 65. 1788. *O. wachenheimii* Benoist, Bull. Mus. Hist. Nat. Paris 30: 510. 1924. Figures 14.**

Trees 15–30 m tall, trunk 30–80 cm in diameter, dioecious (unisexual), leafy branchlets 1.5–5 mm thick, very minutely (0.1 mm) puberulent with inconspicuous hairs near the apex but quickly becoming glabrous and dark in color, smooth and terete. Leaves alternate or subopposite, petioles 4–14 mm long, 0.8–1.9 mm thick, glabrous and flat above, drying dark in color; leaf blades 7–15(–19) cm long, 2–6(–8) cm broad, elliptic to oblong-obovate, narrowly obovate or obovate, usually broadest

above the middle, acute to short-acuminate (rarely rounded) at the apex, acute to cuneate at the base and slightly decurrent on the petiole, margin entire and slightly recurved when dry, drying stiffly chartaceous to subcoriaceous and pale to dark grayish green, essentially glabrous above and below, with (3-)5-8 major secondary veins on each side, with a few weakly defined loop-connections near the margin, central secondaries arising at angles of 40°-60°, the larger veins often drying reddish brown, the smallest veins usually forming a fine (0.1-0.6 mm) reticulum usually visible on both surfaces but more prominent beneath. **Inflorescences** axillary, extra-axillary or pseudoterminal, 3-14 cm long, racemose or paniculate, few to many-flowered, peduncle 1-4 cm long, glabrous or very minutely puberulent, drying dark, pedicels 1-3 mm long, ca. 0.8 mm thick. **Flowers** functionally unisexual, 5-7 mm broad, greenish to cream-white, outer tepals broadly imbricate, 2-3(-4) mm long and 2-3 mm broad, minutely puberulent on both surfaces, becoming reflexed; **male flowers** with stamens on prominent (0.9 mm) filaments, anthers ca. 1.3 mm long and 1.2 mm broad, the lower thecae slightly lateral to the upper, inner stamens ca. 2 mm long, staminodia absent, pistillode ca. 3 mm long; **female flowers** with the outer stamens on short (0.2 mm) filaments and with smaller (0.7 mm) anthers, pistil ca. 3 mm long, ovary ovoid and equalling the style in length, stigma discoid. **Fruits** borne a flat disclike receptacle 6-10 mm in diameter and 1.5-2 mm thick, often slightly recurved, margin rounded in life (fide Hammel) but with upper and lower ridges when dry, sometimes with the bases of persisting floral parts, green; berry subglobose, 13-18 mm long and 10-15 mm in diameter, green and glaucous at maturity, usually with short (1 mm) persisting style base at the apex of the fruits.

Trees of wet evergreen forest formations, from near sea level to 1500 m elevation. In Costa Rica, flowers have been collected in October and December-February. Young fruits have been collected in June, and mature fruits in August-November and March (near Panama). The species has been collected in the Caribbean lowlands (La Selva), near Turrialba, at Monteverde, and on the Pacific slope near Panama at 1300 m elevation. It has not been collected on the Pacific slope below 1200 m in Costa Rica. The species ranges from Nicaragua southward to Peru, Venezuela, the Guianas, and the West Indies.

Ocotea floribunda is recognized by its very dark (almost black) stems, stiff leaves drying grayish green and with a finely reticulated surface, unisexual flowers, globose fruits with persisting style base, and the flattened fruiting receptacle with ridged edge. Herbarium material of this species resembles *O. meziana*, *O. veraguensis*, and some species of *Licaria*. This species appears to be uncommon and has been collected in Costa Rica only recently. Costa Rican material differs from the West Indian collections in a number of ways and may prove to be worthy of subspecific recognition. There

is an unusual population in the southern part of the Cordillera de Talamanca, where the base of the lamina is both decurrent and revolute (*Davidse 24359*, CR, MO; *Hartshorn 2165*, Lent 2705 CR, F); flowers of the Davidse collection make the placement of these collections under *O. floribunda* quite certain.

Ocotea glaucosericea Rohwer, Mitt. Inst. Allg. Bot. Hamburg 20: 144. 1986, *nomen novum* for *Nectandra hypoglauca* Standl. ex C. K. Allen, J. Arnold Arbor. 26: 399. 1945, not *O. hypoglauca* (Nees) Mez. Figure 12.

Trees to over 30 m tall, leafy branchlets 3-8 mm thick, densely and minutely (0.2 mm) puberulent with ascending or appressed hairs, yellowish brown to grayish brown, longitudinally ridged. **Leaves** alternate in a spiral, petioles poorly defined and continuous with the decurrent lamina base, 1-3 cm long, with broad revolute lateral margins; **leaf blades** 9-17 cm long, 4-10 cm broad, obovate to narrowly obovate, elliptic-obovate or oblong-obovate, abruptly rounded at the apex or obtuse (bluntly acute in narrow leaves), tapering gradually to the cuneate and decurrent base, margin entire and usually revolute at the base, drying subcoriaceous and lustrous above with the minor venation slightly raised, glabrous except on the midvein basally, paler in color beneath and with minute (0.1-0.2 mm) slender appressed hairs usually lying parallel with the secondary veins, with (5-)6-9 major secondary veins on each side, the central secondaries arising at angles of 30°-50°. **Inflorescences** axillary to distal leaves, 8-18 cm long, paniculate, peduncles 3-9 cm long, densely appressed puberulent and yellowish, pedicels 2-4 mm long. **Flowers** ca. 4 mm long, 4-6 mm broad, densely grayish or yellowish brown puberulent on the outside, tepals ca. 2.8 mm long and 2.2 mm broad; **outer stamens** 1-1.5 mm long with short (0.2-0.6 mm) broad filaments, outer anthers 0.9-1 mm long and 0.7-0.8 mm broad, the thecae superposed or the lower somewhat lateral to the upper, staminodes absent or small (to 0.6 mm); **pistil** ca. 3 mm long, ovary ellipsoid, style ca. 1 mm long, stigma capitate. **Fruits** borne in a conical receptacle about 2 cm long, 1.2-1.8 cm broad and ca. 5 mm deep; berry 2.5-3 cm long, 2-2.5 cm in diameter, globose or oblong.

Trees of evergreen montane forest formations, from 1500 to 2500 m elevation. Flowering material has been collected in April-May and July; fruits have been collected in March-June. The species is endemic to the Cordillera de Talamanca in Costa Rica (El Cedral de Sta. Maria de Dota, La Cangreja, and Las Tablas near the Río Cotoncito), and appears to be common in the Chiriquí highlands of Panama.

Ocotea glaucosericea is recognized by its stiff obovate leaves, lustrous on the upper surface and decurrent and revolute at the base. The highland

habitat, upper leaf surface, and smaller fruits on shallower receptacles distinguish this species from *O. sp. aff. caracasana*, with which this species has been considered synonymous by Hammel (1986). This species is also closely related to *O. skutchii*, and there are collections that appear to be intermediate between them. *Ocotea austinii* and *O. whitei* are also part of this complex. All these taxa appear to be part of a closely related species group, united by characters of the flowers, large fruits, leaf form, and the slender appressed hairs on the lower leaf surfaces. These species resemble *O. insularis* and its allies, but those differ in pubescence and fruits, and are not as closely related.

***Ocotea gomezii* W. Burger, sp. nov. Figure 6.**

Arbor 10 m alta, ramulis foliiferis 3–6 mm crassis, ferrugineo-tomentosis. Folia alterna, petiolis 12–26 mm longis, tomentosis; laminis 10–18(–24) cm longis, 6–11(–14.5) cm latis, late ellipticis vel suborbicularibus, apice obtuso vel breviter acuminato, subtus ferrugineo puberulis, nervis secundariis 5–8(–10) paribus. Inflorescentiae 10–18 cm longae, paniculatae, floribus paucis, pedunculis 6–13 cm longis, tomentosis. Flores ca. 10 mm longi et 12 mm lati, tepalis ca. 6 mm longis, puberulis; stamina ser. I–II ca. 3 mm longa, antheris ca. 1.6 mm longis; gynoecium 2.5–3.7 mm longum. Fructus ignotus; cupula 15–20 mm longa et 15–20 mm lata, margine lobata.

Trees 6–10 m tall, leafy branchlets 3–6 mm thick and densely ferruginous-tomentulose with soft curved and straight hairs ca. 0.5 mm long, remaining tomentulose but becoming grayish. Leaves alternate and not crowded distally, petioles 12–26 mm long, 2.5–3.5 mm thick, densely tomentulose; leaf blades 10–18(–24) cm long, 6–11(–14.5) cm broad, broadly elliptic to suborbicular, usually broadest near the middle and rarely somewhat ovate or obovate, bluntly obtuse to short-acuminate with a tip to 15 mm long, obtuse to rounded and subtruncate at the base, drying stiffly chartaceous and dark brown to olive green, slightly lustrous above and minutely puberulent above the major veins, densely tomentulose beneath with ferruginous or yellowish brown hairs ca. 0.7 mm long, with 5–8(–10) major secondary veins on each side, central secondaries arising at angles of 45°–60°, major veins very prominent beneath and forming an arcuate submarginal vein distally, tertiary venation also slightly raised. Inflorescences few-branched panicles in axils of distal leaves or pseudoterminal, 10–18 cm long, peduncles 6–13 cm long, 1.7–3 mm thick, densely ferruginous puberulent, flowers borne in groups of 1–3 on short (1 cm) lateral branches subtended by a bract 5–6 mm long. Flowers ca. 10 mm long and 12 mm broad, campanulate, yellowish white, densely puberulent on the outside and papillate-puberulent within, tepals to 6 mm long and 3 mm wide with the inner series smaller than the outer; outer stamens to 3 mm long, outer anthers ca. 1.6 mm long and 1 mm broad, oblong, valves superposed, filaments with long trichomes, inner stamens with large

glands abaxially, staminodes absent; pistil 2.5–3.7 mm long, ovary narrowed to the base, style ca. 2 mm long, slender, stigma slightly lobed. Fruits borne in a conical cup 15–20 mm long and 15–20 mm broad, the cup surface densely hirsutulous, the perianth parts persisting and forming large (3–5 mm) lobes on the margin of the cup; young berry with hairs over the basal surface, mature berry not seen.

TYPE—Costa Rica, Alajuela Province, valley of the Río Lorencito in the Reserva Forestal de San Ramón, 14 March 1987. *Gómez-Laurito, Burger, Mora, Ortiz & Antonio 11450* (holotype, CR; isotypes, CAS, F, DUKE, HBG, MO, NY, USJ).

Trees of very moist cloud forest and premontane rain forest formations of the Caribbean slope and continental divide, from 800 to 1400 m elevation. Flowers have been collected in January–April and July. Fruits have been reported in August and January. The species is endemic to Costa Rica, and ranges from near Volcán Rincón de la Vieja in the west to Moravia de Chirripó in the east, and probably further eastward along the Caribbean slope of the Cordillera de Talamanca.

Ocotea gomezii is a very unusual species, distinguished by its ferruginous puberulence, broadly rounded leaves, large puberulent flowers, and fruiting receptacles with large perianth lobes. The puberulence and lobed fruiting receptacles resemble *O. mollifolia*, but that species has very different inflorescences, and thinner, more obovate leaves. *Ocotea pseudopalmana* is similar but has smaller flowers, entire fruit cups, and grows at higher elevations. The large glands of the new species are reminiscent of *Pleurothyrium palmanum*, and there are other similarities that should be looked at further. The first collection of this species was by Brenes (328(685)/6092, F, NY); other collections are *Bermúdez 268* (USJ), *Dryer 1612* (CR, F), *Gómez-L. 4590* (CR, USJ), *Hammel & Trainer 15044* (MO), *Holdridge 6827, 6829* (CR, NY), and *Poveda et al. 947* (CR, F), 1519 (USJ). The best flowering collection of this species was made by Jorge Gómez-Laurito, whose collections are adding significantly to our knowledge of Costa Rica's rich flora.

***Ocotea hartshorniana* Hammel, J. Arnold Arbor. 67: 128. 1986. Figure 8.**

Trees 10–30 m tall, to 1 m diameter d.b.h., with buttresses to 2 m high and 1 m broad or with prop roots, bark pinkish tan to orange, leafy branchlets 2.5–6 cm thick, at first densely reddish brown or yellowish brown puberulent with hairs 0.1–0.5 mm long, often ascending

and slightly strigulose, longitudinal ridges usually present. **Leaves** alternate, petioles 4–18(–24) mm long, densely puberulent or the hairs minute and apparently glabrous, flat above or slightly sulcate; **leaf blades** 12–17(–20) cm long, 3–6(–8) cm broad, oblong-obovate to obovate or elliptic-oblong, usually broadest above the middle, abruptly narrowed to a short acuminate or caudate-acuminate apex, gradually narrowed to a decurrent base, margins entire and usually recurved at the base, drying stiffly chartaceous, puberulent on the midvein above or glabrescent, sparsely to densely puberulent on the veins beneath, hairs 0.2–0.5 mm long and often reddish brown in color, sometimes glaucous beneath, with 4–8 major secondaries on each side, central secondaries arising at angles of 25°–55°, tertiary veins usually subparallel and at right angles to the secondaries. **Inflorescences** 5–15 cm long, axillary to distal leaves or occasionally pseudoterminal, broadly (8 cm) paniculate, many flowered and yellowish brown to reddish brown puberulent, peduncle 1–5 cm long, distal branches of the panicle much shorter than the basal. **Flowers** 3–4 mm long, ca. 4 mm broad, densely short-puberulent, tepals 1.5–2 mm long and erect at anthesis; outer **stamens** ca. 1.2 mm long with anthers 0.6–0.8 mm long and equally broad or slightly narrower, thecae superposed, staminodes absent; **pistil** ca. 2.5 mm long, ovary 1.5 mm long and narrowed at the base, stigma discoid. **Fruits** enclosed within a cup 10–15 mm long and 10–16 mm broad, ca. 6 mm deep and enclosing $\frac{1}{2}$ – $\frac{1}{3}$ of the fruits, margin entire or with broad blunt lobes, cuplike and rounded at the base, brownish, pedicels 1.5–4 mm thick; berry ca. 2 cm long and 1 cm thick (dried), ovoid-cylindrical or oblong, obtuse at the apex and apiculate, green at maturity.

Trees of wet evergreen forests of the Caribbean slope and lowlands, from 50 to 1200 m elevation. Flowers have been collected in April–July; young fruits have been collected in September–February, while mature fruits have been collected in April–May. This species is only known from La Selva, the Caribbean slopes of the central highlands in Costa Rica, and a collection from Esmeraldas Province in Ecuador.

Ocotea hartshorniana is recognized by its large stature, the obovate-oblong laminae with subparallel tertiary veins, and the usually reddish brown or yellowish brown puberulence on flowers, inflorescences, and leaves. The stilt roots or buttresses are also unusual. The young globose “cups” have a very small opening and enclose nearly all of the developing fruits. This species is related to *Ocotea* sp. aff. *caracasana* and its allies, a species group with stilt roots, decurrent lamina bases, and very similar flowers.

Ocotea helicterifolia (Meissn.) Hemsl., Biol. centr. amer., Bot. 3: 73. 1882. *Oreodaphne helicterifolia* Meissn. in DC., Prodr. 15, pt. 1: 123. 1864. *O. mexicana* Meissn., loc. cit. 118. 1864. *Phoebe*

helicterifolia (Meissn.) Mez, Jahrb. Königl. Bot. Gart. Berlin 5: 193. 1889. *Phoebe betazensis* Mez, loc. cit. 192. 1889. Figure 8.

Small to medium-sized trees 4–15(–25) m tall, leafy branchlets 2–5 mm thick, hirsute with slender stiff yellowish hairs to 2.5 mm long, becoming glabrous and terete. **Leaves** alternate or occasionally congested at the ends of branchlets, petioles 4–12 mm long, ca. 1.5 mm thick, densely hirsutulous; **leaf blades** (9–)12–25(–30) cm long, (2.5–)4.5–10(–12) cm broad, elliptic-obovate to oblanceolate, obovate or pandurate, usually broadest above the middle, gradually to abruptly narrowed at the apex and acuminate (rarely rounded or obtuse) at the apex, the narrowed tip 0–15 mm long, rounded to subcordate or obtuse at the base, often unequal at the petiole, margin entire, drying membranaceous to stiffly chartaceous and yellowish green to brown, puberulent on the major veins above, conspicuously puberulent beneath with slender brownish hairs to 2–3 mm long, with 6–10(–12) major secondary veins on each side, central secondaries arising at angles of 45°–66°, tertiary veins elevated beneath and often subparallel. **Inflorescence** axillary from distal leaves or from leafless nodes, to 18(–25) cm long and pendulous, few-flowered panicles with a long (to 13 cm) hirsutulous peduncle in ours (occasionally glabrous elsewhere), flowers often in umbellate clusters on slender lateral branches, pedicels 3–6 mm long and very slender. **Flowers** 3–6 mm long and 3–5 mm broad, white or yellowish, perianth usually glabrous on the outside and drying dark; outer **anthers** 0.8–1.6 mm long, 0.7–1.3 mm broad, elliptic-oblong to ovate, flat, thecae superposed, the connective sometimes prolonged beyond the thecae, filament short or absent, inner stamens narrow, staminodes slender to ovate or absent, to 0.8 mm long; **pistil** ca. 2 mm long with globose-ellipsoid ovary and thick style ca. 1 mm long, stigma subcapitate or discoid. **Fruits** borne on a long pendulous infructescence, pedicels to 2 cm long and 3 mm thick below the abruptly expanded cupulate receptacle, cup 3–4 mm long, 7–14 mm broad and 2–3 mm deep, becoming red; berry ellipsoid 2–2.4 cm long and 1.2–1.7 cm in diameter (dry), becoming black.

Trees of lowland evergreen rain forests in Costa Rica, from 20 to 500 m elevation on the Caribbean slopes, and in the Osa peninsula (as interpreted here, see below). Flowering material has been collected in February–March; fruits have been collected in August. The species ranges from eastern and southern Mexico through Guatemala and Honduras to Costa Rica.

Ocotea helicterifolia (often called *Phoebe helicterifolia*) is a very variable species but usually easily identified because of the short-petiolate leaves with long (ca. 2 mm) slender hairs, laminae broadest above the middle, acuminate at the apex and slightly rounded at the base, and the long-pendant inflorescences with puberulent peduncles, but with glabrous or sparsely puberulent perianth that dries black. The relatively large sessile outer stamens

are flat and sometimes have their connective prolonged distally. The very shallow fruiting receptacle, and usual presence of staminodes (in northern populations) further distinguish this species. However, there are many problems associated with the specimens placed here. First, they encompass an unusual spectrum of variation, especially in Mexico and Guatemala. Secondly, *O. valeriana* may prove to be a higher altitude subspecies, since it seems to parallel the variation seen in the Guatemalan and Honduran highlands of material retained in *O. helicterifolia*. See the discussion under *O. valeriana* and *O. valeroides*. *Nectandra belizensis* may also be related, though the form of the anthers is different.

***Ocotea holdridgeana* W. Burger, sp. nov. Figure 12.**

Arbor 5–15 m alta, ramulis foliiferis 1.5–3.5 mm crassis. Folia alterna, petiolis 8–18 mm longis; laminis 8–15(–18) cm longis et 2–5(–6.5) cm latis, ellipticis, ovatis, elliptico-ovatis vel lanceolatis, apice acuminato, subtus glabris vel puberulis in nervis, saepe domatiis praeditis, nervis secundariis 3–6 paribus. Inflorescentiae paniculatae racemiformae, 3–9 cm longae, pedunculis usque 4 cm longis. Flores usque 7 mm longi et 10 mm lati, extus glabri, periantho intus papillato-puberulo; stamina ser I–II 2–2.8 mm longa, antheris 1.5–2.4 mm longis, staminodiis gracilibus vel nullis; gynoecio 1.6–2.7 mm longo, stylo usque 1.2 mm longo. Fructus oblongus vel ellipsoidus, ca. 25 mm longus et 13 mm crassus; cupula 1 cm lata et 1–2 mm profunda.

Trees 5–15 m tall, leafy branchlets 1.5–3.5 mm thick, minutely (0.1–0.2 mm) appressed puberulent with slender brownish hairs, becoming longitudinally striate and dark gray. Leaves alternate, petioles 8–18 mm long, 0.8–1.5 mm thick, sulcate above, sparsely and very minutely appressed puberulent; leaf blades 8–15(–18) cm long, 2–5(–6.5) cm broad, elliptic to elliptic-ovate, elliptic-oblong or lanceolate, tapering gradually to the acuminate apex, the narrowed tip 0.2–1.2 cm long, acute at the base and slightly decurrent on the petiole, drying stiffly chartaceous and dark or yellowish brown, the upper surface often lustrous and with the minor venation easily visible, glabrous or minutely puberulent above the major veins, glabrous or appressed puberulent along the veins beneath, with 3–6 major secondary veins on each side, the basal veins usually strongly ascending (subtriplyveined) or the venation pinnate, central secondaries arising at angles of 30°–50°, conspicuous pit domatia usually present in the axils of the proximal veins beneath, the domatia often raised and visible on the upper surface (dry). Inflorescences axillary to distal leaves or pseudoterminal, 3–9 cm long, few-flowered and racemose, primary peduncle to 4 cm long, ca. 1 mm thick, minutely appressed puberulent, pedicels 2–4 mm long. Flowers to 7 mm long and 10 mm broad, white, glabrous on the out-

side, tepals 2.5–5.6 mm long, 1.4–4 mm broad, papillate-puberulent on the inner surface; outer stamens 2–2.8 mm long and with a short broad filament, outer anthers 1.5–2.4 mm long, oblong, connective often slightly prolonged beyond the superposed thecae, inner stamens to 3 mm long, staminodes small (1 mm) and usually slender or absent; pistil 1.6–2.7 mm long, style to 1.2 mm long, ovary globose to obovoid, stigma capitate. Fruits borne on an expanded (1 cm broad) receptacle only 1–2 mm deep, fruiting pedicels ca. 15 mm long and 2.5–4 mm thick, gradually expanded at the apex into the shallow receptacle, red; berry ca. 25 mm long and 13 mm in diameter, oblong-ellipsoid or slightly oblong-obovoid, green or tinged with red.

TYPE—Costa Rica, San José Province, 0.9 km above La Chonta and 100 m from the Pan American highway, elevation 2460 m, 11 May 1969, Roy W. Lent 1677 (holotype, F 1958283; negative, 61124; isotypes, CR, DUKE, MO). Additional Costa Rican collections are: Brown 17393 (F, LSU), Davidse & G. Herrera 29106 (CR, MO), Gómez et al. 21496 (CR, MO), Gómez-Laurito 11077 (CR, F, USJ), Holdridge 6570 (CR, NY), Madriz 34 (CR, F), Poveda 753 (CR, F), and Zamora et al. 879 (CR, F).

Trees of evergreen montane rain forest and montane wet forest formations, between (1100) 1600 and 2700 m elevation. Flowering collections have been made in February–April, July–September, and November–December. Fruiting material has been collected in February, April, and November. This species is only known from the Caribbean slopes and near the continental divide in the central highlands and the Cordillera de Talamanca; it also occurs in westernmost Panama (McPherson 9444, MO).

Ocotea holdridgeana is recognized by the lustrous narrow leaves, often somewhat tripliveined, and with conspicuous pit domatia in basal vein axils on the lower surface. The large flowers, glabrous on the outside, long (2 mm) stamens with short (0.2–0.4 mm) filaments, connective often prolonged a little beyond the thecae, and the subcapitate stigma are also unusual features. These characteristics define a very distinctive species, which appears to be related to *O. brenesii*. Some specimens had earlier been identified as *Phoebe tonduzii*, but the type of that name appears to be an unusual variant of *P. cinnamomifolia*. While *O. holdridgeana* has staminodes, it does not have three well-developed staminodes in each flower, as is characteristic of *Phoebe*. The many collections of Leslie Holdridge and his astute identifications have been extremely helpful in understanding the Lauraceae of Costa Rica.

Ocotea insularis (Meissn.) Mez, Jahrb. Königl. Bot. Gart. Berlin 5: 271. 1889. *Phoebe insularis* Meissn. in DC., Prodr. 15, pt. 1: 33. 1864. *O. cuneata* Mez, Bot. Jahrb. Syst. 30, Beibl. 67: 17. 1901, non *O. cuneata* (Griseb.) Gómez, 1894. *O. ira* Mez & Pittier, Bull. Herb. Boissier, ser. 2, 3: 232. 1903. *O. tonduzii* Standley, Publ. Field Mus. Nat. Hist., Bot. Ser. 18: 456. 1937 (based on *O. cuneata* Mez). *Aiouea lundelliana* C. K. Allen, J. Arnold Arbor. 26: 419. 1945. Figure 10.

Trees 10–25 m tall, trunks sometimes with short buttresses, leafy branchlets 2.5–7(–12) mm thick, glabrous or minutely (0.1–0.3 mm) appressed puberulent with slender straight yellowish brown hairs (at least near the shoot apex), longitudinally ridged but becoming terete, dark brown to grayish brown. Leaves alternate and usually close together distally, petioles 0–12 mm long and often poorly differentiated, flat or slightly sulcate above, usually with revolute margins; leaf blades (4–)8–20(–28) cm long, (2–)5–9(–12) cm broad, obovate to spatulate, elliptic-obovate or obovate-oblong, abruptly rounded at the bluntly obtuse or short-acuminate apex (sometimes acute on small leaves), tapering gradually to the cuneate or attenuate and decurrent base, the margin entire and slightly revolute (especially at the base), narrowed portion of the lamina base to 2 cm long, drying subcoriaceous and dark brown to pale grayish brown (often reddish brown in lower-elevation populations), glabrous and the minor veins obscure above, lower surfaces glabrous or with thin inconspicuous appressed hairs 0.2–0.3 mm long, domatia of tufted hairs often present in the vein axils beneath, with 6–10 major secondary veins on each side, central secondaries arising at angles of 30°–60°, tertiary venation subparallel but usually obscure. Inflorescences 10–20 cm long, axillary to distal leaves, broadly panicle with flowers usually clustered at the ends of short (1–3 cm) lateral branches, peduncle 4–10 cm long and 2–3 mm thick, reddish brown, glabrous or puberulent, pedicels 1–4 mm long and sparsely puberulent. Flowers densely to sparsely puberulent on the outside, tepals 1.5–2 mm long, ca. 1.3 mm broad; outer stamens with short (0.2–0.6 mm) filaments, outer anthers 0.5–1 mm long and equally broad or narrower, ovate to oblong, thecae superposed, staminodes very rarely present; pistil 1.5–2.8 mm long, ovary half the length of the pistil, style slender, stigma discoid. Fruits borne on a short (4–7 mm) shallow (2–4 mm deep) conical or cupulate receptacle 6–9(–12) mm broad at the top, margin entire or with persisting perianth parts, the cup abruptly expanded above the thickened (2–3 mm) pedicel, cup and pedicel ca. 1.5 cm long, becoming red; berry ellipsoid-oblong, 12–20 mm long and 6–10 mm in diameter (dry), dark green to black at maturity.

Trees of wet evergreen rain forest and cloud forest formations, from near sea level to 1600 (2000) m elevation. Flowering collections have been made in all months except October. Fruits have been collected in all months except November. This species (in a wide sense) probably ranges

from southeastern Nicaragua to Panama, and possibly as far as coastal Ecuador. It was first collected on Cocos Island.

Ocotea insularis is recognized by its stiff, essentially glabrous, obovate leaves usually bluntly rounded at the apex and decurrent on the petiole, with revolute margins basally. The relatively small ellipsoid-oblong fruits, borne in small cups with perianth parts usually persisting on the margin, also help to identify members of this species. Unfortunately, this species shows considerable local divergence (see below) and appears to be closely related to *Aiouea costaricensis*. *Ocotea endresiana* may be no more than an unusual form of *O. insularis*. Difficulties can also be encountered in differentiating material of *Ocotea* sp. aff. *caracasana* and its allies (including *O. skutchii* and *O. whitei*), all of which have decurrent leaf bases and rather similar floral morphology. See the discussions under these species. *Ocotea rivularis* is also closely related but it has very large leaves.

The highland populations of *Ocotea insularis* seem to be common around Monteverde in the Cordillera de Tilarán, and a number of specimens come from the northwestern edge of the Meseta Central (San Ramón and Zarcero). Only a very few collections have been made near Volcán Poás and Volcán Barva (Barba) and on the western side of Irazú. A few collections have been made south of Cartago, from Muñeco, Orosi, and Cachí, in very wet forests. The species is apparently more common in the western part of the Cordillera de Talamanca, in the Chiriquí highlands, and eastward into Coclé Province, Panama. Among the collections from the Chiriquí highlands are several in which the upper thecae of the outer anthers are reduced or absent. It was such a collection (*P. White 225*, MO) which was the basis of the name *Aiouea lundelliana*. A similar situation seems to be found in the flowers of *Williams 16344* (US, USJ) from near La Congreja, Cartago. These specimens suggest a trend in loss of the upper thecae, and they may indicate how *Aiouea costaricensis* (q.v.) originated from *Ocotea insularis*-like ancestors. In this regard it is interesting to note that *Aiouea costaricensis* and *O. insularis* appear to be sympatric only between Volcán Barva (Barba) and Zarcero, despite living in rather similar forest formations elsewhere. These two species and their interrelatedness deserve closer study.

The name *Ocotea insularis* is based on the Cocos Island population, which differs from most of our highland material in its larger more elliptic leaves with acute/obtuse apices and a tendency to dry

dark. The tufts of reddish hairs along the midvein on the undersides of the Cocos Island specimens are not found in any mainland material, though somewhat similar hairs may be found in the vein axils. Some collections from the General Valley closely resemble the Cocos Island material as regards leaf form and color after drying. The lower-elevation collections from the Caribbean slope also have larger (12–28 cm) leaves, but they are often slightly lustrous above, and are more reddish brown beneath; in addition, the fruit cups are often entire.

The following key summarizes some of this variation. It is clear that the problems in this group of species can only be solved after further study. We have decided to treat this group conservatively and place collections possibly belonging to *O. ira* and *O. tonduzii* under *O. insularis* sensu lato. We feel that without a thorough study of collections from Panama, coastal Colombia, and coastal Ecuador no better classification can be presented at this time.

Key to Possible Subdivision of *Ocotea insularis*

- 1a. Leaves elliptic to obovate and often bluntly acute or acuminate at the apex, usually drying dark brown, with tufts of reddish brown hairs along the midrib on the lower leaf surface; a dominant tree of Cocos Island *O. insularis* s.s.
- 1b. Leaves usually obovate to oblanceolate with the larger laminae usually rounded at the apex, never with tufts of reddish hairs along the length of the midvein (but sometimes in the vein axils); trees of the mainland 2a
- 2a. Leaves drying darker brown or reddish brown, 15–25 cm long; fruits 15–25 mm long and borne in a cup with an entire margin; from below 1000 m elevation *O. ira*
- 2b. Leaves usually drying pale grayish brown, 5–20 cm long; fruits 12–18 mm long and usually borne in a cup with some persisting perianth lobes; above 1000 m in the Cordillera de Tilarán and around the central highlands *O. tonduzii*

***Ocotea laetevirens* Standl. & Steyerl., Publ. Field Mus. Nat. Hist., Bot. Ser. 23: 114. 1944. Figure 12.**

Trees 4–18 m tall, leafy branchlets 2–8 mm thick, strongly 1–3-ridged from early stages (strongly angular in cross section) but becoming terete, glabrous or with minute (0.2 mm) thin ascending hairs near the shoot apex, greenish (dry) or brown. **Leaves** alternate, petioles 8–22 mm long, 1.2–2.5 mm thick, with adaxial ridges forming a sulcus; **leaf blades** 7–18 cm long, 3–8 cm broad, elliptic to elliptic-obovate or elliptic-oblong, acute to short-acuminate (occasionally bluntly obtuse) at the apex, tapering gradually to the obtuse or acute base and slightly decurrent on the petiole, margin slightly revolute when dry, drying stiffly chartaceous to subcoriaceous and yellowish green to greenish brown, glabrous and slightly lustrous with the tertiary venation visible on the upper surface, glabrescent and duller beneath with the minor venation raised and forming a poorly defined reticulum, with 3–7 major secondary veins on each side, the central secondaries arising at angles of 30°–60°, the basal secondaries occasionally prominent and arcuate-ascending, domatia-like developments of tufted hairs or pits often present in the axils of proximal secondary veins beneath. **Inflorescences** axillary to both distal and proximal leaves, to 20 cm long, an open many-branched panicle, peduncle 3–12 cm long and ca. 1.3 mm thick, glabrous, pedicels ca. 2 mm long. **Flowers** 2.5–4 mm long, 2.5–4 mm broad,

campanulate, white but drying dark, glabrous on the outside or minutely papillate distally, tepals ca. 2 mm long and 1.7 mm broad; outer **stamens** 1.4–1.8 mm long with oblong or ovate anthers 0.7–0.8(–1.1) mm long and 0.6–0.8(–0.9) mm broad, filaments usually prominent (0.5–1 mm) and broad, thecae clearly superposed, inner stamens 1.5–2 mm long and with large glands, staminodes absent or very slender (to 0.8 mm long); **pistil** 1.7–2.5 mm long, ovary 1–1.3 mm in diameter, style 0.7–1.1 mm long, stigma simple or oblique. **Fruits** borne in a cupulate or conic receptacle 1.2–2.5 cm long, 1–1.6 cm broad and 3–6 mm deep, gradually expanded above the thickened pedicel, surface rough but lacking prominent lenticels, becoming red; berry 2.2–3 cm long, 1.3–1.8 cm in diameter (dry), ellipsoid, becoming black.

Trees of montane evergreen forest formations, from 1200–2000 m elevation. In Costa Rica flowering material has been collected in March–April, July, and December; fruits have been collected in March–April, June–August, and December–January. This species has only been collected from the northeastern portion of the Meseta Central (Volcán Barva to Tablazo) and the western part of the Cordillera de Talamanca in Costa Rica. The species is also known from Guatemala.

Ocotea laetevirens is distinguished by its stiff

glabrous leaves that often turn yellowish green or pale brown when dried, the slightly decurrent lamina base, the almost glabrous flowers, the outer stamens with prominent filaments, poorly developed stigma on a conspicuous style, shallow fruit cup, and ellipsoid fruits. We follow C. K. Allen (1945) and Hammel (1986) in using this name for these Costa Rican plants. Even though the leaves of the type (*Steyermark 49189*, F, from Guatemala) are thinner and much more acuminate than in Costa Rican material, the flowers are nearly identical. Other highland species with stiff glabrous pale-drying leaves that are often glossy above and can be confused with this species are *Ocotea meziana*, *Nectandra cufodontisii*, and *Phoebe hammeliana*.

This species is poorly understood at present. It may be much more variable than described above, with some individuals having smaller, more coriaceous leaves. Two larger-leaved (20–30 cm) collections, with longer more open pendant infructescences, from the Osa peninsula (*Primack 96*, MO) and Mastatal de Puriscal (*Gómez-Laurito 11237*, CR, F, USJ) are tentatively placed under this species. (Note that these last two collections are both from lower elevation habitats, and they may not be conspecific.) It seems best to place these latter anomalous collections under *O. laetevirens* until we have better samples of the populations they represent. *Ocotea verapazensis* Standl. & Steyerm. and *O. standleyi* C. K. Allen (based on *Phoebe macrophylla* Standl. & Steyerm.) may prove to be synonymous with an expanded concept of *O. laetevirens*; all the relevant types are from evergreen forests at about 1500 m elevation in Guatemala. See also *Ocotea* sp. aff. *O. laetevirens* at the end of the species descriptions.

***Ocotea lentii* W. Burger, sp. nov. Figure 2.**

Arbor 4–8 m alta, ramulis foliiferis 5–10 mm crassis. Folia alterna, petiolis 8–30 mm longis et 2.5–4 mm crassis; laminis 18–40 cm longis et 8–16 cm latis, obovatis vel elliptico-obovatis, apice breviter acuminato vel rotundato, basi cuneato, subtus strigosis in nervis, pilis 0.2–1 mm longis, nervis secundariis 7–11 paribus. Inflorescentiae paniculatae, 8–20 cm longae, saepe racemiformae, pedunculis 3–12 cm longis. Flores 5–7 mm longi et 6–10 mm lati, extus glabri vel minute puberuli, tepalis intus papillato-puberulis; stamina ser. I–II antheris 1.2–1.4 mm longis, staminodiis nullis vel parvulis (0.6 mm); gynoeceum ca. 2.5 mm longum, ovario ellipsoideo, 1.5–1.9 mm longo. Fructus ellipsoideus vel oblongoideus, 3–6 cm longus et 2–3 cm crassus; cupula 8–25 mm lata, 2–8 mm profunda.

Small trees 4–8 m tall, leafy branchlets 5–10 mm thick, hirsute with straight stiff yellowish hairs 0.5–1.3 mm long and persisting on the terete stems. Leaves alternate or crowded together distally, petioles 8–30 mm long, 2.5–4 mm thick, densely hirsute with stiff hairs, narrowly sulcate above; leaf blades 18–40 cm long, 8–16 cm broad, obovate to elliptic-obovate, abruptly narrowed to the cuneate base, margin often undulate (dry), the laminae drying chartaceous to stiffly chartaceous and dark greenish or brown above, densely and minutely (0.3 mm) puberulent on the major veins above and with longer (ca. 1 mm) hairs between the veins, lower surface with stiff straight hairs 0.2–0.8(–1.2) long on both the major and minor veins, with 7–11 major secondary veins on each side, central secondaries arising at angles of 40°–70°, secondary and tertiary venation prominent beneath, tertiary veins often subparallel and perpendicular to the secondaries. Inflorescences axillary to distal leaves or from leafless nodes, 8–20 cm long, elongate panicles with short lateral branches (almost racemiform), primary peduncle 3–12 cm long, slender (1.5 mm) and sparsely hirsute, pedicels to 10 mm long. Flowers 5–7 mm long, 6–10 mm broad, perianth glabrous or sparsely puberulent on the outside, papillate-puberulent on the inside; outer stamens subsessile, anthers 1.2–1.4 mm long, ca. 1.2 mm broad, thecae superposed but the lower often somewhat lateral, staminodes absent or small (0.6 mm) and clavate, with erect straight hairs around the rim of the floral tube and base of the stamens; pistil ca. 2.5 mm long, ovary 1.5–1.9 mm long, ellipsoid, style slender, stigma capitate. Fruits borne on a flat, conical or broadly cupulate receptacle, 4–10 mm long, 8–25 mm broad and 2–8 mm deep, pedicels becoming 2–4 cm long and 2.5–6 mm thick; berry 3–6 cm long, 2–3 cm in diameter, ellipsoid, the base not tightly enclosed in the cup when a cup is present (dry).

TYPE—Costa Rica, Cartago Province, hillside overlooking the Río Grande de Orosi, 3.5 km SE of Tapantí, elevation 1400 m, 9 April 1967, *Roy W. Lent 794* (holotype, F 1749021; negative, 61119; isotypes, CR, MO).

Small trees of the very wet cloud forest formations of the Caribbean slope, at about 1400 m elevation. Flowers have been collected in April, while fruits have been collected in April and August. At present the species is known from only three collections (*Gómez 18814*, CR, MO, *Lent 794*, 2070, CR, F), all from near Tapantí, along the Río Grande de Orosi.

Ocotea lentii is recognized by its very large but thin-textured obovate leaves with short straight stiff hairs, long pedunculate inflorescences with relatively few flowers, and large ellipsoid fruits. The upper edge of the floral tube with straight lustrous hairs, and the subsessile anthers about as broad as long, are also distinctive features. The general form of the flowers and vegetative parts relate this species to *Ocotea valeriana*, but the very

large leaves and fruits of *O. lentii* are amply distinct. *Ocotea valerioides*, with large leaves and very similar floral structure, is more closely related. It too, has a tendency for the outer anthers to become broad and develop a *Nectandra*-like configuration. *Ocotea lentii* and *O. valerioides* differ in elevation, leaf texture, and color (dried), as well as vesture, inflorescence-form, and size of the fruits. See the discussions under *O. valerioides* and *O. mollifolia*. Roy Lent's Costa Rican collections number about 4,000 and include many rare and important finds, of which this unusual species is an example.

Ocotea leucoxylo (Sw.) Laness., Pl. util. colon. franc. 156. 1886. *Laurus leucoxylo* Sw., Prodr. 65. 1788. *O. subsericea* Standl., Publ. Field Mus. Nat. Hist., Bot. Ser. 18: 456. 1937. *O. lenticellata* Lundell, Wrightia 5: 54. 1974. Figure 14.

Small or medium-sized trees, 3–15(–25 m) tall, dioecious (unisexual), leafy branchlets 1.7–6.5 m thick, glabrous or with very minute (0.05–0.1 mm) grayish appressed ascending hairs, often with longitudinal ridges but becoming terete. **Leaves** alternate and evenly spaced, petioles 10–22 mm long, 1.5–2.5 mm thick, with elevated adaxial ridges usually forming a shallow sulcus above; **leaf blades** 10–23(–27) cm long, 3–9 cm broad, elliptic-oblong to oblong or elliptic-lanceolate, usually acuminate at the apex with a narrow tip 0.5–2 cm long, acute to obtuse at the base, margin usually slightly revolute, the laminae drying very stiffly chartaceous to subcoriaceous and grayish green to dark olive green, glabrous above and the midvein flat, essentially glabrous (in ours) or very sparsely and minutely puberulent beneath, with 4–8 major secondary veins on each side, primary and secondary veins prominent beneath, central secondaries arising at angles of 30°–50°(–60°), epidermal cells somewhat convex on the lower surface and giving an uneven or scale-like effect (10×). **Inflorescences** solitary from the axils of leaves or leafless nodes throughout the length of new twigs, 4–9(–13) cm long, paniculate with well-spaced lateral branches, basal branches longer than the distal, pedicels 1–3 mm long. **Male flowers** ca. 2.5 mm long and 2.5 mm broad (to 3 × 3 mm elsewhere), white to yellowish, tepals 1.5(–2) mm long and 1 mm broad, very minutely papillate puberulent on the edges; outer stamens with anthers 0.5–1 mm long and 0.5–0.9 mm broad, with short (0.2–0.3 mm) broad filaments, thecae superposed or the lower slightly lateral to the upper, inner stamens ca. 1.5 mm long with anthers 0.9 mm long, staminodes absent; pistillode ca. 2 mm long and 0.2–0.5 mm thick, stigma discoid. Female flowers not seen (probably very similar to the male). **Fruits** subtended by a broadly obconic or saucer-like receptacle 4–10 mm long, 5–8 mm broad, and 1–3 mm deep, reddish brown, often with distinctive wart like lenticels, rim entire; berry 8–10 mm in diameter (dry, to 15 mm in life), globose to globose-obovoid, green to purple, the fruiting inflorescences rarely more than 8 cm long.

Trees of tropical wet to premontane rain forest formations on the Caribbean slope and adjacent continental divide, from 20 to 1800 m elevation. The trees flower in February–July at La Selva (Hammel 1986, p. 229), and fruits have been collected throughout the year, except November, in Costa Rica. The species ranges from southern Mexico and the West Indies to South America.

Ocotea leucoxylo is recognized by its stiff oblong glabrous leaves, strongly angular young stems, small functionally unisexual flowers, and small globose fruits, subtended by a small cupulate or obconic warty receptacle. Hammel (1986) mentions the foul-smelling foliage (when crushed), the distantly spaced inflorescences, grayish green leaves and scaly lower leaf surface as additional distinguishing features. The “scaly effect” on the lower leaf surface may simply be the reflections of light from the convex surfaces of epidermal cells (in life); there are no scales under the microscope (100×). We follow Hammel (1986), who included *O. lenticellata* from Belize under this species. This species has also been cited as *O. leucoxylo* (Sw.) Gómez de la Maza (Dicc. Nombres Vulg. Cub. Puerto Riq. 12.), but Howard (1981) states that this publication was issued in 1889, and the day and the month are unknown. The type of Standley's *O. subsericea* (Brenes 6789, CR, F) has immature foliage and larger more puberulent flowers; it probably belongs in synonymy here.

Ocotea meziana C. K. Allen, J. Arnold. Arbor. 26: 360–361. 1945. Figure 14.

Trees 2–15 m tall, trunk to 80 cm d.b.h., bark grayish or brown, leafy branchlets 1.3–4 mm thick, at first with short (0.2 mm) ascending yellowish hairs but quickly becoming glabrous and pale grayish to yellowish green. **Leaves** alternate, larger in low elevation plants than in montane plants (see below), petioles 5–16(–30) mm long, 1–2 mm broad, flat or slightly sulcate above; **leaf blades** 5–15 or 11–22 cm long, 2–6 or 4–10 cm broad, elliptic to narrowly elliptic or elliptic-oblong (broadly elliptic at lower elevations), tapering gradually to the short-acuminate apex and acute base (tapering more abruptly in the broader leaves of lower elevations), drying stiffly chartaceous and gray or greenish gray, smooth and glabrous above with the venation flat, essentially glabrous beneath, with 4–6 major secondary veins on each side, the central secondaries arising at angles of 30°–60°, with pit domatia in the axils of major veins or along the secondary veins, the smallest veins forming a distinct reticulum on the lower surfaces with areolae about 0.5 mm broad. **Inflorescences** axillary or extra-axillary on distal twigs, to 10(–15) cm long, few-branched panicles, peduncle 1.5–6 cm long, glabrous or very minutely puberulent, lateral branches with few (3–7) flowers, pedicels

2–5 mm long and articulate near the base, drying dark. Flowers ca. 2–3 mm long, 4 mm broad, yellowish green but drying black, essentially glabrous, tepals 1.2–2 mm long; outer stamens with prominent (ca. 1 mm) filaments, outer anthers 0.7–1 mm long, narrow with superposed thecae, staminodes absent; pistil 1.5–2.5 long, ovary turbinate or narrowed near the base, style ca. 1 mm long, stigma simple. Fruits borne on a shallow (ca. 2–3 mm cup) cup 8–14 mm broad, 1.5–3 cm long, funnelform and often abruptly flared at the apex, red; berry 2–3 cm long, 1.3–2 cm in diameter (dried), becoming purple or black.

Trees of the wet evergreen forest formations of the Caribbean slope and the continental divide, from 50 to 2300 m elevation. Flowering collections have been made in February–July, September–October, and December. Fruiting material has been collected in July–December. The species, as presently understood, ranges from northern Costa Rica to Coclé Province in Panama.

Ocotea meziana is recognized by the few-flowered and essentially glabrous inflorescences with small flowers that dry blackish, the glabrous (or very minutely puberulent) leaves that dry grayish or greenish and slightly lustrous beneath, and the shallow funnelform cupules about 1 cm broad at the apex. This treatment follows Hammel's (1986) interpretation, and includes the larger-leaved specimens from La Selva, together with the smaller-leaved highland (800 to 2100 m) material. Pit domatia along the secondary veins are often present in highland material, as in the type collection (*A. Smith 359*, ♀) from about 1600 m elevation. *Ocotea meziana* is closely related to *O. laetevirens* (q.v.). Herbarium material of *O. meziana* may resemble *Ocotea cernua*, *O. tenera*, *Licaria cufodontisii*, and *L. sarapiquensis*, but the fine reticulum formed by the minor venation on the lower surface when dry helps to separate *O. meziana* from all of these other species.

Ocotea mollicella (Blake) van der Werff, comb. nov. *Phoebe mollicella* Blake, Contr. Gray Herb. 52: 64. 1917. Figure 4.

Trees 6–16 m tall, distal branchlets 0.7–3 mm thick, usually pale grayish or yellowish brown tomentulose with thin hairs 0.1–0.3 mm long, terete, becoming slightly striate. Leaves alternate, petioles 6–12 mm long, ca. 1 mm thick, flat above, puberulent; leaf blades 3–7(–9) cm long, 1–2.3(–3) cm broad, narrowly elliptic to elliptic-lanceolate or elliptic-oblong, tapering gradually to the acute or acuminate apex, acute at the base, drying chartaceous, usually dark and slightly lustrous above, glabrescent above, grayish puberulent below with slender hairs 0.1–0.4 mm long, with 3–6 major secondary veins

on each side, the central secondaries arising at angles of 30°–50°. Inflorescences small and axillary to older or fallen leaves, racemose panicles to 6 cm long, peduncles to 4 cm long, slender (0.5 mm) and grayish puberulent, flowers solitary or 2–3 on short branches of the rachis, pedicels 1–5 mm long. Flowers 4–6 mm broad, buds 2–3 mm long, tepals ca. 3 mm long, obtuse, glabrous distally and within, pellucid punctate; outer stamens ca. 1.3 mm long with anthers ca. 0.8 mm long and 0.9 mm broad, ovate with superposed thecae, inner stamens with oblong anthers ca. 0.7 mm long, staminodes small (0.5–0.8 mm) and with or without a glandlike apex; pistil ca. 2 mm long, ovary globose and glabrous, style ca. 0.6 mm long, stigma simple or slightly discoid. Fruits borne on a short cup ca. 6 mm broad, usually with the broad but short tepals persisting at the edge, becoming red; berry ca. 2 cm long and 1.3 cm in diameter, ellipsoid, becoming black.

Trees of wet evergreen montane forest formations, between 1400 and 2300 m elevation in central Costa Rica. Flowering collections have been made in December–February; fruits have been collected in May–August. This species is only known from the region around Zarcero, the slopes of Volcán Irazú, and the western parts of the Cordillera de Talamanca (Copey and Sta. María de Dota) in Costa Rica.

Ocotea mollicella is recognized by its small narrow leaves with soft grayish puberulence beneath, small inflorescences that become dark on drying, presence of staminodes, and restricted highland habitat. There is little good fruiting material, and the fruiting description may require revision. This species is known as *quizarrá amarillo*. This species is very closely related to *Ocotea pittieri*, and there is the possibility that *O. mollicella* is only an unusual subspecific element of that species. However, the soft grayish puberulence is quite characteristic and intermediate collections are not apparent. The two species are here transferred from *Phoebe* to *Ocotea*; see the discussion under *O. pittieri*.

Ocotea mollifolia Mez & Pittier, Bull. Herb. Boissier, ser. 2, 3: 233. 1903. Figure 7.

Small and medium-sized trees 4–20 m tall, prop roots often present (fide Hammel), leafy branchlets 2–6 mm thick, densely puberulent with yellowish brown to orange brown hairs 0.2–0.5 mm long. Leaves alternate or occasionally subopposite, petioles 4–12(–18) mm long, 1.5–3.5 mm thick, densely puberulent; leaf blades (9–)12–24 cm long, 6–14 cm broad, obovate to broadly elliptic-obovate or oblong, nearly always broadest above the middle, usually rounded and abruptly narrowed to an acute or short-acuminate apex with a tip 0.5–1.5 cm long, narrowed gradually to an acute or obtuse base (never

decurent), drying chartaceous to stiffly chartaceous, puberulent on the larger veins above, puberulent beneath with straight or crooked slender hairs to 0.5 mm long, yellowish brown to dull brown in color, with 5–9 major secondary veins on each side, central secondaries arising at angles of 30°–60°, tertiary veins prominent beneath and often subparallel and perpendicular to the secondaries. **Inflorescences** axillary or apparently extra-axillary, 6–20(–30) cm long, an open panicle, primary peduncle to 14 cm long and 1.5–2.5 mm thick, densely puberulent, pedicels 2–9 mm long. **Flowers** 3–4(–5) mm long, 3–5(–7) mm broad, cream white but becoming brownish on drying, tepals 1.5–2.2(–3) mm long, densely puberulent on the outside; outer **stamens** subsessile with ovate to oblong anthers 0.7–1.4 mm long, thecae superposed and the connective sometimes prolonged apically, inner stamens 1–1.8 mm long, staminodes present and slender (ca. 0.8 mm long) or absent; **pistil** 1.5–2.5 mm long, ovary turbinate or ellipsoid, style short to long (1.4 mm) and glabrous or puberulent (as in the type), stigma simple or slightly discoid. **Fruits** borne on a conical cup 10–18 mm long and ca. 15 mm broad, shallow or deep (2–5 mm), rim of the cup usually with broad (3 mm) persisting perianth parts 1–2 mm long, becoming red; berry 2–3(–4) cm long, 1.5–2 cm in diameter, oblong-cylindrical.

Trees of stream sides and forest understory usually on hilly sites, on the lower slopes of the Caribbean escarpment between 50 and 900 m elevation, and near Palmar Sur de Osa on the Pacific slope. Flowering material has been collected in January–March, and flowering has been observed in February–June at La Selva (Hammel 1986). Mature fruits have been collected in September–January. This species is only known from Costa Rica.

Ocotea mollifolia is recognized by the conspicuously puberulent and usually obovate lamina that are thin in texture and, while narrowed gradually to the base, are not decurrent on the petiole. The open inflorescences with widely spaced flowers, dense puberulence on most parts, fruit cups with persistent lobes on the margins, and prop roots near the base of the trunk are further distinguishing characters. Despite obvious differences between typical members of each species, this species may be related to *O. gomezii*; collections from around 500 to 700 m exhibit some shared characteristics (but they are not clearly intermediate as one would expect from a cline or hybridization). In this regard Burger *et al.* 11730 (CR, F, NY) from about 600 m has much larger flowers and floral parts than our other, lower-elevation, collections of *O. mollifolia*. While these flowers approach those of *O. gomezii* in size, the large open inflorescences are more typical *O. mollifolia*. The prop roots and other characteristics suggest a relationship with *O. hartshorniana* and *O. sp. aff. caracasana*.

***Ocotea monteverdensis* W. Burger, sp. nov.** Figure 4.

Arbor usque 25 m alta, ramulis foliiferis 2–5.5 mm crassis. Folia alterna, petiolis 2–8 mm longis; laminae 4–12 cm longis et 1.5–4 cm latis, ellipticis vel anguste elliptico-oblongis, apice saepe acuto, basi acuto vel cuneato, decurrente, subtus adpresse puberulis, nervis secundariis 3–8 paribus. Inflorescentiae paniculatae, 6–12 cm longae, pedunculis 2–5 cm longis. Flores 3–3.5 mm longi et 4–5 mm lati, extus dense puberuli, tepalis intus papillato-puberulis; stamina ser. I–II antheris 0.6–0.9 mm longis, staminodiis nullis; gynoecium 1.5–2.2 mm longum. Fructus ellipsoideus, usque 3 cm longus et 1.5 cm crassus; cupula 12–16 mm lata et 1–3 mm profunda.

Trees to 25 m tall, to 55 cm d.b.h., leafy branchlets 2–5.5 mm thick, at first yellowish brown or orange brown tomentulose with dense short (ca. 0.2 mm) tomentulose hairs, with prominent longitudinal ridges but becoming terete and grayish. **Leaves** alternate, often closely clustered distally, petioles not clearly differentiated, 2–8 mm long, with lateral margins and flat above; **leaf blades** 4–12 cm long, 1.5–4 cm broad, elliptic to narrowly elliptic or narrowly elliptic-oblong, tapering gradually to an acute (rarely obtuse) apex, tapering gradually to the acute (obtuse or cuneate) base and decurrent on the petiole, margin slightly revolute near the base, the laminae drying stiffly chartaceous or subcoriaceous, grayish green or grayish brown above with the tertiary veins paler and distinct, smooth above and essentially glabrous except above the midvein, grayish beneath with a dense covering of small (0.2 mm) slender appressed ascending hairs, glabrescent in age, with 3–8 major secondary veins on each side, central secondaries arising at angles of 30°–60°. **Inflorescences** axillary to distal leaves or pseudoterminal, 6–12 cm long, paniculate and many-flowered, peduncles 2–5 cm long, ca. 2 mm thick, brownish puberulent, pedicels 1–3 mm long. **Flowers** 3–3.5 mm long, 4–5 mm broad, densely ferruginous puberulent on the exterior, tepals 1.5–2 mm long and ca. 1.5 mm broad, papillate puberulent within; outer **stamens** 1.3–1.5 mm long, subsessile or with short (0.3 mm) puberulent filaments, outer anthers 0.6–0.9 mm long, 0.6–0.7 mm broad, rectangular, thecae superposed or the lower slightly lateral, inner stamens ca. 1.6 mm long with anthers ca. 0.8 mm long, glands large, staminodes not seen; **pistil** 1.5–2.2 mm long, style 0.5–0.7 mm long and slender, stigma simple. **Fruits** borne in a shallow (1–3 mm) cup 12–16 mm broad, expanded gradually from the pedicel and obconic or somewhat saucer-shaped, red, fruiting pedicel 4–10 mm long and ca. 3 mm thick; berry becoming as much as 3 cm long and 1.5 cm in diameter (dry), ellipsoid, green.

TYPE—Costa Rica, Puntarenas Province, Monte Verde, in Figuerola's pasture, elevation about 1450 m, 27 July 1977, Gary S. Hartshorn 1900 (holotype, CR 91924; isotypes, F 1866719; negative, 61120, MO).

Trees of montane cloud forest formations in the Cordillera de Tilarán and westernmost slopes of

the Meseta Central, from about 800 to 900 m near San Ramón to 1400 to 1600 m at Monteverde. Flowering material has been collected in June–August, and fruiting material has been collected in July–August. This species is only known from west-central Costa Rica.

Ocotea monteverdensis is recognized by the smaller elliptic leaves that are densely appressed puberulent beneath, the decurrent lamina base, the ferruginous puberulence on stems and inflorescences, the larger ellipsoid fruits borne in shallow cups, and the restricted range. Specimens of this species may resemble *Ocotea mollicella*, but that species lacks the dense pubescence, the decurrent leaf base, and differs in flowers and fruits. *Ocotea monteverdensis* appears to be most closely related to *O. skutchii*, *O. hartshorniana*, and their allies. The following collections are placed here: *Brenes 3849* (F, NY), *Dryer 1332, 1591* (CR, F), *Gentry & Haber 48736* (MO), *Poveda 1108* (CR, F), *J. & K. Utley 5407* (DUKE, F), and *N. Wheelwright 1, 30B, 33, 75* (all MO).

***Ocotea nicaraguensis* Mez, Jahrb. Königl. Bot. Gart. Berlin 5: 238. 1889. *O. pentagona* Mez, Bot. Jahrb. Syst. 30, Beibl. 67: 17. 1901. Figure 3.**

Slender trees 6–8(–18) m tall, trunk 10–20 cm d.b.h., leafy branchlets 4–8 mm thick, strongly angled in cross section with 3–5 prominent longitudinal ridges, very minutely appressed puberulent or glabrous, distal stems usually hollow and harboring ants. Leaves alternate, petioles 5–12(–20) mm long, 2–4 mm thick, slightly or deeply sulcate above, often drying dark; leaf blades 14–40(–55) cm long, 4.5–12(–15) cm broad, very narrowly obovate to oblong-obovate, oblanceolate or oblong-elliptic, rounded to bluntly obtuse or short-acuminate at the apex, tapering gradually to the obtuse (rounded) to cuneate (but not decurrent) base, drying subcoriaceous to coriaceous and often pale grayish brown, glabrous above and below, midvein up to 5 mm broad beneath, with 7–10(–12) major secondary veins on each side, central secondaries arising at angles of 30°–50°(–65°), tertiary veins often perpendicular to the secondaries and subparallel, slightly raised on the lower surface, domatia absent. Inflorescences axillary to distal leaves, 15–30 cm long, paniculate but with short (2–3 cm) lateral branches and somewhat racemose in form, peduncle 7–12 cm long, 2–3 mm thick, very minutely puberulent or glabrous, pedicels 1.5–5 mm long. Flowers 2.2–3 mm long, 3–5 mm broad, very minutely puberulent or glabrous, tepals ovate and thin, usually glabrous within; outer stamens with short (0.5 mm) filaments and narrow anthers ca. 0.9 mm long, thecae superposed, inner stamens 1.4–1.8 mm long, staminodia absent; pistil 2–2.4 mm long, the style narrowed gradually and equalling the ovary in length, stigma

slightly discoid. Fruits borne on a shallow (1–2 mm deep) receptacle ca. 8 mm broad, with the perianth bases (2–3 mm broad and 1–2 mm long) usually persisting, pedicel becoming 5–15 mm long and 3–4 mm thick at the apex, becoming reddish; berry 12–25 mm long and 6–12 mm thick (dried), ellipsoid to ovoid, becoming purple or black.

Trees of evergreen forest formations below 1000 (?1300) m elevation, on both the Caribbean and Pacific slopes of Costa Rica. Flowering collections have been made in August–October, and fruiting material has been collected in January–April and November. The species appears to be most common in the Caribbean lowlands, the Cordillera de Tilarán (600 to 1000 m), the General Valley, and the Golfo Dulce region. This species ranges from southeastern Nicaragua to westernmost Panama.

Ocotea nicaraguensis is recognized by its large, stiff, often oblanceolate leaves on short thick petioles, the hollow distal stems, lack of conspicuous puberulence, and the small fruiting receptacles with (usually) persisting perianth bases. The prominent longitudinal ridges on the young stems are also useful in identification, and separating this species from *O. atirrensis*, with much thinner leaves that are often caudate-acuminate and dry dark in color. *Ocotea paulii* of higher elevations also lacks the prominently ridged stems and has smaller more oblong leaves. All three of these species have the distal stems hollow and often inhabited by small ants. *Ocotea aurantiodora* has similar leaves and solid stems with even more prominent ridges, but the fruits are very different.

***Ocotea oblonga* (Meissn.) Mez, Jahrb. Königl. Bot. Gart. Berlin 5: 366. 1889. *Mespilodaphne oblonga* Meissn. in DC., Prodr. 15, pt. 1: 107. 1864. *O. portoricensis* Mez, loc. cit. 364. 1889. *Phoebe mayana* Lundell, Amer. Midl. Naturalist 29: 473. 1943. Figure 11.**

Trees 8–30 m tall, 20–45 cm d.b.h., dioecious, often becoming buttressed in age, sometimes with whorled branching, leafy branchlets 1.5–4 mm thick, glabrous or very minutely (0.1 mm) puberulent near the apex, longitudinally ridged but becoming terete and lenticellate, dark or grayish. Leaves alternate, petioles 1–2 cm long but poorly differentiated, 1–2 mm broad, flat above, glabrous or minutely puberulent; leaf blades 5–15(–22) cm long, 2–4(–6) cm broad, oblanceolate to narrowly elliptic-obovate or narrowly obovate, usually short-acuminate at the apex (bluntly acute to obtuse), tapering very gradually to the cuneate or decurrent base, drying chartaceous to stiffly chartaceous and usually very dark above with the major veins slightly raised and the minor veins

obscure, grayish or brownish beneath and glabrous or obscurely appressed puberulent with small (0.2–0.4 mm) thin hairs, with 5–8 major secondary veins on each side, the central secondaries arising at angles of 30°–50°, pit domatia often present near the midvein beneath. **Inflorescences** axillary to distal leaves, 5–13 cm long, racemose panicles with short (1–2 cm) lateral branches, peduncle 8–30 mm long, 0.7–2 mm thick, sparsely to densely puberulent, pedicels 1–3 mm long. **Flowers** functionally unisexual, 1.7–2.5 mm long, ca. 3.5 mm broad, campanulate, minutely and densely appressed puberulent on the outside, tepals 1.2–1.5(–2) mm long, 1.2–1.4 mm broad, papillate puberulent within; **male flowers** with outer anthers ca. 1 mm long on filaments ca. 0.4 mm long, thecae superposed in oblong anthers, inner stamens ca. 2 mm long with small (0.5 mm) glands, staminodes absent; **female flowers** with stamens half the size of those in the male flowers; pistil 1.5–2 mm long, ovary ovoid and ca. 0.7 mm in diameter, style thick and ca. 1 mm long, stigma a flat-topped disc. **Fruits** borne on a flat or saucer-like receptacle 4–6 mm broad and only 1–2 mm long, abruptly expanded above the short (3–8 mm) thickened (3–4 mm) pedicel (the thickened pedicel may look like a cup in early stages); berry 9–18 mm long, 7–9 mm in diameter (dry), ellipsoid to ovoid or oblong.

Trees of evergreen forest formations of the Caribbean slope and partly deciduous formations of the General Valley, between 600 and 1000 m elevation in Costa Rica; from near sea level to 1000 m elsewhere. Flowers have been collected in May, August, and October in Costa Rica and July–August in central Panama; fruits have been collected in October–early February. This species ranges from Belize and the West Indies to Bolivia and the Guianas.

Ocotea oblonga is recognized by the smaller oblanceolate leaves with decurrent lamina base, obscure pubescence, unusual pit domatia (sometimes absent), unisexual flowers, and small ellipsoid fruits on small flat receptacles. Vegetatively, our collections resemble the lowland *O. sp. aff. O. bijuga* and the Monteverde population of *O. whitei*, but those species have very different fruits, and the plants are not dioecious. Costa Rican collections are from near Volcán Rincón de La Vieja (Guanacaste), the region of Buena Vista de San Carlos (Alajuela), Tukurrique and Juan Viñas (Cartago), and near the Río Convento in the General Valley (San José/Puntarenas). This species is similar to *O. cuneifolia* (Ruiz & Pavón) Mez, *O. neesiana* (Miq.) Kosterm., and *O. florulenta* (Meissn.) Mez, of South America. *Ocotea eucuneata* Lundell with slightly thinner and more acuminate leaves may be a synonym from Belize.

Ocotea paulii C. K. Allen, J. Arnold *Arbor.* 26: 345. 1945. Figure 3.

Small trees 3–8(–15) m tall, occasionally shrub like and somewhat scadent, leafy branchlets 3–8 mm thick, glabrous, with 3–5 prominent longitudinal ridges, smooth and grayish or brown between the ridges (rarely terete), distal stems hollow. **Leaves** alternate or rarely pseudoverticillate, petioles 6–15(–22) long, 1.5–3(–4) mm thick, slightly canaliculate above, glabrous and usually drying dark; **leaf blades** 10–23(–33) cm long, 3–7.5 cm broad, narrowly oblong to elliptic-oblong or very narrowly ovate-oblong, abruptly short-acuminate at the apex (occasionally rounded or tapering gradually to a longer acuminate apex), acute to obtuse or slightly rounded at the base, margin entire and flat or revolute, drying subcoriaceous to coriaceous and grayish to reddish brown, glabrous above and below, with 5–11 major secondary veins on each side, major veins usually prominent beneath, central secondaries arising at angles of 35°–55°, tertiary veins often subparallel but not conspicuous. **Inflorescences** 15–25 cm long, subterminal or axillary to distal leaves, paniculate with lateral branches to 5 cm long, many-flowered, peduncle 5–8 cm long, glabrescent, pedicels 1–2 mm long. **Flowers** 2–3 mm long and ca. 3 mm broad, glabrous or with a few minute hairs, tepals ca. 1.5 mm long and equally broad, ovate; outer **stamens** with short (0.4 mm) filaments, outer anthers 0.7–0.8 mm long, narrowly ovate with superposed thecae, inner stamens ca. 1.2 mm long, staminodes absent; **pistil** 1.5–2 mm long, style equalling the ovoid ovary in length, stigma slightly discoid. **Fruits** borne on short (2–4 mm) shallow receptacles 6–10 mm broad and 1–2 mm deep, margin usually entire, pedicels becoming 6 mm long and 2–3 mm broad at the apex; berry ca. 2 cm long and 1 cm thick (dry), ellipsoid-oblong.

Small trees and clambering shrubs of evergreen montane forest formations, between 600 and 1600 (2300) m elevation. Flowers have been collected in all months except October–November, but fruits have only been collected in March and May. This species is only known from the northern part of the Meseta Central (San Ramón to Zarcero) and the highlands of Chiriquí, Coclé, and Panama provinces in Panama.

Ocotea paulii is recognized by its usually small stature, hollow distal stems, narrowly oblong leaves often exceeding 15 cm in length, glabrous parts, and small narrow fruits borne on small shallow receptacles. This species differs from the closely related *O. atirrensis*, *O. wedeliana*, and *O. nicaraguensis* in its higher-altitude habitat, smaller, more consistently oblong leaves, and more profusely branched inflorescences. There appears to be intergradation between *O. atirrensis* and *O. paulii* on the Caribbean slope at about 1000 m elevation. The populations of Costa Rica and Panama differ somewhat in leaf form and texture. More importantly, while Panamanian collections may have the upper thecae of the outer anthers reduced in size, there are Costa Rican collections in which

the outer anthers may be 2-thecous in some flowers (*A. Smith 633, 907, f.*)

Ocotea pittieri (Mez) van der Werff, comb. nov.
Phoebe pittieri Mez, Bot. Jahrb. Syst. 30, Beibl. 67: 16. 1901. Figure 4.

Shrubs or small to medium-sized trees, 2–10(–20) m tall, leafy branchlets 1.3–4 mm thick, at first grayish or yellowish puberulent with short (0.1–0.3 mm) straight or crooked hairs, persisting or glabrescent. Leaves alternate, petioles 5–12 mm long, ca. 1 mm thick, puberulent, lateral margins flat above or slightly grooved (not sulcate); leaf blades (2.5–)4–8(–10) cm long, 1.5–4(–5) cm broad, narrowly to broadly elliptic, elliptic-oblong or slightly obovate, acute to short-acuminate (obtusate in short broad leaves) at the apex, acute to obtuse at the base, drying stiffly chartaceous, pale brown or occasionally dark, usually lustrous and sparsely puberulent on the midvein above, very sparsely to densely puberulent beneath with slender or crooked hairs, often with tufts of longer (0.6 mm) hairs in the vein axils or along the midvein beneath, with 2–6 major secondary veins on each side, central secondaries arising at angles of 30°–60°. Inflorescences axillary from distal or older leaves, 5–9 cm long, paniculate, peduncles usually longer than the flowering rachis, pedicels 4–8 mm long, glabrous or puberulent. Flowers 3–8 mm broad, tepals 2–3 mm long, equal, glabrous or puberulent on the outside, glabrous or papillate-puberulent within; outer stamens with oblong anthers 0.7–1 mm long, 0.5–1 mm broad, on filaments 0.5–1 mm long, inner stamens ca. 1.4 mm long with narrow anthers 0.7 mm long, staminodes 0.5–1 mm long and slender or capitate (sometimes absent), floral tube often with hairs at the edge; pistil 2–3 mm long, glabrous, style ca. 1 mm long, stigma simple or lobed. Fruits subtended by a shallow cup 10–12 mm broad and 2–3 mm deep, margin entire or with short persisting perianth parts, gradually or abruptly expanded above the elongated (1–2 cm) thickened (ca. 4 mm) pedicel; berry 15–30 mm long, 10–20 mm thick, ellipsoid, dark green.

Shrubs and trees of evergreen montane forest formations, between (1000) 1500 and 3200 m elevation. Flowers have been collected in September and December–June; fruits have been collected in January–August. The species is found in the Cordillera de Tilarán, along the northern edge of the Meseta Central near Palmira, on Volcán Irazú, and above Cartago, and from the Cordillera de Talamanca to the Chiriquí highlands of Panama.

Ocotea pittieri (formerly *Phoebe pittieri*) is usually recognized by the stiff smaller hirsutulous leaves, with minor venation raised below, the often lustrous upper surfaces, and a tendency to dry yellowish brown. We interpret this species broadly, and in the sense that the name has been used by Standley and others (in herb.). *Ocotea pittieri* has not been collected in the area between Volcán Poás

and the western slopes of Volcán Irazú. This peculiar pattern is also found in *O. mollicella* which is closely related and easy to confuse with *O. pittieri*. The leaves appear to be broader and larger in collections from the eastern part of the Cordillera de Talamanca. *Ira amarillo* is reported as a common name in Costa Rica.

Staminodes are often poorly developed in this species, though they can be well developed in some individuals. Leaf texture and venation is very different from *Phoebe cinnamomifolia* and its allies. Moreover, Oscar Castro of the University of Costa Rica has found (pers. comm.) that the chemistry of *O. pittieri* is like that of some Costa Rican *Ocotea* spp., and not like that of *Phoebe mexicana* (part of *P. cinnamomifolia* in a wide sense). Thus the correct placement of *Ocotea pittieri* and its close relative *O. mollicella* is in the genus *Ocotea*. Specimens from Mexico and northern Central America placed under the names *Phoebe bourgeauviana* Mez and *Phoebe psychotrioides* Mez appear to be closely related to *O. pittieri*.

The type of *Ocotea pittieri* (Tonduz 11893, photo of specimen destroyed at B in F, US) has broader thinner leaves that have dried darker than is usual for this species. This type material resembles *O. brenesii* somewhat, but that species never has such narrow leaves, and the leaves usually dry very dark and thin. It appears that some newly flushed leaves have dried dark and thin (in the material at US), but other leaves (as in the photo from B) appear more characteristic of the specimens traditionally placed under this name in herbaria. The photo, we believe, justifies the continued use of this name for the material placed here.

Ocotea pseudopalmana W. Burger, sp. nov. Figure 6.

Arbor usque 30 m alta, ramulis foliiferis 2.6–9 mm crassis, ferrugineo-puberulis. Folia alterna, petiolis 6–15 mm longis, puberulis; laminis 8–16(–21) cm longis et 3–9 cm latis, ellipticis vel oblongo-ellipticis, apice obtuso vel brevi-acuminato, subtus brunneolo-puberulis, nervis secundariis nullis; gynoeceum 2.3–4 mm longum, stylo usque 2.3 mm longo. Fructus ellipsoideus vel oblongus, 2.2–2.8 cm longus et 1.5–2 cm crassus; cupula 11–14 mm lata, 3–8 mm longa.

Trees 4–20(–30) m tall, leafy branchlets 2.6–6(–9) mm thick, densely velutinous to tomentulose with short (0.2–0.6 mm) yellowish brown or brownish hairs, terete or

with longitudinal ridges in early stages. **Leaves** alternate in a spiral, petioles 6–15 mm long, 2–3 mm thick, flat or slightly sulcate above, densely puberulent; **leaf blades** 8–16(–21) cm long, 3–9 cm broad, elliptic to elliptic-oblong or slightly obovate, tapering abruptly to a short-acuminate or bluntly obtuse apex, obtuse to cuneate at the base and often slightly decurrent, margin often slightly revolute (especially near the base), drying subcoriaceous or coriaceous, puberulent on the major veins above but becoming glabrescent and impressed in age, lower surface with brown or yellowish brown hairs 0.3–0.5 mm long, with 5–8 major secondary veins on each side, the central secondaries arising at angles of 45°–70°, tertiary venation usually prominent beneath. **Inflorescences** solitary and axillary to leaves, 6–15 cm long, racemose or narrowly paniculate and with few (4–12) flowers, peduncle 4–10 cm long, 1.2–2 mm thick, densely brownish puberulent, pedicels 3–8 mm long. **Flowers** 5–7 mm long, 6–8 mm broad, campanulate, densely puberulent on the outside, tepals ca. 3.5 mm long and 3 mm broad, drying dark and papillate-puberulent within; **outer stamens** with prominent (0.6 mm) broad filaments and oblong anthers ca. 1 mm long and 1 mm broad, inner stamens ca. 2 mm long with glands 0.7–1 mm thick, staminodia absent; **pistil** 2.3–4 mm long, ovary narrowed at the base, style 1.5–2.3 mm long, stigma subcapitate. **Fruits** borne on a flat or shallow (0–3 mm) cup 11–14 mm broad, to 8 mm long and conical or as little as 3 mm long and saucer-like, the cup gradually or abruptly expanded above the thickened pedicel, red at maturity; berry 2.2–2.8 cm long and 1.5–2 cm in diameter (dry), broadly ellipsoid or oblong, becoming black.

TYPE—Costa Rica, San José Province, east of La Chonta, 11 May 1969, *Roy W. Lent 1679* (holotype, F 1749018; negative, 61218; isotype, CR).

Trees of wet evergreen montane forest formations, from 1500 to 2500 m elevation in areas subjected to moist winds from the Caribbean and adjacent areas. Flowering material has been collected in February–September; mature fruits have been collected in April–October. This species is only known from the slopes of Volcán Irazú and eastward through the Cordillera de Talamanca as far as the border with Panama.

Ocotea pseudopalmana is recognized by the dense pubescence on the underside of the leaves and exterior of flowers, the stiff leaves that usually dry dark brown above, the few-flowered inflorescences, the larger flower size, and the cloud forest habitat. This species is related to *O. gomezii* with much larger flowers, larger more rounded leaves, and lower-altitude (800 to 1400 m) habitat. This species resembles *O. mollifolia*, but that species has broader thinner leaves, smaller flowers, and fruit cups with persisting perianth lobes. This species also resembles members of the *O. helicterifolia*-*O. valeriana* complex, but those species have smaller glabrescent flowers with staminodes

and deeply cupulate fruiting receptacles. The material placed here resembles *Phoebe amplifolia* Mez & J. D. Smith, from highland Guatemala; but while that species has rather similar flowers, the small (0.7 mm) sagittate-capitate staminodes are distinctive, and the leaves are larger and often with long (3 cm) petioles. Some of the collections placed here were earlier identified as *Ocotea palmana*, but that species is actually a *Pleurothyrium* (q.v.). Material placed here includes: *Almeda & Nakai 3834* (CAS, CR, F), *Brown 17518* (F, LSU), *Davidse et al. 28550, 28906* (CR, MO), *Holdridge 6555, 6575* (CR, NY), *Rosbach 3171* (GH), *Standley 38633, 38848* (US), *Wilbur & Almeda 16714* (DUKE).

Ocotea puberula (Rich.) Nees, Syst. Laurin. 472.

1836. *Laurus puberula* Rich., Actes Soc. Hist. Nat. Paris 1: 108. 1792. *O. pyramidata* Blake ex Brandegee, Univ. Calif. Publ. Bot. 7: 326. 1920.

Trees 7–15(–27) m tall, to 50 cm d.b.h., bark pale gray, leafy branchlets 1.7–7 mm thick, flattened or ribbed with longitudinal ridges extending downward from the leaf bases, glabrous or sparsely and minutely (0.1 mm) puberulent, young stems drying dark, older stems pale grayish. **Leaves** with petioles 10–26(–30) mm long, 0.7–2 mm broad, glabrous distally but with minute (0.1 mm) hairs near the base adaxially, distally sulcate above; **leaf blades** 7–21(–25) cm long, 2.5–8(–12) cm broad, elliptic-oblong to narrowly elliptic or narrowly ovate-elliptic, tapering gradually to an acuminate apex (or tapering abruptly to a short-acuminate apex in broader leaves), acute to obtuse at the base and slightly decurrent on the petiole, drying stiffly chartaceous and grayish green to olive green, dull or lustrous above, essentially glabrous above, glabrous beneath or with minute hairs along the major veins, with 5–9 major secondary veins, lacking domatia, tertiary veins elevated on the dried surfaces above and below and forming a weak reticulum of broad (1–3 mm) areolae. **Inflorescences** axillary, 4–7 cm long, peduncles 1–8 mm long, rachis minutely puberulent, with a few proximal lateral branches to 15 mm long, pedicels 1–3 mm long. **Flowers** unisexual and dioecious, glabrous distally on the outside; male flowers 3–5 mm long, perianth lobes 2–2.7 mm long, 1.7–2.2 mm broad; **outer stamens** 2–2.5 mm long, filament flattened, anthers ca. 1.2 mm long and 0.7 mm broad, valves superposed, inner stamens slightly shorter, glands 0.7–1 mm wide, staminodes absent; pistillode ca. 1.3 mm long and 0.4 mm in diameter. **Female flowers** 2–3 mm long, 2.5–3.5 mm broad, perianth parts ca. 1.5 mm long, nonfunctional stamens 1–1.2 mm long and with anthers ca. 0.5 mm long; **pistil** ca. 2.2 mm long, ovary ca. 0.9 mm in diameter, style ca. 0.8 mm long, stigma flat, disclike, and drying dark. **Fruits** borne on a short (2–4 mm) distally flattened receptacle 4–8 mm broad at the top (but more cuplike in life), with undulate or 6-lobed margin, pedicels 4–16 mm long; berry 6–8 mm in diameter (dried), globose, green becoming black and lustrous.

A species of lowland evergreen and partly deciduous forest formations. Flowers have been collected in December–January in Panama; fruits have been collected in January–February. Though little collected in Central America, this species ranges from Mexico to Argentina.

Ocotea puberula is recognized by the functionally unisexual flowers on unisexual (dioecious) trees, small globose fruits subtended by flattened receptacles or weakly developed cups, and larger elliptic-oblong *Nectandra*-like leaves. Fruiting material closely resembles a number of our species of *Nectandra*, but the inflorescences of *O. puberula* have fewer branches and the cups are not as well developed. This species was first collected in Costa Rica near Palmar Norte in 1988, after the manuscript was completed; it was not possible to include this species in the keys. We thank J. Rohwer for the determination.

***Ocotea rivularis* Standl. & L. O. Williams, Ceiba 1: 238, 1951. Figure 2.**

Medium-sized trees to 15 m tall, leafy branchlets 4–12 mm thick. Leaves alternate, petioles ca. 1 cm long and 5 mm thick, sulcate and winged, glabrous; leaf blade 30–45 cm long, 15–23 cm broad, obovate, abruptly rounded near the apex to a bluntly short-acuminate apex, tapering gradually to the attenuate base, margin entire and slightly revolute, drying stiffly chartaceous, smooth and glabrous above, essentially glabrous and reddish brown beneath, with 10–14 major secondary veins on each side, central secondaries arising at angles of 50°–65°, tertiary venation subparallel but obscure. Inflorescences axillary to distal leaves, 18–30 cm long, paniculate, peduncles 7–10 cm long, reddish and 2–3.5 mm thick, pedicels 1–2 mm long, minutely puberulent. Flowers ca. 3 mm long and 3 mm broad, greenish, tepals to 2 mm long and glabrous within; outer stamens with filaments almost equalling the length of the anthers, outer anthers ca. 0.6 mm long and 0.5 mm broad, staminodes absent; pistil ca. 2 mm long with slender style 0.8 mm long. Fruits borne in a small (4 mm long and 6 mm broad) cupulate receptacle 2–3 mm deep with persisting small broad perianth bases; berry ca. 12 mm long and ellipsoid.

Trees of the evergreen rain forest formations of the Pacific lowlands; flowering in July–early August. This species is endemic to southern Puntarenas Province in the Golfo Dulce area.

Ocotea rivularis is easily recognized by its very large obovate thin-textured leaves, attenuate lamina base with revolute margins, large inflorescences with small flowers, and small lobed cups with ellipsoid fruits. The leaves are essentially glabrous but may have very thin appressed hairs (0.2

mm long) on the underside which are difficult to see. This species is very closely related to *O. insularis*, with smaller thicker leaves. Paul Allen (1956, pp. 276–277) stated that the species was common around the type locality near Esquinas. This species is only known from Allen 5590 (F, MO, US, the type) and Grayum et al. 4068 (CR, MO), from near Rincón.

***Ocotea skutchii* C. K. Allen, J. Arnold Arbor. 26: 352, 1945. *Nectandra producta* C. K. Allen, loc. cit. 397, 1945. *O. williamsii* P. A. Allen, The Rain Forests of Golfo Dulce, 410, pl. 27, 1956, non *O. williamsii* (O. C. Schmidt) Kosterm., J. Sci. Res. (Jakarta) 1: 122, 1952. Figure 11.**

Trees to 30 m tall, often with prop roots near the base, leafy branchlets 2.5–5 mm thick, minutely (0.1–0.3) puberulent with brownish or silvery appressed hairs but quickly becoming glabrous, terete. Leaves alternate, petioles 0.5–5 cm long but difficult to delimit because of the decurrent and revolute lamina base, narrowed portion of the leaf base to 5 cm long, minutely puberulent or glabrescent, flat above; leaf blades 8–13 cm long, 2.5–5 cm broad, elliptic-obovate to elliptic-oblong or narrowly elliptic-oblong, usually short-acuminate at the apex, tapering gradually to a cuneate or acute base and decurrent on the petiole, margin strongly revolute near the base, drying stiffly chartaceous to subcoriaceous, glabrous except for minute hairs above the midvein near the petiole, often lustrous above and glaucous beneath, minutely and obscurely puberulent beneath with thin appressed hairs ca. 0.3 mm long and parallel with the secondary veins, with 5–9 major secondary veins on each side, central secondaries arising at angles of 35°–55°. Inflorescences axillary to distal leaves, 8–18 cm long, openly branched panicles, peduncles to 6 cm long, ca. 1.5 mm thick and sparsely appressed puberulent, pedicels 1–3(–5) mm long. Flowers 2.5–3.5 mm long, 3.5–5.5 mm broad, campanulate, tepals ca. 2 mm long and 1.5 mm broad, obtuse, densely puberulent on the outside and minutely papillate within; outer stamens 0.6–1.3 mm long, filaments 0.1–0.7 mm long, outer anthers 0.5–0.8 mm long and equally broad or broader, thecae superposed or occasionally the lower somewhat lateral to the upper (*Nectandra*-like), inner stamens ca. 1.5 mm long and with large glands, staminodes not seen; pistil 1.5–2.5 mm long, style slender and equalling the ovary in length, stigma slightly discoid. Fruits borne in a broadly cupulate receptacle ca. 1 cm long and 10–15 mm broad, red; berry 3–4 cm long, 13–18 mm in diameter, ellipsoid-oblong.

Trees of evergreen lower montane forest formations in the central volcanic highlands and the Cordillera de Talamanca, from (30) 600 to 1400 m elevation. Flowering material has been collected in December (*Skutch 3062*, GH, NY, the type of *O. skutchii*) and January (*Skutch 3906*, AA, NY, the

type of *N. producta*). Fruits were collected in April (*Salas 392*, USJ). This species is only known from the central highlands and the General Valley in Costa Rica.

Ocotea skutchii is recognized by the average-sized elliptic-obovate leaves with long-decurrent and revolute lamina base, the slender appressed hairs on the lower leaf surfaces, and the puberulent flowers with variable stamens. The leaves are often lustrous above and glaucous beneath. This species is part of a group of taxa related to *O. glaucosericea*, which often become tall trees with basal prop roots and have the same characteristic pubescence on the lower leaf surfaces in early stages. There is the possibility that the plants placed here may intergrade with *O. glaucosericea* at slightly higher elevations. A few collections of *O. austinii* (such as *Solano 3 CR*, F) also appear as if they could represent intermediates with *O. skutchii*. There is also the possibility that this species intergrades with *O. whitei* of somewhat higher elevations. Whether collections which appear intermediate are simply extremes of variation within their species, or whether this is actually a single polymorphic complex of intergrading populations, are questions that cannot be resolved without further study and more collections.

Caroline Allen (1966) placed Paul Allen's *Ocotea williamsii* (1956) into synonymy under *O. skutchii*, and this may be correct. The long narrow fruits (4.8 × 2 cm) on small cupular receptacles are distinctive. The flowers of the type (*Allen 5983*, US) are abnormally developed, lacking both stamens and pistils. The tufts of hairs along the midvein on the lower leaf surface may also be abnormal. Regardless, the name *O. williamsii* is a later homonym and cannot be used as a specific epithet.

***Ocotea stenoneura* Mez & Pittier**, Bull. Herb. Boissier, ser. 2, 3: 233. 1903, emend. C. K. Allen, J. Arnold Arbor. 26: 334–335. 1945.

Trees to 20 m tall, leafy branchlets 3–7 mm thick, densely reddish brown tomentulose, becoming grayish and terete. **Leaves** alternate, petioles difficult to delimit because of the strongly revolute lamina margin, narrowed basal portion of the leaf 1.5–3 cm long and 2.5–7 mm broad, flat or broadly sulcate above; **leaf blades** ca. 18–20 cm long, 9 cm broad, broadest at or near the middle, elliptic-oblong, abruptly narrowed at the acute to short-acuminate apex, tapering and slightly rounded above the revolute base, drying subcoriaceous, glabrous above or with short hairs above the midvein and with the subparallel tertiary venation often slightly raised above, densely ferruginous-pilose (or tomentulose?) be-

neath with appressed hairs 0.1–0.5 mm long, with 10–12 major secondary veins on each side, the central secondaries arising at angles of 35°–60°. **Inflorescences** axillary to distal leaves, somewhat shorter than the leaves, peduncles 4–8 cm long to 4 mm thick and densely puberulent. **Flowers** unknown, dried stamens (on the fruiting cupules) resembling those of *O. insularis* (fide Rohrer, 1986, p. 145). **Fruits** borne on flat saucer-like receptacles, ca. 1 cm broad and 2–3 mm deep, often with triangular perianth lobes persisting on the margin; berry (perhaps not mature) globose, 10–13 mm in diameter.

A poorly known species of evergreen forests, from near sea level to 1000 m elevation. Collected near Las Vueltas, Tucurrique, Cartago Province; fruiting in February (*Tonduz 13377*, photo of B at F, the lectotype; C. K. Allen, 1945). *Skutch 3014* (MO, NY), flowering in December in the General Valley, is provisionally placed here. The species is endemic to Costa Rica.

Ocotea stenoneura is distinguished by its larger puberulent leaves with short strongly revolute lamina base, and the small globose fruits on relatively flat receptacles. Whether this material represents a very rare species or aberrant individuals of a population placed under another name in this treatment is difficult to say. Some specimens earlier identified as *Ocotea stenoneura* are now placed under *O. dentata*, a member of the *O. insularis* alliance, with very different fruits and more obovate leaves.

***Ocotea tenera* Mez & J. D. Smith ex Mez**, Bull. Herb. Boissier, ser. 2, 3: 234. 1903. Figure 13.

Shrubs or small trees 3–8(–12) m tall, to 15(–20) cm d.b.h., leafy branchlets 1.5–3.8 mm thick, glabrous from the earliest stages, drying terete and dark. **Leaves** alternate, usually distichous in a single plane and not crowded, petioles 6–12 mm long, ca. 1 mm thick, lateral margins forming a sulcus adaxially, glabrous; **leaf blades** (5–)7–16(–20) cm long, (1.5–)3–6(–8) cm broad, elliptic to elliptic-oblong or ovate-elliptic, tapering gradually to the acute or acuminate apex, acute to obtuse at the base, usually drying very dark and thin-chartaceous in texture, glabrous above and below, minor veins slightly raised above, with 4–7 major secondary veins on each side, central secondaries arising at angles of 50°–70°, often loop-connected near the margin distally, often with pit domatia. **Inflorescences** 4–8(–12) cm long, axillary or extra-axillary on distal stems, paniculate with relatively few widely spaced flowers, glabrous, peduncles to 4 cm long, pedicels slender, ca. 3.5 mm long. **Flowers** greenish white to yellowish (but drying black), 1.5–3 mm long, glabrous, tepals ca. 1.5 mm long; outer **stamens** 0.6–1.2 mm long, with broad short filaments, outer anthers ca. 0.7 mm long, narrowed apically and with superposed thecae, staminodes absent or minute, glabrous or with a few hairs around the edge of the floral tube within;

pistil 1.5–2.3 mm long, ovary globose or ovoid, style usually equalling the ovary in length, stigma simple. **Fruits** borne on the flattened apex of the thickened pedicel, a cuplike receptacle absent or shallow (2–3 mm), 1 cm broad and with an undulate margin, usually pendant, becoming rose red or bright red, thickened portion of the pedicel 1–3 cm long; berry 2–3 cm long and 1–2 cm thick, ovoid or oblong, becoming purple or black.

Trees usually found at forest edges and in secondary vegetation at lower elevations and in forest understory at higher elevation, in evergreen wet forest formations of the Caribbean slope and central highlands, between 50 and 1500 (1700) m elevation. Flowering collections have been made in August–March, and fruits have been collected in August–September. This species is endemic to Costa Rica, ranging from the Cordillera de Tilarán to the valley of the Río Reventazón and Puerto Limón.

Ocotea tenera is a distinctive species of Lauraceae with its small stature, limited range, thin elliptic leaves that dry very dark, minute flowers which almost become black when dry, ellipsoid fruits on a flattened receptacle at the apex of a thickened pedicel, and the lack of puberulence. The species has been reported to be dioecious (C. K. Allen, 1945, p. 357) but this may be an error, as most plants appear to have bisexual flowers. *Ocotea tenera* is closely related to *O. bernoulliana* Mez of Guatemala, but that species has a more deeply cupulate fruiting receptacle and the leaves do not become as dark when dry. *Ocotea brenesii*, with broader leaves, larger flowers, and the floral cup hairy within, appears to be closely related to *O. tenera* and may be difficult to separate. *Ocotea cernua* and *O. meziana* are also similar, but their leaves do not become so dark when dried.

***Ocotea valeriana* (Standl.) W. Burger, comb. nov.**

Phoebe valeriana Standl., Field Mus. Nat. Hist., Bot. Ser. 18: 460. 1937. *P. smithii* C. K. Allen, J. Arnold Arbor. 26: 317–318. 1945. Figure 6.

Trees 3–12(–20) m tall, leafy branchlets 2.5–8 mm thick, densely strigulose to tomentulose with yellowish brown to dark brown hairs 0.1–0.5 mm long. **Leaves** alternate, differing greatly in size and shape on different trees, petioles 4–22(–28) mm long, 1.7–3 mm thick, sulcate above, tomentulose to strigulose; **leaf blades** 8–25 cm long, 3.5–14 cm broad, broadly obovate to oblong (usually widest above the middle), abruptly narrowed to the short-acuminate, obtuse or rounded apex, obtuse to rounded (cordulate) at the base, equal or subequal, drying subcoriaceous and yellowish brown to dark brown, minutely puberulent on the vein above and sparsely pu-

berulent to glabrous between the veins, dull or lustrous, strigulose on the veins beneath with slender hairs ca. 0.3 mm long, with (4–)5–10 major secondary veins on each side, central secondaries arising at angles of 35°–60°. **Inflorescences** 5–25 cm long, distal and with the subtending leaves often caducous, peduncles (1–)3–9 cm long, 1–3 mm thick, densely strigulose, dark or with yellowish brown hairs, lateral branches of the rachis with (1–)3–7 flowers and not further branched, pedicels slender, 2–10 mm long. **Flowers** 4–6 mm long and 6–15 mm broad, essentially glabrous outside and within, perianth pellucid punctate, tepals ca. 3 mm long; outer **stamens** with anthers 0.9–1.5(–2) mm long, 1–1.3(–1.7) mm broad, oblong to slightly broader than long, filaments very short, staminodes absent or small or up to 1 mm long; **pistil** ca. 2.5 mm long, ovary ca. 1.5 mm in diameter, narrowed at the base, style ca. 1 mm long, stigma discoid. **Fruits** borne in a cup 9–14 mm long, 10–18 mm broad, 5–8 mm deep, cupulate or hemispheric, margin entire or with the persisting perianth bases, red; berry ca. 3 cm long and 1.8 cm in diameter, obovoid to ellipsoid, obtusely apiculate at the apex, black.

Trees of evergreen montane forest formations, from (1000) 1400 to 2200 m elevation. Flowering in January–May; fruits have been collected in December–February and May–June. The species ranges from the Cordillera de Tilarán, along the Caribbean escarpment and continental divide of the central volcanic highlands as far east as the western slopes of the General Valley in the Cordillera de Talamanca. Endemic to Costa Rica (but see below).

Ocotea valeriana (formerly *Phoebe valeriana*) is a very variable species characterized by the stiffly chartaceous to subcoriaceous laminae that are puberulent beneath and usually broadest above the middle. The glabrous flowers drying black, pellucid-punctate perianth, distinctive puberulent inflorescences with lateral branches usually bearing long-pedicel flowers (and not further branched), and middle elevation habitat further distinguish this species. Staminodes may be present or absent, but there are rarely three well-developed staminodes, as in species of *Phoebe*. *Ocotea valeriana* may prove to be a high elevation derivative of *O. helicterifolia*, but the fruit cups are larger and deeper than in Costa Rican material of that species. There are highland specimens from Guatemala that are very similar to *O. valeriana*, but these are placed in *O. helicterifolia* and seem to intergrade with more typical lowland forms of *O. helicterifolia* in Guatemala and Mexico. There is little evidence for such intergradation in Costa Rica, but it may be present (see the discussion under *O. helicterifolia*).

Phoebe smithii (based on *A. Smith P.C. 367*, ♀) has very short petioles, short inflorescences, and

more oblong laminae slightly rounded at the base. In addition, the anthers are more often broad (their length equaling their width), and the staminodes are smaller or more often absent. Specimens here placed under *Ocotea valeriana*, but more like the type of *P. smithii* appear to predominate in collections made from the Cordillera de Tilarán. However, there are many intermediates throughout the range of the species, and populations at several localities have both the extreme forms and the intermediates.

***Ocotea valeroides* W. Burger, sp. nov. Figure 2.**

Arbor 5–15 m alta, ramulis foliiferis 5–12 mm crassis. Folia alterna, saepe aggregata, petiolis 4–14 mm longis, 3–6 mm crassis; laminis 13–38 cm longis et 10–22 cm latis, obovatis vel oblongo-obovatis, subtus tomentosus, nervis secundariis 8–12 paribus. Inflorescentiae paniculatae, 9–30 cm longae, pedunculis usque 18 cm longis. Flores 4–5(–7) mm longi et 8–10 mm lati, extus parce puberuli, tepalis intus minute papillatis; stamina ser. I–II antheris 1–1.2 mm longis, staminodiis nullis. Fructus ellipsoideus, 28–36 mm longus.

Small trees 5–15 m tall, to 40 cm d.b.h., leafy branchlets 5–12 mm thick, densely tomentulose with yellowish to dark grayish brown hairs to 0.5 mm long. Leaves usually clustered at the ends of branchlets, petioles 4–14 mm long, 3–6 mm thick, densely tomentulose, broadly sulcate above; leaf blades 13–38 cm long, 10–22 cm broad, obovate to oblong-obovate or slightly pandurate, abruptly rounded and short-acuminate at the apex, tapering gradually to the cuneate base and slightly rounded at the petiole, drying stiffly chartaceous, dark brown above and slightly lustrous, minutely puberulent above the major veins, lower surface paler in color and with a dense tomentum of short (0.3 mm) thin straight hairs slightly rough to the touch, with 8–12 major secondary veins on each side, central secondaries arising at angles of 40°–60°, tertiary veins prominent beneath and often subparallel. Inflorescences axillary to distal leaves or scalelike undeveloped leaves, racemiform panicles with short lateral branches to more openly paniculate with spreading side branches, (5–)9–30 cm long, primary peduncles to 18 cm long, 1–2.5 mm thick, densely yellowish brown puberulent, pedicels 3–11 mm long. Flowers 8–10 mm broad, 4–5(–7) mm long, rotate at anthesis, perianth parts ca. 4 mm long and 2 mm broad, sparsely puberulent on the outside and minutely papillate within; outer stamens subsessile and sometimes broader than long, outer anthers 1–1.2 mm long and 0.9–1.2 mm broad, thecae usually superposed but the lower occasionally lateral (resembling *Nectandra*), inner stamens biglandular, staminodes not seen, the edge of the floral tube with straight erect hairs around the base of the stamens; pistil 1.7–2.5 mm long, ovary rounded, style slender, 0.7–1.1 mm long, stigma discoid. Fruits borne on a broad (12–16 mm), shallow (ca. 5 mm deep) cup gradually expanded from a thickened (3–5 mm) pedicel, longitudinal ridges sometimes present and giving the margin of the cup an

undulate appearance, becoming red; fruits 28–36 mm long and 14–22 mm in diameter, ellipsoid or slightly obovoid.

TYPE—Costa Rica, Alajuela Province, 1 km S of Cariblanco along the Sarapiquí road, elevation about 850 m, 15 Sept. 1974, Gary S. Hartshorn 1530 (holotype, CR 71922; isotypes, F [negative, 61118], MO).

Trees of the very wet Caribbean slope and lowlands, between 40 and 850 m elevation. Flowers have been collected in July and September; fruits were collected March–May and July. This species has only been collected in central Costa Rica (from Cariblanco, Alajuela, to between Siquirres and Turrialba, Limón) and in the province of Bocas del Toro, Panama.

Ocotea valeroides is recognized by the large obovate puberulent leaves with short thick petioles, the larger flowers with subsessile anthers, and racemiform panicles with densely yellowish brown puberulent rachis. This material had been filed under *Phoebe valeriana* (now *Ocotea valeriana*) in herbaria, but *O. valeroides* has much larger leaves, a lower elevation habitat, more puberulent flowers, and stamens with the anthers often developing a *Nectandra*-like configuration. In fact, this species may represent a tendency fully expressed in *Nectandra belizensis*, which appears to be related, as does *O. helicterifolia*. All these species are part of a complex that deserves serious study. Within our material the lower elevation collections have larger leaves (Gómez & Herrera, 23619, CR, MO; Grayum et al. 3519, CR, F, MO; Zamora & Elizondo 674, CR, F), and those around 800 m have somewhat smaller leaves (Hartshorn 1530, CR; Holdridge 6719, CR, NY; Poveda & Castro 3920, CR, F). The altitudinal separation of *O. valeroides* and *O. valeriana* is consistent with patterns seen in many genera and families; a clinal connection is unlikely. There may be a close relationship with *O. lentii*, and the possibility of intermediates with that species should be explored. The leaves of a fruiting collection from Panama (Kirkbride & Duke 486, MO) differs from Costa Rican collections in vesture and prominence of the tertiary veins, while another collection from Panama (von Wedel 2264, MO) is more typical.

***Ocotea veraguensis* (Meissn.) Mez, Jahrb. Königl. Bot. Gart. Berlin 5: 240. 1889. *Sassafridium veraguense* Meissn. in DC., Prodr. 15, pt. 1: 171. 1864. *O. paradoxa* Mez, Bot. Jahrb. Syst. 30,**

Bcibl. 67: 16. 1901. *O. bakeri* Blake, Contrib. Gray Herb. 52: 65. 1917. Figure 14.

Small trees 4–10 m tall, leafy branchlets 1.2–5 mm thick, at first minutely puberulent with grayish appressed hairs 0.1–0.3 mm long, surfaces becoming grayish or dark and smooth to striate. Leaves separate along the stem or somewhat clustered distally, petioles (3–)5–10(–15) mm long, ca. 1 mm thick, lateral margins forming an adaxial sulcus and the midvein prominent within the sulcus; leaf blades 6–14 cm long, 2–5 cm broad, elliptic to elliptic-oblong, elliptic-obovate or narrowly ovate-lanceolate, obtuse to bluntly acute at the apex (sometimes rounded and rarely acute), acute to obtuse at the base, drying stiffly chartaceous to subcoriaceous, smooth and glabrous above and below (rarely minutely puberulent beneath), often drying grayish and slightly lustrous above, with 5–8 major secondary veins on each side and the central secondaries arising at angles of 30°–60°. Inflorescences axillary to distal leaves or pseudoterminal, 5–16 cm long, basal branches of the inflorescence longer than the distal and forming a rounded panicle of 8–50 flowers, peduncle 3–9 cm long, very minutely puberulent. Flowers 5–10 mm broad, white turning brown, with the odor of jasmine, tepals imbricate, to 3 mm broad and rounded at the apex, minutely papillate puberulent; outer anthers 1.5–2.5 mm long and sessile or subsessile, ovate-triangular to lanceolate and flat, papillate puberulent, staminodes inconspicuous or absent; pistil 1.5–2 mm long. Fruits borne in a shallow cup 1–1.6 cm broad and 1–5 mm deep, usually with an outer undulate ridge and an interior entire margin, the cup abruptly expanded above the thickened pedicel, red at maturity; berry up to 2.5 cm long and 1.8 cm thick, ellipsoid, becoming black.

A species of deciduous and partly deciduous forest formations, from near sea level to about 1200 (1600) m elevation along the Pacific slope and Meseta Central. The principal flowering time is in December–March, and fruiting is mostly in February–May. This species ranges from central Mexico to Panama.

Ocotea veraguensis is recognized by its stiff glabrous leaves that often dry grayish (or yellowish), inflorescences with long peduncles, relatively large flowers with flattened papillate puberulent outer stamens, and the short broad fruit cup with 2-ridged margin. The restriction to deciduous or seasonally very dry forests along the Pacific slope is another distinction. The margins of the fruit cups resemble those found in *Licaria*, and collections from moister forests, such as on the Osa peninsula, resemble *L. cufodontisii* in their darker more acuminate leaves.

Ocotea viridiflora Lundell, Wrightia 5: 36. 1974.

Trees 3–8(–20) m tall, leafy branchlets 1–3 mm thick, glabrous, longitudinally ridged in early stages but soon

becoming terete and dark or grayish. Leaves alternate in a spiral, petioles (4–)5–12 mm long, 0.7–1.2 mm thick, glabrous, with adaxial ridges forming a deep narrow sulcus above near the stem; leaf blades 3–10(–12) cm long, 1–4 cm broad, narrowly elliptic to elliptic-oblong or slightly oblanceolate, gradually narrowed to the acuminate or caudate-acuminate apex, the narrow (2–3 mm) tip 1–2 cm long on some leaves, acute at the base and slightly decurrent on the petiole, drying stiffly chartaceous, glabrous and slightly lustrous above with the venation slightly elevated, glabrous beneath, with (3–)4–7 major secondary veins on each side, central secondaries arising at angles of 30°–60°, the minor venation raised beneath when dry and forming a reticulum of weakly defined areolae, distinctive pit domatia often present in the vein axils and on the secondary veins beneath. Inflorescences axillary to distal leaves, small (2–5 cm) and racemose or umbellate (rarely paniculate), peduncles 1–3 cm long and ca. 0.5 mm thick, glabrous, pedicels 2.5–7 mm long. Flowers 2.5–4 mm long and 3–4 mm broad, glabrous on the outside, tepals ca. 2 mm long and glabrous within; outer stamens 1.3–2 mm long, outer anthers 0.8–1 mm long and 0.6–0.8 mm broad, rectangular with superposed thecae, inner stamens ca. 2.2 mm long with large (2.2 mm) glands and strigulose filaments, staminodes slender and small (0.5 mm), slightly strigulose; pistil 2–3 mm long, ovary ellipsoid, style half the length of the pistil, stigma slightly discoid. Fruits borne in a small deep cup ca. 7 mm long and 10 mm broad, perianth parts persisting or deciduous and the cup entire, red; berry ellipsoid to oblong, 12–25 mm long and 6–12 mm in diameter, green (becoming black?).

Trees of cloud forest formations at elevations of 1400 to 2000 m, along the central cordilleras and in the Chiriquí highlands. Flowers have been collected in April–May; fruits have been collected in March and May–June. A poorly understood species of western Panama, possibly also represented in Costa Rica (see below).

Ocotea viridiflora is recognized by its small narrowly elliptic glabrous leaves with elevated venation (when dry) and distinctive pit domatia, long-acuminate leaf tips, small few-flowered glabrous inflorescences, and oblong fruits in well-developed cups. This species appears to be a close relative of the larger-leaved *O. meziana*, and perhaps *O. laetevirens*. The type of *O. viridiflora* differs from *O. meziana* in having completely glabrous terminal buds. Our use of this name for specimens from Monteverde may be incorrect: the Panamanian populations appear to have lobed fruit cups, while the Costa Rican populations appear to have entire cups. *Nectandra davidsoniana* C. K. Allen of the Chiriquí highlands is another small-leaved species with *Ocotea*-like stamens, easily confused with this species. *Nectandra salicina* has similarly shaped small leaves and lives in similar forests, but lacks pit domatia.

Ocotea wedeliana C. K. Allen, J. Arnold Arbor. 26: 339. 1945.

Trees 3–15 m tall with slender (10 cm) trunks, leafy branchlets 1.2–4 mm thick, minutely (0.1 mm) appressed puberulent and dark but soon becoming glabrous and grayish, usually with 5 narrow longitudinal ridges, the central part of the stem often with a narrow hollow passage. **Leaves** alternate, petioles 6–12 mm long, 1.4–2.5 mm thick, with 2 lateral ridges and usually sulcate above, becoming dark and glabrous; **leaf blades** 12–27 cm long, 4–8(–10) cm broad, narrowly elliptic to narrowly elliptic-oblong or narrowly elliptic-obovate, tapering to an obtuse apex with acuminate tip, the slender tip 7–20 mm long, tapering gradually to the cuneate or acute base, drying thin-chartaceous and often grayish to dark brown, glabrous above and the major veins flat or slightly impressed, sometimes minutely dark punctate above, glabrescent beneath, with 6–9 major secondary veins on each side, the central secondaries arising at angles of 40°–60°. **Inflorescences** axillary to distal leaves, 10–15 cm long, racemose panicles with short (15 mm) few-flowered (3–9) lateral branches, peduncles 7–11 cm long, ca. 1 mm thick and glabrous, pedicels 2–4.5 mm long. **Flowers** white, 2.5–3.5 mm long, 2.5–3.5 mm broad, campanulate, perianth very minutely (0.05–0.1 mm) puberulent on the outside, tepals ca. 2 mm long and 2 mm broad, broadly ovate and obtuse; **outer stamens** ca. 1.5 mm long with puberulent poorly defined filaments, **outer anthers** ca. 1 mm long and 0.8 mm broad, oblong, thecae superposed, **inner stamens** ca. 2 mm long and puberulent beneath the anthers, glands sessile and reniform, staminodes absent; **pistil** 1.8–2.3 mm long with ovoid ovary 1.1 mm in diameter, style ca. 1 mm long with slightly discoid stigma. **Fruits** borne on an expanded flat or saucer-like receptacle 1–2 mm long, 5–8 mm broad, and 0–2 mm deep, margin undulate, becoming red; berry oblong, 12–20 mm long and 8–11 mm in diameter, becoming bluish green.

Trees of the evergreen lowland Caribbean (tropical moist) forest formations. Flowers have been collected in May, and fruits have been collected in January–March. The species ranges from southernmost Costa Rica (*Grayum & Schatz 5286*, CR, MO) and adjacent Bocas del Toro Province to central Panama.

Ocotea wedeliana is recognized by the long thin narrowly elliptic-oblong leaves, narrow longitudinal ribs on distal stems, small oblong fruits, and flat or saucer-like cup with undulate margin. It is not clear whether the open spaces in the center of the twigs are a consistent feature of this species, or if ants inhabit these spaces. This species appears to be closely related to the larger-leaved *O. atirrensis*, and *O. paulii* of higher elevations. The two latter species appear to intergrade at about 500 to 1000 m elevation, and some of those collections resemble *O. wedeliana* quite closely. This species is called *sigua* in Panama.

Ocotea whitei Woodson, Ann. Missouri Bot. Gard. 24: 188. 1937. *Nectandra whitei* (Woodson) C. K. Allen, J. Arnold Arbor. 26: 398. 1945. *O. eusericea* Lundell, *Wrightia* 5: 338. 1977. Figure 11.

Trees 10–35 m tall, leafy branchlets 2–5 mm thick, minutely sericeous at first but soon becoming glabrous and dark brown. **Leaves** alternate, usually clustered at the ends of branchlets, petioles poorly differentiated, 4–18 mm long, sulcate near the base and with lateral margins continuous with the lamina margins, narrowed portion of the leaf to 3 cm long; **leaf blades** (5–)7–14 cm long, (1.5–)2–4.5 cm broad, narrowly obovate to oblanceolate or elliptic-obovate, short-acuminate to bluntly obtuse (rarely rounded in Costa Rica), tapering gradually to an attenuate and decurrent base, margin entire and conspicuously recurved near the base, drying stiffly chartaceous to subcoriaceous, upper surface usually dark and dull with minor venation inconspicuous in Costa Rican collections (but often lustrous and with the tertiary venation slightly raised in Panamanian collections), lower surface glabrous or with thin appressed hairs ca. 0.2 mm long and usually difficult to see, with 6–12 major secondary veins on each side, central secondaries arising at angles of 35°–50°, tertiary venation often slightly elevated beneath, domatia of tufted hairs or pits very rarely present in vein axils beneath. **Inflorescences** axillary to distal leaves, to 15 cm long, peduncles to 6 cm long and 2–3 mm thick, minutely appressed puberulent or glabrous, reddish brown, pedicels 1–2 mm long, puberulent. **Flowers** ca. 3 mm long and 3.5 mm broad, yellowish, puberulent on the outside, tepals ca. 2 mm long and minutely puberulent within; **outer stamens** with short filaments, **outer anthers** 0.6–0.9 mm long and 0.7–1 mm broad, often slightly longer than broad with thecae superposed or the lower somewhat lateral (as in *Nectandra*), staminodes usually absent (in Costa Rican collections); **pistil** ca. 2 mm long, style slender, ovary ovoid. **Fruits** borne in a cupulate or funnelliform receptacle 6–12 mm long, 8–12(–14) mm broad, usually shallow (1–3 mm) but occasionally deeply cupulate, margin entire or undulating, red; berry 15–38 mm long, 10–18 mm thick, ellipsoid or oblong, green.

Trees of wet evergreen cloud forest formations, from 1200 to 2500 m elevation. Flowering collections have been made in March–September; fruits have been collected in May–September and December–January. The species, as here understood, ranges from the Cordillera de Tilarán through the Cordillera de Talamanca into Panama (but see below).

Ocotea whitei is recognized by the smaller and narrow (often oblanceolate) leaves with decurrent lamina base and lamina margin usually revolute near the petiole, and the ellipsoid fruits borne on a small shallow cup. Collections from the area near Monteverde placed here have leaves that are often long-acuminate and usually dry dark with a flat dull upper surface. However, collections near the

border with Panama tend to have lustrous upper leaf surfaces and short-acuminate apices. This species appears to be very variable in the Chiriquí highlands, and the type collection (*Seibert 307*, AA, MO, NY), with leaves drying yellowish brown and the slightly raised tertiary venation on the lustrous upper surfaces, is very different from Monteverde material. Nevertheless, the pattern of variation seen in *O. whitei* in the Chiriquí highlands makes it appear reasonable to place the Monteverde collections under this name; also, the flowers and fruits appear to be identical. This species is closely related to *O. austinii*, and specimens which may represent intermediates have been collected in the Chiriquí highlands. *Ocotea skutchii* is also closely related and there may be intergradation between the two around 1000 m elevation. All these species are, in turn, related to *O. glaucosericea* and its allies, and they form a complex that is difficult to decipher; it may even be a single polymorphic entity with local subspecies (but considered as separate species here).

***Ocotea* sp. A. aff. *Ocotea laetevirens* Standl. & Steyerl.**

Trees 15–25 m tall, leafy branchlets 5–7 mm thick, glabrescent, longitudinally ridged but soon becoming terete. Leaves alternate, petioles 10–25 mm long, 2–4 mm thick, narrowly sulcate above with thin elevated adaxial margins (but with rounded or broadly sulcate petioles in *Standley & Valerio 44651*), glabrous; leaf blades 14–30 cm long, 7–18 cm broad, broadly obovate to broadly elliptic-obovate, abruptly narrowed or rounded to the bluntly obtuse and slightly decurrent base, margin slightly revolute near the base, drying stiffly chartaceous or subcoriaceous and yellowish brown, glabrous and lustrous above, with the minor venation slightly raised (flat in *Standley & Valerio 44651*), glabrous beneath (but with a few hairs in the vein axils in *Poveda et al. 3501*), with 4–7 major secondary veins on each side, central secondaries arising at angles of 40°–60°, lower surface with the minor venation raised and forming a distinct or somewhat obscure reticulum. Inflorescences in anthesis not seen; infructescences short (6 cm in *Standley & Valerio 44651*) to long (22 cm in *Allen 1740*), the peduncles becoming 3–4 mm thick. Fruits borne in pale brown gradually expanded conical cups (in *Standley & Valerio 44651*) or dark cups abruptly expanded from the base (in *Allen 1740*), 10–15 mm long and 10–20 mm broad at the top, 3–7 mm deep, the margins slightly irregular with persisting perianth bases; fruits about 10 mm long and 10 mm broad (but perhaps not mature) and with flat distal surfaces and rugose sides (based on *Allen 1740*; the other collection lacks fruits).

Trees of evergreen lower montane forest formations from near Tilarán at about 750 m ele-

vation (*Standley & Valerio 44651*, US), near Turrialba (*Poveda et al. 3501*, CR, F), and the north rim of El Valle de Antón, between 600 and 1000 m elevation in Coclé Province, Panama (*Allen 1740*, F, MO). Fruiting material was collected in January at Tilarán and March in Panama.

Ocotea sp. A (aff. *O. laetevirens*) is distinguished by its larger glabrous obovate leaves with reticulate minor venation and slightly decurrent lamina base, and the deep, slightly warty, fruit cups with irregular rims. The fruits of the Allen collection differ from all our other Lauraceae with their lustrous flattened tops, but this may be an artifact of immaturity (these flattened tops do not exceed the rims of the cups). The specimens placed here may not be conspecific; only more and better collections can help resolve the status and placement of these collections. Several aspects of leaf structure and the fruit cup suggest a relationship with *O. laetevirens*. A collection with immature fruits from Rincón de Osa (*Liesner 2091*, CR, MO) may also belong here. *Grayum et al. 7859* (CR, MO) from the Atlantic slope of Volcán Barva at 1200 m and with fruits 4.5 × 2.5 cm is provisionally placed here.

***Ocotea* sp. B.**

Trees, ca. 15 m tall, trunk with broad-based prickles (projections) 1–3 cm long, leafy internodes 1–2(–4) mm thick, minutely (0.1 mm) puberulent (juvenile) or glabrescent, becoming dark reddish brown. Leaves alternate, petioles 4–7 mm long; leaf blades 6–10 cm long, (1.5–)2–3 cm broad, elliptic-oblongate, bluntly short-acuminate at the apex, tapering gradually to the decurrent base, drying chartaceous, glabrescent above, sparsely and minutely puberulent along the midvein beneath, with 10–14 obscure secondary veins on each side, the distal secondaries loop-connected near the margin, domatia absent. Inflorescences solitary and axillary, 5–10 cm long, paniculate, peduncles 3–6 cm long, subglabrous, distal flowers in cymose pairs. Flowers 2–3 mm long, 3 mm broad, puberulent on the outside, tepals 1.2–1.4 mm long; outer stamens ca. 0.6 mm long, glabrous, outer anthers 0.4 mm long and 0.5 mm broad, thecae superposed, inner stamens ca. 0.8 mm long with glands 0.3 mm thick, staminodes absent; pistil 1.5 mm long, with a short (0.5 mm) style and simple stigma. Fruits unknown.

Ocotea sp. B is distinguished by the *Zanthoxylum*-like projections on the trunk (absent on younger individuals). The smaller subglabrous elliptic-oblongate leaves with decurrent bases and small paired flowers are also unusual. We have only two collections from near the Marengo Biological Station on the Osa Peninsula: *Burger et al. 12376* (juvenile foliage) and *12377* with a few

flowers in February 1988. More material is needed for a formal description and to determine possible relationships.

Persea Miller

REFERENCES—L. E. Kopp, A taxonomic revision of the genus *Persea* in the Western Hemisphere (Perseae-Lauraceae). Mem. New York Bot. Gard. 14(1):1–120. 1966. L. O. Williams, The avocados, a synopsis of the genus *Persea*, subg. *Persea*. Econ. Bot. 31: 315–320. 1977.

Trees or shrubs, bisexual. Leaves alternate or rarely verticillate, petiolate, the leaf blades entire and pinnately veined. **Inflorescences** axillary or pseudoterminal, solitary or in fascicles, paniculate to racemose (rarely capitate), with persistent or deciduous bracts, puberulent and usually with many flowers, pedicels usually present. **Flowers** bisexual, perianth of 6 parts (tepals) in 2 whorls (series), campanulate to rotate, the outer tepals usually shorter than the inner and glabrous on the inner (adaxial) surface as in subgenus *Eriodaphne* or the outer tepals are equal to the inner tepals and puberulent on their inner surface in subgenus *Persea*, tepals often persisting in fruits, a floral cup or tube absent or only slightly developed; **androecium** of 9 stamens and 3 staminodes, stamens of the outer whorls (series I–II) introrse and with long filaments (in our species), outer anthers 4-theous (rarely 2-theous), the thecae superposed in 2 planes (in Central America), inner stamens (series III) with prominent filaments and each with 2 stipitate or sessile glands near the base, with 4-theous anthers dehiscent laterally, lateral-extrorse or the upper thecae lateral and the lower extrorse (rarely 2-theous or the inner series nonfunctional), staminodes (series IV) usually large and con-

spicuous with sagittate-acute apices; **pistil** glabrous or puberulent, ovary globose to ellipsoid (occasionally stipitate), the style slender and longer than the ovary, stigma small to discoid or triangular-peltate. **Fruits** borne on an enlarged woody or succulent pedicel, the receptacle not forming an enlarged cup, perianth parts often persisting but not enlarging beneath the fruits; berry globose to ellipsoid or pyriform, 1–5 cm in diameter (to 15 cm in *P. americana*).

Persea is a genus with over 200 named species, largely in the Western Hemisphere (ca. 80 spp.), with additional species in India, Southeast Asia, and outliers in Australia, the Mascarene Islands, the Azores, and the Canary Islands. Costa Rican members of this genus are recognized by the larger flowers (for Lauraceae) with anthers borne on well-developed filaments, the large staminodia, the perianth often persisting at the base of the fruits, and the lack of cupulate or broadly flattened receptacles beneath the mature fruits. In addition, most Costa Rican species of *Persea* tend to have longer petioles than other Costa Rican species of Lauraceae, and the minor venation usually forms a visible reticulum (sometimes raised) over the surface of the dried lamina. Despite the distinctiveness of the genus, there may be species that intergrade with *Phoebe* in Central America. It should be noted that Kostermans (1957) suggested that some species of *Phoebe* should be placed in *Persea*. Some of our species of *Beilschmiedia* resemble *Persea* in fruit and vegetative characteristics, but they have 2-theous anthers.

Key to Species of *Persea*

- 1a. Leaves often subopposite and crowded near the ends of branchlets, stems often with broadly thickened nodes where the leaf clusters were borne and from which multiple branches emerge; leaves glabrous and elliptic-oblong; tepals subequal 2a
- 1b. Leaves rarely subopposite or crowded at a thickened distal node, stems rarely with larger nodes from which multiple branches emerge; leaves glabrous or puberulent 3a
 - 2a. Flower buds densely whitish tomentulose; fruits said to be broader than long and reniform *P. rigens*
 - 2b. Flower buds sparsely puberulent; fruits unknown *P. silvatica*
- 3a. Fruits often exceeding 3 cm in length, not subtended by persisting tepals; leaves usually drying chartaceous, often broadly ovate or obovate; often puberulent beneath with spreading or erect hairs; tepals subequal 4a
- 3b. Fruits rarely exceeding 3 cm in length, usually subtended by the persisting tepals; leaves usually drying subcoriaceous to coriaceous, with appressed parallel hairs, spreading hairs or glabrous; tepals unequal with the outer clearly shorter than the inner (subequal in *P. albida*) 5a
 - 4a. Flower pedicels 2–5 mm long; leaves broadly ovate to broadly obovate, abruptly rounded and short-acuminate at the apex, acute to obtuse at the base, sparsely puberulent beneath; 0–2500 m *P. americana*

- 4b. Flower pedicels 10–25 mm long; leaves very broadly elliptic to broadly obovate, rounded at the apex and without a tip, obtuse to subtruncate at the base, densely puberulent beneath; 1000–2600 m *P. schiedeana*
- 5a. Leaves 3–9 cm long and 1–3 cm broad, with a dense indumentum of sericeous parallel hairs beneath; fruits globose and 7 mm in diameter; rarely collected trees of the Pacific slope, ca. 1200 m *P. brenesii*
- 5b. Leaves larger, or if of similar size highland species 6a
- 6a. Trees usually found only above 2000 m elevation; leaves often small (less than 10 cm long) and very coriaceous; fruits ca. 1 cm in diameter 7a
- 6b. Trees rarely found above 2000 m elevation (except in *P. veraguasensis*); leaves rarely small and coriaceous 8a
- 7a. Leaves ferruginous puberulent (at least in early stages), variable in size and form but often ovate; branchlets becoming black, 3–9 mm thick; high cordilleras *P. vesticula*
- 7b. Leaves glabrous or minutely villous; elliptic-oblong to oblong-obovate; branchlets very dark reddish brown, 2–5 mm thick; Chiriquí highlands and adjacent Costa Rica .. *P. obtusifolia*
- 8a. Leaves lanceolate to oblong or narrowly ovate, tapering gradually to the acute or bluntly obtuse apex, usually drying yellowish or pale brown; fruits 5–12 mm in diameter; 300–2300 m elevation 9a
- 8b. Leaves broadly elliptic to oblong-obovate, rounded to bluntly obtuse or short-acuminate at the apex, usually drying dark brown; fruits 12–17 mm in diameter; rarely collected, around 1000 m elevation 10a
- 9a. Flowers with outer tepals 2–2.5 mm long and inner tepals 3–5 mm long, tips of the inner tepals persisting and the fruits subtended by the unequal parts; leaves with 5–10 pairs of major secondary veins *P. veraguasensis*
- 9b. Flowers with outer tepals 1–2 mm long and inner tepals 4–6 mm long; tips of the inner tepals breaking off and the fruits subtended by subequal parts; leaves with 8–12 pairs of major secondary veins *P. caerulea*
- 10a. Leaves elliptic to elliptic-oblong, often slightly glaucous beneath, flat between the secondaries and the tertiaries not raised beneath, with (4–)5–8 pairs of major secondary veins; outer tepals puberulent on their inner surfaces *P. albida*
- 10b. Leaves broadly elliptic to oblong-obovate, the tertiary veins raised on the lower surface, never glaucous, with 5–13 pairs of major secondary veins; outer tepals glabrous on their inner surfaces *P. povedae*

Persea albida Kosterm., Reinwardtia 7: 51. 1969, *nomen novum* for *P. pallida* Mez & Pittier, Bull. Herb. Boissier ser 2, 3: 231. 1903, non *P. pallida* (Nees) Oliver, 1880. Figure 15.

Trees, ca. 15 m tall, leafy branchlets 3–6 mm thick, minutely appressed puberulent (sericeous to strigulose), becoming (sub)glabrous and dark in color, longitudinally striate. **Leaves** alternate (rarely subopposite), petioles 1.5–3.5 cm long, 1–2 mm thick, dark and glabrous, slightly sulcate above; **leaf blades** 7–18 cm long, (3–)4–8 cm broad, elliptic to elliptic-oblong, short acuminate to bluntly obtuse or rounded at the apex, obtuse to acute at the base, margin becoming revolute when dry, drying stiffly chartaceous to subcoriaceous and often dark brown, upper surface glabrous, slightly lustrous and with a fine (0.2–0.5 mm) reticulum of raised minor venation, sparsely and minutely (0.2–0.4 mm) puberulent beneath, often somewhat glaucous beneath becoming glabrescent, with (4–)5–8 pairs of major secondary veins on each side, central secondaries arising at angles of 40°–60°, a reticulum of small (0.2–0.5 mm) areolae formed by the raised minor venation beneath. **Inflorescences** 10–15 cm long,

in axils of distal leaves, primary peduncles 5–9 cm long and more than half the length of the inflorescence, sparsely puberulent. **Flowers** yellowish, ca. 6–8 mm long and 4–6 mm in diameter, perianth densely and minutely sericeous on the outer surfaces, both outer and inner whorls of tepals puberulent within, the whorls subequal; outer **stamens** with narrow anthers ca. 1.7 mm long, on short puberulent filaments, inner stamens 3 mm long with sessile glands, staminodes 1.2–1.6 mm long with a large (1–1.3 mm) glabrous triangular-sagittate apex; **pistil** 3–5 mm long with a slender style 2–3 mm long, ovary glabrous, stigma discoid. **Fruits** subtended by the persisting campanulate perianth parts, outer tepals ca. 5 mm long and 5 mm broad at the base, inner parts ca. 6 mm long and 4–5 mm broad; berry globose, 10–15 mm in diameter.

Trees of lower montane evergreen forest formations, at about 1000 to 1500 m elevation on the Pacific slope of southernmost Costa Rica (but see below). Immature flowers were collected in February (*Pittier 11111*, CR, US, the type from Valle

de Coto), mature flowers were collected in March (*Burger et al. 12182*, CR, F, MO, NY, at Las Alturas de Coto Brus), and fruits were collected in August (*Raven 21891*, CR, F, south of San Vito de Coto Brus). The species is known from only these collections and a recent collection from highland (2000 m) Honduras (*Keyser 1397*, EAP, F).

Persea albida is recognized by the slender long dark petioles, elliptic-oblong leaves minutely puberulent and often glaucous beneath, and with a fine reticulum of raised minor venation on both surfaces. The slightly unequal perianth parts puberulent on all surfaces, prominent sagittate staminodes, and smaller globose fruits also help distinguish this species. An additional sterile collection (*Standley 51268*, US) from El Muñeco in Cartago Province at 1400 m elevation may be this species. *Persea albida* is similar to *P. povedae*.

***Persea americana* Miller, Gard. Dict. ed. 8. (without pagination) 1768. *Laurus persea* L., Sp. Pl. 370. 1753. *P. drymifolia* Schlechtend. & Cham., Linnæa 6: 365. 1831. Figure 15.**

Small to large trees 5–40 m tall, often with a dense rounded crown, leafy branchlets 1.5–6 mm thick, densely to sparsely puberulent with slender pale brownish hairs 0.1–0.4 mm long, remaining puberulent or glabrescent. Leaves alternate or subopposite, petioles 1–6 cm long, 1–2.5 mm thick, sulcate above, glabrous or puberulent; leaf blades 6–22(–30) cm long, 3–14(–19) cm broad, narrowly to broadly ovate or ovate-elliptic, sometimes obovate or suborbicular, usually short-acuminate at the apex (acute to obtuse), acute to obtuse or rounded and often slightly asymmetric at the base, margin entire, drying chartaceous, smooth and glabrescent above, sparsely to moderately puberulent beneath with short (0.1–0.4 mm) slender hairs, with 5–9 major secondary veins on each side, central secondaries arising at angles of 30°–50°, tertiary veins often raised on both surfaces when dry. Inflorescences axillary to distal leaves or in terminal clusters, 4–12 cm long, compact or loosely branched panicles, peduncles 1–7 cm long, slender and puberulent, pedicels 2–5 mm long, yellowish brown puberulent. Flowers 5–8 mm long, campanulate, outer tepals 4–6 mm long and 1–3 mm broad, ovate-elliptic to oblong, acute at the apex, inner whorl 4–7 mm long, equalling or slightly longer than the outer, both whorls yellowish brown tomentulose on inner and outer surfaces; outer stamens 3.5–4.5 mm long, outer anthers 1.2–1.5 mm long and 0.9 mm broad, the 4 thecae superposed, inner stamens with slender filaments and stalked glands, staminodes 2–3 mm long and broadly or narrowly sagittate at the apex; pistil 3–4 mm long, puberulent with a long slender style, stigma simple. Fruits borne on a thick (3–5 mm) stalk not usually swollen near the apex, perianth deciduous and leaving a rim ca. 6 m broad; berry 5–15 cm long, globose to pyriform or obovoid, dark green, seed 2–5 cm in diameter.

Trees widely cultivated and growing wild in both evergreen and partly deciduous forest formations, from near sea level to about 2500 m elevation throughout Costa Rica and on Cocos Island. Flowering collections have been made primarily in January–March, with a few in August–September. Fruiting specimens have been collected in February, May, August, and November. This species is now widely cultivated throughout the tropics and subtropics of the world.

Persea americana is recognized by its large dark green fruits on a terete pedicel (lacking both a fruit cup and a persisting perianth), the puberulent yellowish flowers, and the usually thin ovate leaves on long petioles, with the upper leaf surfaces dark lustrous green and the underside very pale green. The species is best interpreted in a wide sense; however, the considerable range of diversity often makes the identification of individual sterile collections difficult. Variation within the species in Central America probably reflects a long history of cultivation in this region. The fruits of this species may be the most nutritious of all the cultivated fleshy fruits. The high food quality of the avocado is probably due to coevolution with birds that are fruit-eating specialists and depend on these fruits for nearly all their nutrition. Common names are *abacate*, *aguacate*, *aguacatillo*, and *cura aguacate*. English names include alligator pear, avocado, and butter pear. A large number of names in native Amerindian languages attest to the antiquity of cultivation in Mesoamerica. For a narrower interpretation of this species see Williams (1977).

***Persea americana* var. *nubigena* (L. O. Williams.) Kopp, J. Arnold Arbor. 14: 19. 1966. *P. nubigena* L. O. Williams, Ceiba 1: 55. 1950. *P. gigantea* L. O. Williams, Ceiba 4: 39. 1953.**

These trees of montane cloud forests reach 40 m in height. Their leaves are more coarsely textured with more prominent venation, and they are more puberulent than typical *P. americana*. Also, the leaves tend to be broadly ovate or suborbicular. If it were not for the great variability within *P. americana*, these highland populations might be worthy of specific status, but there do appear to be intermediates between typical variety *americana* and the more distinctive specimens of variety *nubigena*. Unfortunately, some specimens placed here seem to be intermediate with *P. schiedeana*, and it is possible that there has been gene

flow between *P. schiedeana* and *P. americana* at higher elevations.

Two unusual collections with ovate leaves somewhat intermediate between *P. americana* and *P. veraguasensis* on long (15–45 mm) petioles and with globose fruits 3 cm in diameter are provisionally placed here (*Davidse et al.* 24447, 28401, CR, MO, from 1500 to 1600 m near the valley of the Río Cotón in southern Puntarenas Province). They may represent a new species.

Persea brenesii Standley, Publ. Field Mus. Nat. Hist., Bot. Ser. 18: 458. 1937.

Trees 5–9 m tall, leafy branchlets 3–5 mm thick, densely yellowish brown sericeous with straight slender ascending hairs 0.1–0.3 mm long, becoming dark brown in age. Leaves alternate and somewhat crowded on short distal twigs, petioles 7–16 mm long, ca. 2 mm broad, with lateral margins but without a sulcus above; leaf blades (3–)5–9 cm long, 1–2.4(–3) cm broad, elliptic to elliptic-oblong, acute to obtuse at the apex, cuneate at the base, margins entire and slightly involute, drying subcoriaceous, sparsely puberulent above, the lower surface densely grayish brown or yellowish brown sericeous with slender parallel hairs ca. 0.4 mm long, with (3–)4–7 major secondary veins on each side, central secondaries arising at angles of 20°–40°. Inflorescences axillary to distal leaves, to 15 cm long, paniculate, peduncles 3–7 cm long, sericeous, pedicels ca. 2 mm long. Flowers ca. 6 mm long and 6 mm broad, the outer tepals ca. 2 mm long and rounded at the apex, densely sericeous on the outside but glabrous within, inner tepals ca. 4 mm long and acute at the apex, puberulent on both surfaces; outer stamens ca. 2.8 mm long with narrow oblong anthers ca. 1.4 mm long, filaments puberulent, inner stamens ca. 3 mm long, staminodes ca. 1.5 mm long and puberulent; pistil ca. 4 mm long, glabrous, ovary ca. 1.3 mm long, stigma discoid. Fruits subtended by the persisting perianth with the outer series ca. 3 mm long and the inner series ca. 5.5 mm long; berry apparently globose and ca. 7 mm in diameter (dry and perhaps immature).

Trees of wet evergreen forest formations of the northwestern edge of the Meseta Central. The species is known only from near La Palma de San Ramón, Alajuela, at 1100 to 1200 m elevation. Flowers were collected on 27 June 1973 (*Primack et al.* 254, DUKE, F), and immature fruits were collected on 29 September 1925 (*Brenes* 4451, CR, F, the type).

Persea brenesii is recognized by the small stiff elliptic leaves densely sericeous beneath, flowers with perianth whorls of very different length and densely sericeous, and the small globose fruits subtended by persisting perianth parts. The hairs on the lower leaf surfaces are characteristic; they are slender, straight, and mostly paralleling the sec-

ondary veins. There is a possibility that the material placed here is an unusual form of *P. veraguasensis*, but the small leaves on relatively short petioles and the unusual pubescence of lower leaf surfaces are distinctive.

Persea caerulea (Ruiz & Pavón) Mez, Jahrb. Königl. Bot. Gart. Berlin 5: 171. 1889. *Laurus caerulea* Ruiz & Pavón, Laurografia Peruviana t. 2, ?1802. *P. laevigata* H.B.K., Nov. gen. sp. 2: 157. 1817. *P. petiolaris* H.B.K., loc. cit. 159. 1817. *P. skutchii* C. K. Allen, J. Arnold Arbor. 26: 298. 1945. Figure 9.

Small to medium-sized trees, 4–25 m tall, leafy branchlets 1.2–5 mm thick, at first with yellowish or reddish brown hairs 0.1–0.3 mm long, becoming dark in color and glabrescent. Leaves alternate, petioles 1.5–5(–7) cm long, ca. 1.5 mm thick, dark brown and sparsely strigulose; leaf blades 7–15(–24) cm long, 3–7(–12) cm wide, ovate-lanceolate to ovate-elliptic, ovate-oblong or elliptic-oblong, tapering gradually to the acute or bluntly obtuse apex, acute to obtuse or rounded and subtruncate (in larger leaves) at the base, slightly unequal at the base, drying stiffly chartaceous and often very pale yellowish green in color, glabrous above and very sparsely strigulose beneath, with 8–12 major secondary veins on each side, central secondaries arising at angles of 40°–70°, tertiary venation obscure or forming very small (0.3 mm) areolae. Inflorescences axillary to distal leaves (occasionally from older nodes), 5–12 cm long, paniculate, peduncle more than half the length, 4–12 cm long and ca. 1.2 mm thick, sparsely to densely pale yellowish brown strigulose, pedicels 3–5 mm long. Flowers 6–7 mm long, to 15 mm broad, outer tepals 1–2 mm long, inner tepals 4.5–6.5 mm long, yellowish brown puberulent on the outside and glabrous within; outer stamens with anthers 1.5–2 mm long on filaments 1.5–3(–4) mm long, inner stamens with subsessile glands, staminodia sagittate and puberulent, 2–3 mm long; pistil ca. 3.5 mm long, style longer than the ovary and slender, stigma simple or capitate. Fruits subtended by persisting perianth parts of about equal length (because the distal ends of the longer inner tepals break off), ca. 2 mm long; berry 5–9 mm in diameter (dried), globose or subglobose, glaucous (grayish blue) and subtended by a reddish pedicel, glabrous.

Trees of evergreen and partly deciduous forest formations of the Pacific slope in Costa Rica, between (300) 500 and 1500 (2000) m elevation. Flowering collections have been made mostly in February–May and July–August; a collection in November was made in Honduras. Fruits have been collected in April–August. The species ranges from Honduras through Central America to Colombia and Venezuela and southward along the Andes to Bolivia.

Persea caerulea is recognized in the dried condition by its pale colored or orange brown gla-

brescent leaves on long slender petioles. The perianth, with much longer inner tepals that break off near the ends in fruiting stages, makes both the flowers and the fruits distinctive. The species was common in the seasonally very dry Meseta Central; at Monteverde it is only found in the drier forest below 1400 m elevation. The trees often grow along streams and are referred to under the general name *aguacatillo*. This species resembles *P. veraguasensis* and may be difficult to separate in the absence of flowers or fruits.

***Persea donnell-smithii* Mez, Arbeiten Königl. Bot. Gart. Breslau 1: 113. 1892.**

This is a name that has been applied to a few collections from Costa Rica (*Holdridge 6641, 6874, CR*) with large thin obovate leaves, glaucous-grayish beneath, and with long petioles. They are gray and probably unusual individuals of *P. americana*. *Persea donnell-smithii* is a species ranging from southern Mexico to Nicaragua.

***Persea obtusifolia* Kopp, Mem. New York Bot. Gard. 14: 81. 1966. Figure 5.**

Shrubs or small trees 0.5–3(–6) m tall, leafy branchlets 2–4 mm thick, sparsely puberulent with thin ascending whitish or yellowish hairs ca. 0.5 mm long (rarely glabrous). **Leaves** alternate or subopposite, usually clustered at the ends of twigs, petioles 3–12 mm long, ca. 2 mm thick, sulcate above with 2 adaxial ridges, usually puberulent with minute (0.1 mm) or small (0.5 mm) thin hairs (especially at the base), rarely glabrous; **leaf blades** 3.5–9.5 cm long, 2–4 cm broad, elliptic-oblong to oblong-obovate or obovate, bluntly obtuse to rounded at the apex, rounded to cuneate at the base, margin revolute when dry, leaves drying subcoriaceous to coriaceous and yellowish green to pale brown, glabrous above and with a very fine (0.2–0.5 mm) reticulum of minor venation, minutely villous to glabrous beneath, with 4–8 major secondary veins on each side, central secondaries arising at angles of (30°–)40°–70°, a fine (0.2–0.5 mm) reticulum of minor venation also present on the lower surface. **Inflorescences** axillary to distal leaves, 3–7 cm long, peduncles 2.5–5 cm long, ca. 1.5 mm thick, villous or glabrous, flowers few in cymose groups, pedicels 2–4 mm long, densely sericeous. **Flowers** 4–6 mm long, 3–4 mm broad, perianth erect and densely sericeous with yellowish or ferruginous hairs on the outside, outer tepals to 4 mm long and glabrous within, inner tepals to 6 mm long and 3 mm broad, puberulent within; **outer stamens** to 4 mm long with prominent hirsute filaments ca. 2.5 mm long, anthers narrow and ca. 1.5 mm long, inner stamens ca. 2.8 mm long with subsessile glands on the lower part of the filament, staminodes small (0.5 mm) and linear; **pistil** 3–4 mm long and glabrous, with a slender style ca. 2 mm long, stigma capitate or simple. **Fruits**

subtended by the persisting, erect or spreading tepals, the outer ca. 3 mm long and the inner ca. 4 mm long; berry globose, ca. 1 cm in diameter, slightly apiculate at the apex, green becoming black (not glaucous).

Small trees and shrubs of high montane elfin forest formations and in drier sites at high elevation, from (1800) 2000 to 3000 m elevation. Flowers have been collected in July–August; fruits have been collected in November and March. This species is only known from easternmost Costa Rica in the Cordillera de Talamanca, and in the Chiriquí highlands of Panama.

Persea obtusifolia is recognized by the small stiff leaves often rounded at the apex, the short few-flowered inflorescences with long peduncles, densely sericeous perianth, and the small globose fruits subtended by the persisting perianth parts. Both surfaces of the dried leaves display a fine reticulum of raised minor venation. This species resembles small-leaved specimens of *P. vesticula*, but *P. obtusifolia* differs in leaf shape and fruiting perianth; the two species are closely related. A collection by L. D. Gómez et al. (21654, CR, MO) is placed here and may represent an ecotype or perhaps even a hybrid with *Ocotea whitei*. However, its *Ocotea*-like flowers may not be mature, and its narrow, completely glabrous leaves have the reticulation characteristic of *P. obtusifolia*. The only other Costa Rican collection is *Davidse et al. 25542* (CR, MO).

***Persea povedae* W. Burger, sp. nov. Figure 12.**

Arbor usque 12 m alta, ramulis foliiferis 4–9 mm crassis. Folia alterna vel subverticillata, petiolis 15–40 mm longis; laminis (9–)11–23 cm longis et (4–)6–10 cm latis, late ellipticis, elliptico-obovatis vel oblongo-obovatis, apice obtuso vel rotundato, glabris, nervis secundariis (5–)7–13 paribus. Inflorescentiae fructiferae usque 15 cm longae. Flores ignoti per anthesin; tepala externa breviter et intus glabra. Fructus globosus, 1.3–1.7 cm in diametro.

Trees to 12 m tall, leafy branchlets 4–9 mm thick, glabrous or minutely (0.1–0.4 mm) and very sparsely puberulent at the apex, orange brown to almost black, becoming longitudinally striate with a few lenticels. **Leaves** alternate to closely clustered (subverticillate) distally, petioles 15–40 mm long, 1.2–3 mm thick, glabrous (rarely sparsely and minutely puberulent), narrowly sulcate above; **leaf blades** (9–)11–23 cm long, (4–)6–10 cm broad, broadly elliptic to elliptic-obovate or oblong-obovate, usually broadest at or above the middle, bluntly obtuse to rounded at the apex, gradually narrowed to the obtuse or acute base, margin entire and slightly revolute when dry, the leaves drying subcoriaceous, glabrous above and the midvein impressed, the upper surface with a retic-

ulum of small (0.2–0.5 mm) areolae formed by the raised minor venation, lower surface glabrous, with (5–)7–13 major secondary veins on each side, central secondaries arising at angles of 40°–70°, the lower surface usually developing a flat or slightly raised reticulum of minor venation forming areolae 0.1–0.3 mm broad. **Inflorescences** from the axils of distal leaves, to 15 cm long in fruits, peduncles 3–11 cm long in fruits. **Flowers** not seen but the perianth partly persisting in fruits, outer tepals shorter than the inner and glabrous on the inner surface, inner tepals puberulent on both surfaces; persisting **stamens** (series II) 4-theous (in *Poveda 740* at MO), straight lustrous hairs ca. 0.7 mm long present around the base of the ovary (fruits). **Fruits** borne on a gradually thickened pedicel 1–2 cm long and 3–6 mm broad at the top, usually with large (2–3 mm) brown lenticel-like protuberances, apex of the receptacle flat or slightly (1 mm) depressed; berry globose, 13–17 mm in diameter, becoming dark purple.

TYPE—Costa Rica, Alajuela Province, La Paz de San Ramón, 30 Oct. 1973, *Poveda 740* (holotype, CR 53308; isotype, MO).

Trees of evergreen forest formations along the continental divide on the western edge of the Meseta Central, at about 1000 m elevation. Fruits have been collected in October–November. This species has only been collected at La Palma, Piedades, and La Paz, all near San Ramón in Alajuela Province.

Persea povedae is recognized by the stiff glabrous, medium- to larger- sized leaves with a very fine reticulum of minor venation usually visible on both surfaces. Globose fruits, thick lenticellate fruiting pedicels, partly persisting perianth parts, and usually obovate leaves clustered at the ends of branchlets further distinguish this species. The following collections are placed here: *Brenes 337* (178), 4769 (F) and *Poveda 740* (CR, MO). Kopp annotated *Brenes 6342* as *Persea* near *P. albida*, and the two species are similar. However, *P. albida* has equal tepals, and the outer tepals are puberulent within, whereas *P. povedae* has unequal tepals and the outer tepals glabrous within. This species closely resembles *P. cuneata* Meissner of Colombia, but that species has smaller (8 mm) ellipsoid fruits, stiffer leaves with more numerous secondary veins that are more prominent beneath, and anthers with only two thecae. Luis Poveda, expert collector and authority on the trees of Costa Rica, was the first person to collect this species since Brenes, over 40 years earlier.

Persea rigens C. K. Allen, J. Arnold *Arbor.* 26: 297. 1945. Figure 15.

Trees 6–20(–35) m tall, leafy branchlets 2.5–8 mm thick, quickly becoming glabrous and reddish brown, smooth or slightly striate, terete, often several arising together from a swollen node. **Leaves** alternate, opposite or whorled, often closely congested distally, petioles 8–27 mm long, 1.5–4 mm thick, glabrescent and drying dark in color, usually sulcate above; **leaf blades** 9–24(–30) cm long, 3.5–9(–11) cm broad, obovate-elliptic to oblanceolate or elliptic-oblong, usually short-acuminate at the apex (less often obtuse or rounded), acute to obtuse at the base, drying stiffly chartaceous to subcoriaceous and often grayish brown to orange brown in color, smooth and glabrous above with the tertiary venation slightly raised to form a reticulum, lower surface essentially glabrous, with 5–9 major secondary veins on each side, the central secondaries arising at angles of 40°–60°. **Inflorescences** clustered at the ends of branchlets, often 2 or more from the axils of leaves or fallen leaves, 5–12 cm long, thyriform panicles, peduncles 2–7 cm long, 1–2 mm thick, densely and minutely puberulent with thin crooked hairs ca. 0.3 mm long, pedicels 1–3.5 mm long. **Flowers** 3–5 mm long, outer tepals ca. 3 mm long and 3 mm broad, inner tepals ca. 3 mm long and 2 mm broad, tomentulose on both inner and outer surfaces; outer **stamens** with anthers 0.8–1.3 mm long on short puberulent filaments, inner stamens ca. 2 mm long, staminodes prominent, 1.4 mm long and with sagittate apices; **pistil** ca. 2.5 mm long, style slender and with a subcapitate stigma. **Fruits** subtended with short (2–4 mm) subequal persisting tepals; berry becoming 1.5–2 cm long and 2–3 cm broad, subreniform in shape and somewhat depressed at the apex (but see below).

A poorly defined species of evergreen forest formations based on a collection by Elbert Little (6058, F, the type) from about 1500 m elevation near the Río Chiriquí Viejo in Chiriquí Province, Panama. The flowers of the type were collected in March but are not fully in anthesis. This species was thought to range from Guatemala, Costa Rica, and Panama to Colombia, Venezuela, and Ecuador, but its correct circumscription is not resolved (see below).

Persea rigens is distinguished by the occasional presence of opposite or whorled leaves clustered at swollen nodes at the ends of branchlets. These swollen nodes can produce several new twigs in later stages. The small puberulent flowers (relative to other *Persea* species with subequal perianth parts) and the fruits becoming broader than long (in South American collections) further distinguish material placed under this name. The glabrous oblanceolate to elliptic leaves with thick dark petioles and fine reticulum of tertiary veins on the upper surface, help in the determination of sterile collections. We are not sure if *Persea rigens* has been collected in Costa Rica because it is difficult to separate this species from the closely related *P. silvatica*, and earlier determinations of Costa Rican collections as *P. rigens* may, in fact, be *P.*

silvatica. See the discussion under *P. silvatica*. The description of fruits as reniform and the placement of a number of South American collections under *P. rigens* (Kopp, 1966, p. 24) require further confirmation.

Persea schiedeana Nees, Syst. laur. 130. 1836. *P. pittieri* Mez, Bot. Jahrb. Syst. 30, Beibl. 67: 15. 1901. Figure 6.

Trees to 30 m tall, branchlets thick and roughened by scars of leaves and bud scales, leafy branchlets 4–8(–16) mm thick, at first densely ferruginous-villous, shoot apex with several imbricate series of broad (ca. 6 mm) distally rounded bud scales. **Leaves** alternate and often closely clustered at the tips of shoots, petioles 1.5–6 cm long, 1.5–3 mm thick, densely puberulent and sulcate above; **leaf blades** 8–26(–33) cm long, 4–20 cm broad, very broadly elliptic to broadly oblong or obovate, usually bluntly rounded at the apex, rounded and truncate to obtuse at the base, margins often somewhat undulate, drying stiffly chartaceous to subcoriaceous, upper surface usually dark and glabrous, lower surface densely orange brown tomentulose with slender hairs 0.3–0.5 mm long, with 6–10 pairs of major secondary veins on each side, central secondaries arising at angles of 30°–60°. **Inflorescences** axillary to distal leaves or subterminal, 4–20 cm long, racemose to thyrselike, in the axils of caducous bracts to 2 cm long, expanding with a new flush of leaves, peduncles 2–7 cm long, densely yellowish or reddish brown puberulent, pedicels 10–26 mm long, slender and densely puberulent. **Flowers** 6–10 mm long, becoming 10–20 mm broad, tepals 6–9 mm long and 2.2–3.3 mm broad, broadly lanceolate, densely tomentulose on both surfaces, outer tepals slightly shorter or slightly longer than the inner; **outer stamens** ca. 5 mm long with filaments ca. 3.5 mm long, narrow and with hairs abaxially, staminodes 1.5–2.5 mm long and linear; **pistil** with an ellipsoid ovary 2–3.5 mm long, style 1.8–3 mm long, stigma simple. **Fruits** subtended by the persisting perianth in early stages, the thickened infructescence with very few fruits; berry globose and to ca. 5 cm in diameter.

Trees of evergreen montane rain forest formations, between 1000 and 2300 (2500) m elevation in Costa Rica. Flowering collections have been made in January–May in Costa Rica, and fruits have been collected in January–February, May, and September. This species ranges from southern Mexico through the Central American highlands to Colombia.

Persea schiedeana is recognized by its broad leaves densely reddish brown puberulent on the undersides, the very rough thick branchlets with bud scales or bud scale scars, the yellow flowers with long narrow stamens, and the cool wet cloud forest habitat. This species has been called *aguacate de montaña* and *aguacatón* in Chiriquí, Panama, and *yas* in Costa Rica. This species may

intergrade with *P. americana*; see the discussion under *P. americana* var. *nubigena*.

Persea silvatica van der Werff, sp. nov.

Arbor ad 10 m. **Ramuli** teretes, apice incrassati. **Folia** chartacea, elliptica vel elliptica-oblonga, 15–25 × 7–12 cm, glabra, subopposita vel apice ramulorum fasciculata, apice acuta vel breviter acuminata, basi acuta; costa nervique (6–10) supra immersi, subtus elevati; reticulatio elevata; petioli in sicco nigri, glabri, 1–1.6 cm longi. **Inflorescentiae** apice ramulorum confertae, basi bracteis vel cicatibus bractearum circumcincti, ad 20 cm longae, minute puberulae. **Tepala** 6, aequalia vel subaequalia, late ovata, 2.5–3.0 mm longa; **stamina** 9, 4-locellata, 6 exteriores locellis introrsis, 3 interiores locellis extrorsis, filamentis pubescentibus. **Staminodia** 3, apice sagittata. **Glandulae** staminum interiorum magnae, basi sagittatae vel cordatae, vix super basim filamentorum affixae. **Ovarium** glabrum, globosum, ca. 1.1 mm diam.; stylus ovarium aequans. **Fructus** non visus.

Trees to 10 m tall, leafy branchlets 2.5–6 mm thick, glabrous, smooth and brown when young, terete, gray-corky when old, usually with several twigs originating from a large bud and these twigs with bracts or bract scars at the very base, ends of the stems often thickened. **Leaves** subopposite or clustered at the swollen ends of branchlets, petioles 10–16 mm long, 1.8–2.5 mm thick, drying black, glabrous, with slightly elevated lateral margins; **leaf blades** 15–25 cm long, 7–12 cm broad, elliptic to elliptic-oblong or slightly obovate, acute or short acuminate at the apex, acute at the base, drying chartaceous to very stiffly chartaceous, primary and secondary veins slightly immersed above and prominent beneath, a reticulum of minor venation slightly raised on both surfaces, glabrous above and below, with 6–10 major secondary veins on each side, central secondaries arising at angles of 40°–65°. **Inflorescences** clustered at the tips of branchlets (only seen on the type), subtended at the base by bracts or bract scars, ca. 20 cm long, paniculate, peduncles 4.5–8 cm long, 2–3 mm thick, very sparsely and minutely puberulent (more densely only at the base), pedicels 2–5 mm long, very minutely (0.1 mm) whitish puberulent. **Flowers** 3–4 mm long and equally broad, campanulate, white to yellowish green, tepals erect and equal at anthesis, 2.5–3 mm long, ovate, minutely puberulent; **stamens** 9 and all 4-theous, outer 6 stamens dehiscent introrsely, ca. 2.4 mm long with puberulent filaments ca. 1.4 mm long, inner stamens ca. 2.1 mm long, with large glands attached slightly above the base of the filament, staminodia 3, ca. 1.3 mm long, with the sagittate tip curved inward over the ovary; **pistil** ca. 2.2 mm long, ovary globose and glabrous, ca. 1.1 mm long, stigma discoid. **Fruits** unknown.

TYPE—Costa Rica, Heredia Province, along the Río Guácimo, southeast of the La Selva Biological Station, 80 m elevation, 14 March 1984, *G. Schatz & H. Young 964* (holotype, MO; isotype, CR).

Trees of the lowland Caribbean rain forest formation. Flowering material was collected in March

(the type) and August (Hammel 9453, DUKE). The species is only known from the area of the La Selva research station (at about 100 m elevation) in north-central Costa Rica.

Persea sylvatica is recognized by its glabrous elliptic leaves clustered or subopposite at the thickened (knoblike) ends of slender twigs. This unusual growth form is also found in *P. rigens*, but that species has much more densely puberulent whitish tomentulose flowers, and less prominently raised minor venation on the dried leaves. Earlier, specimens of this species were identified as *P. rigens*; compare material filed under that name.

Kopp (1966) divided Neotropical *Persea* species into two subgenera in her revision. Subgenus *Persea* is characterized by equal or subequal tepals, tepals mostly deciduous in fruits, a pubescent ovary, and reflexed perianth at anthesis. Subgenus *Eriodaphne* has unequal tepals (the inner three much longer than the outer), tepals persistent in fruits, a glabrous or pubescent ovary, and spreading or erect tepals at anthesis. *Persea sylvatica* does not fit well in either subgenus, since it shares equal tepals with subgenus *Persea* and a glabrous ovary and persistent tepals with subgenus *Eriodaphne*. Some of the characteristics of *Persea sylvatica* and *P. rigens* suggest a relationship with the Asian subgenus *Machilus*. Moreover, Hammel (1966, p. 233) points out that the flowers of this species are very similar to some Costa Rican species of *Phoebe* (but those species develop cupules in fruits). Additional research, based on better collections, is needed to resolve problems with generic boundaries between the subgenera of *Persea* and some Neotropical species currently placed in *Phoebe*.

Persea veraguasensis Seem., Bot. voy. Herald 193. 1854. *P. veraguensis* Meissn. in DC., Prodr. 15, pt. 1: 51. 1864, *nomen superfl.* Figure 9.

Trees to 12 m tall, leafy branchlets 2–8 mm thick, grayish or yellowish brown with minute (0.2 mm) appressed slender hairs but becoming (sub)glabrous and dark. Leaves alternate, clustered distally or separate, petioles 2–5 cm long, 1–2 mm thick, slightly canaliculate above, glabrescent; leaf blades 6–14(–16) cm long, 2.5–5.5(–6.5) cm broad, lanceolate to ovate or ovate-elliptic, tapering gradually to the acute or bluntly obtuse apex, acute to rounded and subtruncate at the base, unequal, leaves drying stiffly chartaceous to subcoriaceous and pale greenish to reddish brown in color, smooth and glabrous above, minutely and densely appressed puberulent beneath in early stages but soon glabrescent, with 5–10 major secondary veins on each side, central secondaries arising at angles of 40°–60°, tertiary veins forming a reticulum of small (0.2–0.4 mm) areolae on the

lower surface. Inflorescences axillary to distal leaves or clustered near the apex from a leafless short shoot, 5–12(–16) cm long, panicleate, peduncles 2–7 cm long, pale yellowish strigulose, pedicels 0–2 mm long. Flowers 3–5 mm long, ca. 5 mm broad, densely yellowish or grayish strigulose to sericeous on the outer (abaxial) surfaces, outer tepals 2–2.5 mm long and 2–2.2 mm broad, ovate and acute to obtuse at the apex, glabrous within, inner perianth parts 3–5 mm long and 2–2.2 mm broad, acute at the apex, sericeous on both surfaces; outer stamens 1.5–3.5 mm long, anthers ca. 1 mm long with 4 superposed thecae, staminodes ca. 2 mm long, sagittate to spatulate; pistil glabrous, 3–4 mm long with style 1.5–2.2 mm long, stigma discoid. Fruits subtended by the persisting perianth of the shorter outer and longer inner whorls; berry globose, 8–12 mm in diameter (dry), green and said to become glaucous.

Trees of evergreen forests of the central highlands and the Pacific slope, between 800 and 2300 m elevation in Costa Rica. Flowers have been collected in April–September and December, and fruits have been collected in January–April. This species ranges from the Cordillera de Tilarán in western Costa Rica to Veraguas Province in Panama.

Persea veraguasensis is recognized when dry by the pale colored or reddish brown ovate-lanceolate laminae borne on long slender petioles and the minute, often sericeous, puberulence on young vegetative parts and flowers. This species is very similar to *P. caerulea*, but the perianth whorls (tepals) do not differ as much in length in flowers at anthesis. In addition, the tips of the inner tepals do not break off in *P. veraguasensis*, with the result that the tepals differ more in length in this species in the fruiting condition than they do in *P. caerulea*.

Persea vesticula Standl. & Steyer., Publ. Field Mus. Nat. Hist., Bot. Ser. 23: 116. 1944. *P. chiapensis* Lundell, Wrightia 1: 150. 1946. *P. popenoei* L. O. Williams, Ceiba 1: 57. 1950. Figure 5.

Small shrubs to medium-sized trees 2–12(–25) m tall, leafy branchlets 2.5–9 mm thick, at first densely brownish or yellowish puberulent but glabrescent and dark in age. Leaves alternate to subopposite, usually clustered near the ends of branchlets, petioles 4–38 mm long, 1.3–3 mm thick, puberulent or glabrous, flat or slightly sulcate above; leaf blades (3–)4.5–14(–17) cm long, (1.8–)2.5–7 cm broad, elliptic to ovate, acute to bluntly obtuse (rounded in very small leaves) at the apex, obtuse to rounded and subtruncate (rarely acute) at the base, margin becoming revolute, drying subcoriaceous to coriaceous, glabrous to sparsely and minutely puberulent above, lower surface glabrous to sparsely puberulent with slender hairs 0.5 mm long or with a dense tomentum between the veins (in some individuals), with (3–)5–11

major secondary veins on each side, central secondaries arising at angles of 30°–60°. **Inflorescences** axillary to distal leaves, 3–15 cm long, paniculate, peduncles 1.5–11 cm long, densely brownish tomentulose or glabrescent, pedicels ca. 2 mm long. **Flowers** 4–6 mm long, outer tepals 2.5–4.5 mm long and 2–3 mm broad, tomentulose on the outside and usually glabrous within, inner tepals 4–6.5 mm long, densely puberulent on both surfaces; outer **stamens** 1.5–3.5 mm long, outer anthers 1–2.2 mm long, narrowly oblong with 4 superposed thecae, inner stamens 2.2–4 mm long, staminodes 1–1.5 mm long; **pistil** 2.2–4 mm long, glabrous, ovary ovoid or ellipsoid, style slender and 1.1–3 mm long, stigma discoid. **Fruits** subtended by the persisting perianth flattened in a plane ca. 6–8 mm broad, dark brown and puberulent; berry 8–12 mm in diameter (dry), globose and glaucous.

Shrubs and trees of high montane cloud forests and elfin forest formations, between 2000 and 3200 m elevation in Costa Rica. Flowering material has been collected in September–March in Costa Rica and in April–August in Guatemala and Honduras. Fruiting material has been collected in November–April in Central America. The species ranges from Chiapas, Mexico, southward to the Cordillera de Talamanca of Costa Rica, and may extend into adjacent Panama (see below).

Persea vesticula is recognized by its high-elevation habitats, the thick dark twigs with leaves usually clustered at the ends, the puberulent flowers with perianth whorls of differing length, and the small globose glaucous fruits subtended by the persisting tepals. The specimens placed here span a great variety of leaf forms. These range from larger elliptic laminae with numerous strongly ascending secondary veins to very short rounded leaves with only a few secondary veins. Intermediate collections span this range, and the small thick rounded leaves appear to be associated with very high altitudes or exposed windy sites. The flowers also range considerably in size; anthers of Costa Rican material are about 1 mm long, while the type from Guatemala has anthers about 2 mm long. Considering this range of variation it may be difficult to separate some collections from the closely related *P. obtusifolia*. The species is called *ascá*.

Phoebe Nees

Trees or shrubs, bisexual. **Leaf blades** alternate (rarely subopposite), petiolate, leaf blades entire with palmate, tripliveined or pinnate venation, domatia sometimes present in the vein axils of the lower leaf surfaces. **Inflorescences** usually solitary and axillary to distal leaves (subterminal or rarely fasciculate), paniculate and with spreading lateral branches or with short lateral branches

and racemose, distal flower groups often cymose, glabrous or puberulent. **Flowers** bisexual, radially symmetrical, usually campanulate in form, perianth of 6 parts in 2 whorls, outer and inner whorls equal or subequal with the outer parts somewhat shorter, glabrous or puberulent, floral tube short; **androecium** with 9 fertile 4-thecous stamens (in Central America), the thecae superposed in 2 planes, the 6 outer stamens (series I–II) with introrse dehiscence, filaments usually equalling the anthers in length or slightly shorter, the 3 inner stamens (series III) with well-developed filaments and each with 2 sessile or subsessile glands, inner anthers 4-thecous with the lower having extrorse and the upper lateral or lateral-extrorse dehiscence, staminodes (series IV) 3 and prominent, with cordate-sagittate apices usually borne on a short stipe, usually with hairs at the base; **pistil** glabrous (in Costa Rica), ovary subglobose to ellipsoid, style slender and often equalling the ovary in length, stigma discoid to obtuse (simple). **Fruits** borne in a cupulate or saucer-like receptacle, expanded above the thickened pedicel, perianth persisting at the edge of the receptacle or more often deciduous (never enlarging); berry ovoid to ellipsoid or globose.

Phoebe, with over 175 specific epithets, is not well defined. Many species that have been described in Central America are better placed in *Ocotea*, and we have made a number of transfers in this text. Moreover, Kostermans (1957) defined *Phoebe* so as to exclude all the American species, placing them in *Cinnamomum*. Transfer of *Phoebe cinnamomifolia* and its allies to *Cinnamomum* is probably correct, but should be part of a global survey of the species. Kostermans' work (1957) is quite superficial regarding Neotropical taxa, and we prefer to maintain current usage at this time. The three large staminodes with cordate-sagittate apices in each flower, the nine fertile 4-thecous stamens, and fruits subtended by an expanded receptacle, characterize the Costa Rican species placed here. They differ from *Ocotea* primarily in the consistent presence of three well-developed staminodes and from *Persea* because of the development of the receptacle in fruits. Tripliveined leaves characterize a few species in our area.

In this treatment, *Phoebe helicterifolia*, *P. mollicella*, *P. pittieri*, and *P. valeriana* are considered as species of *Ocotea* and have been transferred.

There is a serious problem regarding the circumscription of *Phoebe costaricana* and *P. cinnamomifolia*. The senior author was at first unable to distinguish these two entities, which appear to behave as two different species in Costa Rica, and most specimens were annotated as *P. cinnamomifolia*; see the discussion under *P. cinnamomifolia*.

Phoebe amplifolia Mez and J. D. Smith was said to occur in Costa Rica by C. K. Allen (1945), based on *Popenoe 984* from near Rancho Redondo in

the province of San José. We have not seen this collection and doubt that it is correctly identified.

Phoebe amplifolia is a larger-leaved species of Guatemala, resembling *P. hammeliana*.

Key to Species of *Phoebe*

- 1a. Leaves tripliveined or subtripliveined, with the basal lateral secondary veins strongly ascending; the leaves often drying subcoriaceous and often grayish green to yellowish, glabrous 2a
- 1b. Leaves pinnately veined or if subtripliveined then the laminae drying thin in texture and usually puberulent 4a
- 2a. Leaves strongly tripliveined with the basal lateral veins reaching the distal part of the lamina, midvein with weakly developed secondary veins; fruiting receptacle becoming 12–14 mm wide; southeastern Costa Rica *P. neurophylla*
- 2b. Leaves weakly tripliveined, the basal lateral veins rarely reaching the distal part of the lamina, midvein usually with prominent secondary veins (at least in the distal half) 3a
- 3a. Leaves usually elliptic-oblong to lanceolate, (6–)9–29 cm long, tapering gradually to an acute or acuminate apex; fruit cups 8–12 mm broad; wide-ranging, 0–1900 m *P. cinnamomifolia*
- 3b. Leaves ovate to broadly elliptic, usually tapering abruptly to a short-acuminate or caudate-acuminate apex; fruit cup 5–8 mm broad; Pacific slope, 600–1200 m *P. brenesii*
- 4a. Leaves glabrous beneath, usually drying pale grayish or yellowish green, coriaceous to subcoriaceous 5a
- 4b. Leaves puberulent beneath, usually drying dark brown to yellowish brown; species now transferred to the genus *Ocotea* 6a
- 5a. Leaves 20–50 cm long, petioles 2.5–6 cm long; 0–1000 m elevation *P. chavarriana*
- 5b. Leaves 9–22 cm long, petioles 1.5–3 cm long and often reddish (in life); 1500–2500 m elevation *P. hammeliana*
- 6a. Leaves 1–4 cm broad and 3–10 cm long, usually narrowly elliptic; flowers often with 3 staminodes 7a
- 6b. Leaves 4–14 cm broad and 8–30 cm long, usually broadly elliptic to obovate; flowers rarely with 3 well-developed staminodes 8a
- 7a. Fruit cups ca. 6 mm broad; pubescence on the lower leaf surfaces grayish and soft to the touch; 1400–2300 m *O. mollicella*
- 7b. Fruit cups 10–15 mm broad; pubescence on the lower leaf surfaces brownish and slightly rough to the touch; 1000–3200 m *O. pittieri*
- 8a. Fruit cups 10–18 mm broad and 5–6 mm deep; trees of montane forests, 1000–2000 m *O. valeriana*
- 8b. Fruit cups 7–14 mm broad and 2–3 mm deep; lowland rain forests, 0–500 m *O. helicterifolia*

Phoebe brenesii Standl., Publ. Field Mus. Nat. Hist. Bot. Ser. 18: 459. 1937. Figure 1.

Small or medium-sized trees 5–15(–20) m tall, trunk to 75 cm in diameter, leafy branchlets 1.2–3.5 mm thick, very minutely (0.1 mm) puberulent at first but soon becoming (sub)glabrous, dark in color and longitudinally striate. **Leaves** alternate, often distally clustered, petioles 4–30 mm long, ca. 1 mm thick, with 2 adaxial ridges forming an adaxial sulcus; **leaf blades** 2.5–10.5 cm long, 1.3–4(–5) cm broad, broadly elliptic to elliptic-oblong or ovate-elliptic, usually tapering abruptly to the short-acuminate or caudate-acuminate apex, usually obtuse to rounded at the base, slightly decurrent on the petiole, drying stiffly chartaceous to subcoriaceous and dark or pale yellowish gray, smooth and glabrous above and below, tripliveined with a prominent pair of secondary

veins arising from the primary vein 2–12 mm above the petiole, 1 or 2 additional secondaries arising from the central or distal part of the midvein on each side, tufted hairs (domatia) usually present in the axils of the basal veins beneath, tertiary and smaller veins sometimes forming a slightly raised reticulum beneath. **Inflorescences** axillary, 3–15 cm long with relatively few flowers in a distal open panicle, peduncle to 8 cm long and usually as long or longer than the flowering rachis, glabrous, pedicels 2–4 mm long. **Flowers** 2.5–4 mm long, outer tepals ca. 2.5 mm long and glabrous on the outside; outer **anthers** narrow and ca. 1 mm long with filaments ca. 0.5 mm long, inner stamens ca. 2 mm long, staminodes 1–1.3 mm long with puberulent stipe and glabrous acute apex; **pistil** 2–2.5 mm long, ovary globose to turbinate, style slightly longer than the ovary, stigma capitate. **Fruits** borne on a broadly expanded (5–8 mm) shallow (2–3 mm deep) obconical receptacle ca. 4 mm

long, rim apparently entire but often with 6 slits marking the bases of the tepals, pedicel slightly thickened and 4–5 mm long; berry 10–13 mm long and 5–9 mm in diameter (dry), ellipsoid, becoming black on a red or rose-colored base.

Trees of the Pacific slope between 600 and 1200 m elevation, but reaching 2000 m in Chiriquí. Flowers have been collected in January–April, while fruits have been collected in March–May and September. This species may be restricted to premontane moist forest formations. It is only known from the Meseta Central (San Ramón to Villa Colón), near Boquete in the Chiriquí highlands and in Veraguas Province of Panama.

Phoebe brenesii is recognized by the usually small stiff and abruptly acuminate leaves with tripliveined venation. In addition, the leaves tend to be broad and are often borne on long slender petioles. The glabrous flower buds, prominent staminodes with caudate-acuminate apices, and small fruits on shallow receptacles further distinguish this species. Compare material of this species with the very variable *P. cinnamomifolia*; *P. brenesii* is probably a derivative of that species.

Phoebe chavarriana Hammel, J. Arnold Arbor. 67: 131. 1986. Figure 2.

Small or medium-sized trees 8–15 m tall, 15–35 cm d.b.h., bark reddish brown, leafy branchlets 4–10 mm thick, at first with minute (0.1 mm) appressed ascending grayish hairs, glabrescent and usually drying dark in color, terete. **Leaves** alternate, petioles 2.5–6 cm long, 3–6 mm thick, narrowly sulcate above, glabrous; **leaf blades** 20–50 cm long, 10–23 cm broad, elliptic to somewhat ovate-elliptic, elliptic-oblong or slightly elliptic-obovate, acute to obtuse or very short acuminate at the apex, acute to obtuse or rounded at the base, drying subcoriaceous and grayish green, glabrous above and below, the midvein impressed above, with 6–10 major secondary veins on each side, the central secondaries arising at angles of 45°–65°, leaves appearing glaucous beneath. **Inflorescences** axillary from distal leaves or clustered near the apex, 10–23 cm long, paniculate, peduncles 1–3 cm long and ca. 1 mm thick, sparsely and minutely puberulent, pedicels 1–3 mm long. **Flowers** 2.5–4 mm long, sparsely and minutely puberulent on the outside, perianth whorls subequal, tepals ca. 2.5 mm long, greenish white; **outer stamens** 1.5–1.9 mm long, outer anthers 1–1.2 mm long, oblong with superposed thecae, inner stamens ca. 2 mm long, with sparsely puberulent filaments, staminodes 1.2–1.8 mm long and with sagittate-cordate apex; **pistil** ca. 2.2 mm long, glabrous, ovary globose, style ca. 1 mm long, stigma simple. **Fruits** borne on a flattened receptacle ca. 2 mm deep and 12 mm broad with persisting perianth parts (but only 1–2 mm long), pedicel 1–1.5 cm long and 4–6 mm thick below the expanded apex, conical

and becoming red; berry 15–18 mm long and 10–12 mm in diameter, ovoid, dark green to almost black.

Trees of the lowland rain forest and escarpment on the Caribbean slope, between 50 and 1000 m elevation. Flowering occurs in April–May, and fruits have been collected in July–August. This species is only known from near the confluence of the Río Sarapiquí and Río Puerto Viejo in Heredia, and from near Moravia de Turrialba in Cartago (but see below).

Phoebe chavarriana is recognized by its very large glabrous leaves, and fruits borne on flattened receptacles with very short persisting perianth parts above a conical pedicel. The large staminodes are characteristic of *Phoebe* and *Persea*, but the fruits are similar to those of several other species of *Phoebe*. The species was named in honor of Rafael Chavarria, who helped make the La Selva research station a success.

An unusual collection (*Holdridge 6336*, CR, USJ) with large (50 × 18 cm) obovate leaves and large (30 × 15 mm) oblong fruits from 200 m in the Caribbean lowlands is provisionally placed here. Another unusual collection (*Hartshorn 1456*, CR, F) along the Sarapiquí road at 950 m elevation may be a small-leaved form, with leaves that dry yellowish and similar infructescences (collected in April). *Phoebe chavarriana* is closely related to *Phoebe hammeliana* of higher elevations.

Phoebe cinnamomifolia (H.B.K.) Nees, *Linnaea* 21: 488. 1848. *Persea cinnamomifolia* H.B.K., *Nov. gen. sp.* 2: 160. 1817. *Phoebe mexicana* Meissn. in DC., *Prodr.* 15: 31. 1864. *Persea mexicana* (Meissn.) Hemsl., *Biol. cent. amer. Bot.* 3: 71. 1882. *Phoebe tonduzii* Mez., *Bot. Jahrb. Syst.* 30, Beibl. 67: 15. 1901. *Phoebe costaricana* Mez & Pittier, *Bull. Herb. Boissier* 3: 230. 1903. Figure 1.

Trees (rarely shrubs), 5–25 m tall, trunks often 30–40 cm in diameter, leafy branchlets 1.5–6 mm thick, at first with minute (0.1–0.2 mm) appressed ascending hairs but usually becoming (sub)glabrous and dark brown. **Leaves** alternate, petioles 1–3.5(–5) cm long, 1–3 mm thick, with a broad or narrow sulcus above, minutely puberulent or glabrous; **leaf blades** (6–)9–29 cm long, (3–)4–9(–14) cm broad, elliptic-oblong to oblong, ovate-oblong, lanceolate or falcate, tapering gradually to the acute or acuminate apex, acute to obtuse at the base, drying subcoriaceous to coriaceous and often grayish green or yellowish, usually glabrous above and below but often with tufted hairs in the vein axils beneath, venation usually tripliveined (rarely pinnate) with the basal secondaries arising from 2–20 mm above the petiole and with (2–)3–6 ad-

ditional prominent secondaries on each side, basal secondaries arcuate-ascending and usually reaching the middle of the lamina, tufted hairs or pit domatia usually present in the axils of the major veins beneath. **Inflorescences** (5–)10–25 cm long, solitary or in clusters from axillary short shoots, racemose (with individual or small groups of flowers arising from the primary rachis) to panicle with lateral flowering branches, peduncles slender (ca. 1 mm) and shorter than the flowering rachis, puberulent or glabrous, pedicels 3–5 mm long. **Flowers** 2–4 mm long, 2.2–3.8 mm broad, glabrous or sometimes minutely puberulent, tepals 1.5–2 mm long, erect and often subequal with the outer slightly shorter than the inner; outer **stamens** with filaments 0.2–1 mm long, the narrow outer anthers 0.6–1 mm long, inner stamens 1.5–2 mm long, staminodes 0.8–1.5 mm long with a thick acute apex 0.5–0.8 mm; **pistil** 2–3.5 mm long, ovary rounded, style ca. 1 mm long, narrow, stigma capitate or simple. **Fruits** borne in a cupulate campanulate receptacle 5–10 mm long, 8–12 mm broad and 2–3 mm deep, the perianth parts persisting or deciduous (and then the margin with obscure indentations), becoming red; berry 1–1.8 cm long, 0.7–1.3 cm thick (dry), ellipsoid, dark green.

Trees of evergreen or partly deciduous forest formations on both the Pacific and Caribbean slopes, and ranging from near sea level to 1500 (1900) m elevation. This species has not been collected from below 600 m on the Pacific slope, and it appears to be quite rare below 400 m on the Caribbean slope. The species is common at Monteverde, the eastern portion of the Meseta Central (but not near the volcanoes), the valley of the Río Reventazón, and from the Cordillera de Talamanca to the Chiriquí highlands. Flowering material has been collected in Costa Rica November–May and July. Fruits have been collected in January–May, July–August, and November. This species ranges from southern Mexico through Central America into South America.

Phoebe cinnamomifolia is recognized by the usually larger stiff leaves on long petioles, and the tripliveined laminae. The usually glabrous leaves (except for the tufted domatia), the often clustered racemose inflorescences, small flowers with prominent staminodes, and fruit cup with persisting perianth (or notches in the rim of the cup) further distinguish this species. Specimens placed under this name include a rather heterogeneous assemblage as regards vegetative morphology (see below), but the floral characters are quite uniform. *Phoebe brenesii* and *P. neurophylla* are very closely related to this species; see the discussions under those species.

Phoebe cinnamomifolia is used here in a very broad sense, and includes a variety of forms. Most of the unusual collections are linked by intermediates to the more common forms. The type of *Phoebe tonduzii* (based on *Tonduz 11753*, US) represents a very puberulent form with shorter, more ovate, leaves; it is rarely collected. A few collections with very small elliptic leaves and very small glabrous inflorescences have been collected in the Caribbean lowlands and are placed here provisionally (see *Stork 2314*, F). More significant is the type of *P. costaricana* Mez & Pittier (based on *Pittier 11107*, US) This specimen can be used to characterize a number of higher-altitude (1200 to 1800 m) collections which may represent a distinctive species; it is especially common in the Coto Brus area and adjacent Chiriquí highlands of Panama. The following key attempts to separate *P. costaricana* from most collections of *P. cinnamomifolia* in Costa Rica, but there are many collections that appear to be intermediate and the question of recognizing *P. costaricana* as a species or subspecies requires further study.

Diagnostic Features of *Phoebe costaricana* and *P. cinnamomifolia*

- 1a. Inflorescences nearly always solitary and axillary to distal leaves, glabrous and with few-flowered lateral branches, pedicels to 4 mm long, the flowers not closely clustered; axillary buds inconspicuous and usually less than 2 mm long; the leaves usually strongly tripliveined with only a few prominent secondary veins in the distal half of the lamina, leaf blades rarely more than 12 cm long *P. costaricana*
- 1b. Inflorescences solitary or several on leafless short shoots, pseudoterminal or axillary to distal leaves, densely grayish puberulent to glabrous, pedicels to 3 mm long and flowers often clustered in cymose groups of 7 or more; larger (3–4 mm) axillary buds with whitish hairs and overlapping scales often present and conspicuous in leaf axils and at the tips of twigs; leaves tripliveined but usually with well-developed secondaries throughout the length of the midvein, leaf blades often more than 15 cm long *P. cinnamomifolia*

***Phoebe hammeliana* W. Burger, sp. nov.** Figure 12.

Arbor 8–15 m alta, ramulis foliiferis 2.5–8 mm crassis. Folia alterna, petiolis 1.4–2.8 cm longis; laminis 9–21 cm longis et 5–12 cm latis, ovatis, elliptico-ovatis, vel oblongo-ovatis, apice obtuso vel breviter acuminato, glabris, coriaceis, nervis secundariis 4–8 paribus. Inflorescentiae usque 20 cm longae, pedunculis usque 10 cm longis, rubris. Flores 3–4 mm longi et 5–7 mm lati, extus glabri, stamina ser. I–II filamentis longis et antheris 1–1.2 mm longis, staminodiis 1.5–2 mm longis et capitatis; gynoecium 2.2–2.6 mm longo, ovario subgloboso. Fructus ellipsoideus, 15 mm longus et 10 mm crassus; cupula 8–10 mm lata, ca. 2 mm profunda.

Trees 8–15 mm tall, leafy branchlets 2.5–8 mm thick, glabrous or with minute (0.1 mm) grayish hairs, stems becoming reddish brown and longitudinally striate. **Leaves** alternate or occasionally subopposite, petioles 1.4–2.8 cm long, 1.3–4 mm thick, glabrous or with minute grayish hairs, narrowly sulcate above; **leaf blades** 9–21 cm long, 5–12 cm broad, ovate or elliptic-ovate to ovate-oblong, obtuse to short-acuminate at the apex (and the end of the lamina often twisted to one side), rounded and truncate to obtuse (acute) at the base, often slightly decurrent on the petiole, margin entire or somewhat undulate, drying coriaceous or subcoriaceous and often lustrous above, glabrous on both surfaces, yellow-green in life but drying reddish brown to orange-green, midvein impressed above, with 4–8 major secondary veins on each side, central secondaries arising at angles of 30°–60° (the basal secondaries rarely strongly ascending), tertiary venation obscure. **Inflorescences** axillary to distal leaves or clustered near the apex, to 20 cm long, reddish, glabrous, peduncle to 10 cm long, pedicels 0.5–3.5 (–4.5) mm long. **Flowers** 3–4 mm long and 5–7 mm broad, tepals 2.5–3.5 mm long, 1.5–2 mm broad, glabrous; outer **stamens** 2–2.5 mm long, anthers 1–1.2 mm long and narrowly ovate-oblong, inner stamens ca. 2.2 mm long, staminodes 1.5–2 mm long and with a prominent sagittate apex, a few hairs present within the floral tube; **pistil** 2.2–2.6 mm long, ovary subglobose, style ca. 1.5 mm long, slender, stigma simple or slightly discoid. **Fruits** borne on a shallow (2 mm) cup 8–10 mm broad, bases of the broadened perianth parts persisting or breaking off, pedicel to 2 cm long, conical and often warty, becoming red; berry ca. 15 mm long and 10 mm in diameter (dry), ellipsoid.

TYPE—Costa Rica, San José Province, 0.9 km above La Chonta and 100 m from the Pan-American Highway, elevation 2460 m, 11 May 1969, Roy W. Lent 1678 (holotype, CR; isotypes, DUKE, F; negative, 61123, NY).

Trees of wet evergreen montane forest formations along the continental divide and the Caribbean side of the Central Volcanic highlands, and in the western part of the Cordillera de Talamanca,

between 1200 and 2500 m elevation. Flowers have been collected in May–July, and fruits have been collected in January, March–April, and November. The species is only known from central Costa Rica and the Chiriquí highlands of Panama.

Phoebe hammeliana is recognized by the thick yellowish green leaves usually drying orange-brown, the prominent reddish petioles, small glabrous flowers with prominent staminodes, and the fruits borne on a flattened cup at the apex of a conical pedicel. Growth patterns of distal twigs often resemble those of *Persea rigens* (q.v.). This species is closely related to the lowland *Phoebe chavarriana*, with much larger leaves that are more elliptic in form. A closely related species, but with more prominent basal secondary veins, occurs at similar elevations in Colombia and appears to be undescribed. This species seems to suffer from gall formations, both on the leaves and in the fruiting inflorescences. The following Costa Rican collections are placed here: Gómez 23977 (CR), González 44 (CR, F), Hammel 14091 (DUKE), Hartshorn 1125 (CR, F), Holdridge 5151 (CR, NY), A. Jiménez 2552 (CR, F), Oersted 14938 (F), Poveda 1061 (CR, F), Utley & Utley 3648 (CR, F), Stork 2404 (F). This species is named for Barry Hammel, whose studies and collections at La Selva have made a major contribution to our knowledge of Costa Rica's Lauraceae.

***Phoebe neurophylla* Mez & Pittier, Bull. Herb. Boissier 3: 231. 1903. Figure 1.**

Trees 15–18 m tall, leafy branchlets 1.5–4 mm thick, glabrous but the shoot apex with appressed sericeous hairs. **Leaves** alternate, petioles 9–16 mm long, 1–2 mm thick, sulcate above, glabrous; **leaf blades** (6–)9–21 cm long, (2.3–)3–7 cm broad, elliptic-oblong to oblong, ovate-elliptic or slightly obovate-oblong, short-acuminate at the apex, acute to obtuse and short-decurrent on the petiole, drying stiffly chartaceous and grayish green or pale brown, glabrous on both surfaces, midvein impressed above, venation strongly tripliveined with the major basal secondaries arising 5–10 mm above the petiole and parallel with the margin more than half the length of the lamina, major distal secondaries beginning near the middle of the lamina and 2–3 on each side, prominent pit domatia with tufted hairs present in the basal vein axils beneath. **Inflorescences** 3–7 cm long, 1–5 arising together from axillary short shoots, usually racemose with most of the flowers solitary or in groups directly from the central rachis or paniculate with branched lateral branches, peduncle 1–3.5 cm long, slender (0.5 mm) and glabrous, pedicels 4–5 mm long. **Flowers** 4–5 mm long and 3–4 mm broad, glabrous on the outside, tepals ca. 2.3 mm long, glabrous but minutely

ciliolate along the distal edge; outer **stamens** with prominent (0.6–0.9 mm) filaments bearing narrow anthers 0.7–0.9 mm long, inner stamens with flattened glands, staminodes 1.2–2 mm long with thick acute apices 0.8–0.9 mm long; **pistil** ca. 2.5 mm long, ovary about 1 mm thick and gradually narrowed into the style, stigma capitate. **Fruits** borne on an open receptacle 10–14 mm wide and 2–5 mm deep, the broadly obconic receptacle ca. 5 mm long and with the margin entire or obscurely lobed, pedicel becoming 12 mm long and expanded to 4 mm thick beneath the receptacle, red; berry becoming 20 mm long and 15 mm in diameter, ellipsoid, green.

Trees of the western General Valley and the Golfo Dulce area of the Pacific slope of southern Costa Rica, between 500 and 1000 m elevation (to 1500 m in Nicaragua). Flowering material has been collected in January; fruits have been collected in March (*Pittier 12054*, us, the type) and June–August. The species is found in Nicaragua and southern Costa Rica.

Phoebe neurophylla is recognized by its larger elliptic-oblong leaves with strongly triplinerved venation with the basal secondaries paralleling the margins from near the base to beyond the middle of the lamina. The lack of pubescence, large staminodes, shallow and subentire fruit cup, and restricted range further distinguish this species. Caroline Allen (1945, p. 315) placed a specimen from Zarcero (*A. Smith 142*, F) under this name, but that collection probably belongs under *P. cinnamomifolia*. Likewise, specimens from Mexico ascribed to this species by Allen (1945) will probably prove to be another species. *Phoebe neurophylla* is very closely related to *P. cinnamomifolia*, but the unusual venation, deeper floral tube, slightly larger fruits, and deeper cup support the recognition of this taxon as a species rather than a subspecific element of the very variable and widely ranging species. Also, the floral parts seem to differ, but this is based on a single collection and may be atypical. This species is similar in some ways to the type of *P. costaricana*; see the discussion under *P. cinnamomifolia*.

Pleurothyrium Nees

Medium-sized **trees** of evergreen forest formations. **Leaves** alternate or occasionally subopposite, petiolate, the leaf blades often obovate (elliptic-oblong in ours),

Key to Species of *Pleurothyrium*

- 1a. Leaves becoming more than 30 cm long, usually with an arcuate submarginal vein connecting the secondary veins distally; small trees of lowland rain forests 2a

entire and pinnately veined, often minutely puberulent to tomentose beneath. **Inflorescences** solitary and axillary or pseudoterminal, paniculate or racemose, the flowers usually in cymose or umbellate groups on short lateral branches of the main inflorescence axis, an involucre absent. **Flowers** bisexual, perianth of 2 equal (or subequal) whorls of 3 parts (6 tepals), floral tube short or equalling the ovary; **androecium** of 9 fertile 4-theccous stamens, the outer 6 anthers (series I–II) with the upper thecae usually introrse and the lower thecae lateral-extrorse, often varying in dehiscence by bending and curvature of the stamen, interior 3 stamens (series III) usually with the upper thecae opening laterally and the lower thecae extrorse, the 6 glands of the inner stamens much enlarged and extending outward to the periphery of the androecium, and closely adjacent to the outer stamens, staminodes (series IV) absent or minute; **pistil** with globose to ellipsoid ovary, slender style and discoid stigma. **Fruits** borne in a cupulate receptacle, surface of the cup often pustulate or warty; berry usually ellipsoid.

A genus of perhaps 25 species ranging from Guatemala to northern South America and the Amazon Basin. The glands are enlarged basally and come to lie between the outer stamens; appearing to be associated with the outer stamens, though they originate at the base of the inner stamens. We believe that the presence of these enlarged glands in the periphery of the androecium and the unusual form of the stamens, argues against the submersion of *Pleurothyrium* under *Ocotea*, as advocated by Bernardi (1962) and Kostermans (1957). In some species the glands are connivent and difficult to interpret; or they may be lobed and appear to be more numerous than six. Rohwer and Kubitzki (1985) clarified the nature of the androecium, and their findings are consistent with our observations.

The unusual bent stamens of *Pleurothyrium* and the unique pattern of anther dehiscence may be better understood in the context of *Pleurothyrium golfodulcense*, where the androecial elements are tightly compressed into a dome: dehiscence is outward from the surface of this dome. By becoming bent, all the valves seem capable of “apical” (or outward) dehiscence from the surface of the dome. Thus, small pollinators can work over the surface of the dome, rather than in and among the androecial elements.

- 1b. Leaves never becoming more than 30 cm long, a distinct submarginal vein not developed . . . 3a
 2a. Leaves drying chartaceous and dark, usually obovate, petioles 4–8 mm long; inflorescences to 65 cm long *P. hexaglandulosum*
 2b. Leaves drying subcoriaceous, grayish above and reddish brown beneath, petioles 15–25 mm long *Pleurothyrium* sp. A
 3a. Inflorescences becoming more than 10 cm long, lateral branches of the inflorescences with secondary branches; flowers ca. 6 mm broad, androecium not densely congested; hairs on stems usually less than 0.3 mm long; from below 400 m elevation *Pleurothyrium trianae*
 3b. Inflorescences to 10 cm long, the lateral branches often with only 1 flower; flowers ca. 10 mm broad, androecium densely congested; hairs on stems and petioles 0.2–0.5 mm long 4a
 4a. Leaves obovate to broadly oblong-obovate, leaves 6–15 cm broad, rounded and short-acuminate to caudate-acuminate at the apex; on the Caribbean slope and near the continental divide, 800–1600 m elevation *P. palmanum*
 4b. Leaves elliptic to narrowly elliptic-oblong, leaves 4–7.5 cm broad, acute to long-acuminate at the apex; hills bordering Golfo Dulce below 500 m elevation *P. golfodulcense*

***Pleurothyrium golfodulcense* W. Burger & N. Zamora, sp. nov. Figure 9.**

Arbor ca. 10 m alta, ramulis foliiferis 2–4 mm crassis. Folia alterna, petiolis 11–28 mm longis, 1.3–2 mm crassis, hirsutulis; laminis 9–20 cm longis et 4–7.5 cm latis, elliptico-oblongis, elliptico-obovatis vel oblongo-obovatis, apice breviter acuminato, subtus puberulis, nervis secundariis 5–9 paribus. Inflorescentiae racemosae, 3–9 cm longae, pedunculis 2–4 cm longis. Flores ca. 5 mm longi et 8–12 mm lati, extus puberulenti, tepalis intus papillato-puberulis; stamina ca. 0.7 mm longa, antheris ca. 0.5 mm longis, congestis, staminodiis nullis, glandibus magnis; gynoecium angustum, ca. 2 mm longo. Fructus ignotus; cupula ca. 22 mm lata, 10 mm profunda.

Trees ca. 10 m tall, leafy branchlets 2–4 mm thick, densely yellowish brown or grayish brown hirsutulous with straight or slightly crooked ascending hairs 0.2–0.5 mm long. **Leaves** alternate in a spiral or occasionally subopposite, petioles 11–28 mm long, 1.3–2 mm thick, terete, flattened or slightly sulcate above (adaxially), densely hirsutulous; **leaf blades** 9–20 cm long, 4–7.5 cm broad, elliptic-oblong to elliptic-obovate or oblong-obovate, abruptly narrowed to a short-acuminate or cuspidate apex (rarely obtuse or acute), the tip to 1.5 cm long, usually obtuse at the base (less often acute or slightly rounded) and often asymmetric, margin slightly revolute (dry), drying stiffly chartaceous or subcoriaceous, flat dull and glabrescent on the upper surface but minutely puberulent above the midvein, puberulent on the lower surface and slightly rough to the touch, sparsely or obscurely puberulent between the veins beneath, with 5–9 major secondary veins on each side, central secondaries arising at angles of 40°–60°. **Inflorescences** solitary and axillary to undeveloped leaves near the shoot apex or between the older leaves, 3–9 cm long, racemose with lateral branches becoming 1–2 cm long and bearing only a single flower, peduncles 2–4 cm long, densely ferruginous puberulent, lateral branches subtended by persisting bracts ca. 4 mm long with 2 bracteoles often mid-

way between the rachis and the flower, pedicels 2–7(–12) mm long. **Flowers** 8–12 mm broad, flower buds ca. 5 mm long, densely puberulent on the outside, perianth becoming rotate, tepals ca. 6 mm long and 3–4 mm broad, papillate-puberulent within; **androecium** in the form of a dome 2.5 mm broad, stamens and glands tightly congested with the outer glands connivent and forming a peripheral ring around the androecium, stamens ca. 0.7 mm long and 0.4 mm broad, anthers ca. 0.5 mm long, dehiscence essentially apical from the surface of the dome, glands and stamens closely appressed; **pistil** slender, ca. 2 mm long. **Fruits** borne in a warty cup 2 cm long, ca. 2.2 cm broad and 1 cm deep, margin slightly (1 mm) undulate with the persisting bases of the perianth parts, becoming pink; berry not seen.

TYPE—Costa Rica, Puntarenas Province, Alto de las Mogas, camino a Rincón de Osa, 14 February 1985, *P. E. Sánchez, N. Zamora & M. Brenes 1228* (holotype, CR; isotypes, F, USJ; negative 61185, F).

Trees of lowland rain forest formations around Golfo Dulce in southernmost Costa Rica, between 100 and 900 m elevation. Flowering collections were made in late January and middle February; the January collection had a mature fruit cup. This taxon is known from only three collections: *Allen 5885* (US) from above Palmar Norte, *Burger & Matta 4690* (CR, F) from the hills above Golfito, and the type.

Pleurothyrium golfodulcense is recognized by its brownish puberulent stems and leaves, racemose few-flowered inflorescences, rotate flowers with tightly congested androecium, and deep warty fruit cup. The generally elliptic-oblong leaves are similar to many other Lauraceae, but the compacted

dome like androecium is unique among our species. The androecium is so compact that it is difficult to dissect, and may at first appear to be an abnormality. This species is closely related to *P. palmanum*.

Pleurothyrium hexaglandulosum H. van der Werff, Ann. Missouri Bot. Gard. 75: 417. 1988.

Small trees 5–6 m tall, leafy branches 2.5–6 mm thick, minutely appressed puberulent but quickly becoming (sub)glabrous, dark reddish brown, terete. **Leaves** alternate, petioles 4–8 mm long, 3–4 mm thick, appressed puberulent at first; **leaf blades** 27–46 cm long, 8–15 cm broad, narrowly elliptic-obovate to oblanceolate or narrowly elliptic, narrowed to the short acuminate apex, gradually narrowed to the base and abruptly rounded (subcordate) at the petiole, drying chartaceous or stiffly chartaceous, glabrous above with the major venation flat or immersed, glabrescent beneath or with minute appressed hairs along the major veins, with 9–12 major secondary veins on each side, central secondaries arising at angles of 35°–60°, secondaries loop-connected near the margin (in the type collection) or only weakly loop-connected (in the Costa Rican collection). **Inflorescences** solitary and axillary to distal leaves, (20–)30–65 cm long, paniculate with lateral branches up to 25 cm long near the base and shorter distally, peduncle brownish puberulent or glabrous and dark brown, pedicels 8–20 mm long, minutely grayish puberulent. **Flowers** 7–9 mm broad, becoming rotate with reflexed tepals, greenish to yellowish, tepals equal and 3–4 mm long, minutely puberulent on the outside and minutely papillate-puberulent within (with lines of hairs often defined by pressure of glands and stamens in bud); glands large (1.5 mm broad) and forming a peripheral ring around the androecium, tightly appressed but not fused, the 9 stamens 0.8–1.5 mm long with anthers raised above the glands, filaments with a few hairs along the back, anthers 0.5–0.7 mm long, 4-therous with the valves on opposite sides and lateral dehiscence; pistil 1.5 mm long, ovary broadly ovoid, 1–1.2 mm thick, style 0.2–0.5 mm long, stigma discoid. **Fruits** unknown.

Understory trees of wet evergreen lowland rain forests, and known from only two collections. The Costa Rican collection was made on 3 March 1985, at 150 to 260 m elevation southwest of Rincón de Osa in southern Puntarenas Province (*Croat & Grayum 59792*, CR, F, MO). The type was collected near Portobelo, along the Río Guanache at 50 m elevation in the Province of Colón, Panama (*Hammel & Trainer 14781*, MO).

Pleurothyrium hexaglandulosum is distinguished by its long, narrow, often oblanceolate, thin-textured leaves on very short petioles and drying dark brown. The large glands at the periphery of the androecium are especially promi-

nent in this species. The two collections placed here differ in a number of ways; emphasis on the Costa Rican material accounts for the differences in the above description and the original description.

Pleurothyrium palmanum (Mez & J. D. Smith) Rohwer, Mitt. Inst. Allg. Bot. Hamburg 20: 41. 1986. *Ocotea palmana* Mez & J. D. Smith, Bot. Gaz. 33: 258. 1902. Figure 6.

Trees to 15 m tall and 40 cm d.b.h., leafy branchlets 3–7 mm thick, densely tomentulose with crooked (often appressed) brownish or yellowish brown hairs 0.2–0.5 mm long. **Leaves** alternate, petioles 15–25 mm long, 1.8–5 mm thick, densely ferruginous tomentulose; **leaf blades** (11–)15–28 cm long, (6–)7–15 cm broad, obovate to broadly oblong-obovate or less often oblong, abruptly rounded at the apex and bluntly obtuse to short-acuminate (occasionally caudate-acuminate as in *Barbour 1012*), gradually narrowed to the cuneate or obtuse and equal or unequal base, drying stiffly chartaceous (subcoriaceous), upper surface drying dark brown and appressed puberulent above the major veins, lower surface usually drying pale grayish brown or yellowish brown and usually densely appressed puberulent over the entire surface, with 5–8 major secondary veins on each side, the central secondaries arising at angles of 45°–60°. **Inflorescences** axillary to distal leaves or subterminal, 4–10 cm long, paniculate or racemose, few (<20) flowered, peduncles 1–4 cm long, 0.8–2.3 mm thick, densely ferruginous puberulent, pedicels 1–10 mm long, bracteolate. **Flowers** 5–6 mm long and 10–12 mm broad, perianth densely appressed puberulent on the outside and minutely puberulent on the inside, outer tepals to 4.5 mm long; **stamens** ca. 1 mm long, closely appressed and difficult to interpret, anthers usually bent and with outward dehiscence, filaments very short, glands of the inner stamens enlarged and forming part of the periphery of the androecium (between the outer stamens), staminodes not seen; **pistil** papillose (in the type) or puberulent (in *Barbour 1012*). **Fruits** unknown.

Trees of evergreen lower montane rain forest formations on the Caribbean slope and along the continental divide in the central highlands, from about 800 to 1600 m elevation. Only two flowering collections have been made: *Tonduz 12652* (us, the type) collected near La Palma in September, and *Barbour 1012* (F, NY) from east of Turrialba in May. This species is only known from central Costa Rica.

Pleurothyrium palmanum is recognized by the larger obovate leaves densely appressed puberulent beneath and usually cuneate at the base, the large puberulent flowers with glands visible at the outer periphery of the androecium, and its re-

stricted ecological range. This species can be confused with *Ocotea valeriana* and especially *O. pseudopalmana*, but they tend to grow at higher elevation, have darker brown puberulence, and have very different flowers. Additional sterile collections belonging to this species are *Holdridge 6690* (CR, NY) from Tres Mariás (Barba) and *W. & H. Rowlee 210 & 233* (F, US) from near La Palma. Floral characteristics, pubescence, and geography indicate a close relationship with *P. golfodulcense*.

Pleurothyrium trianae (Mez) Rohwer, Mitt. Inst. Allg. Bot. Hamburg 20: 43. 1986. *Nectandra trianae* Mez, Königl. Bot. Gart. Berlin 5: 439. 1889. Figure 9.

Trees, probably small or medium-sized, leafy branchlets 2–4 mm thick, at first minutely (0.1–0.2 mm) puberulent with thin brownish ascending hairs, becoming (sub)glabrous and dark, terete. **Leaves** alternate, petioles 12–18 mm long, 1.2–2.1 mm broad, flat or slightly sulcate above with 2 adaxial margins, minutely puberulent but becoming (sub)glabrous; **leaf blades** 10–16 cm long, 3–6 cm broad, oblong to elliptic-oblong, acute or short-acuminate at the apex, acute to obtuse at the base, drying stiffly chartaceous (almost subcoriaceous) and grayish brown above, flat and essentially glabrous above, minutely and obscurely brownish puberulent beneath and soft to the touch with slender hairs 0.1–0.3 mm long, with 5–9 major secondary veins on each side, central secondaries arising at angles of 35°–60°. **Inflorescences** apparently axillary to undeveloped leaves among fully developed leaves along the distal stems, to 13 cm long, paniculate with short (2–3 cm) lateral branches, flowers in cymose groups on the lateral branches or secondary branches, flowers in cymose groups on the lateral branches or secondary branches, peduncles 3–6 cm long, 1–1.7 mm thick, pedicels 3–5 mm long, slender and minutely (0.2 mm) puberulent. **Flowers** ca. 4 mm long and 6 mm broad, the floral tube ca. 0.7 mm deep, tepals ca. 3 mm long and oblong, becoming rotate, puberulent on the outside and papillate-puberulent within; **outer anthers** ca. 0.6 mm long and 0.6 mm broad with dehiscence of the upper thecae either introrse or lateral and the lower thecae extrorse, glands ca. 0.5 mm thick; **pistil** 2 mm long, the slender style 0.7 mm long and with a discoid stigma. **Fruits** and fruiting receptacle not seen.

Trees of the evergreen lowland Caribbean rain forest formations, flowering in late March. The only Central American collection was made among fallen vegetation overhanging the Río San Juan, between San Juan del Norte (Greytown) and Delta de San Juan (*Bunting & Licht 872*, F, NY). This locality is between 0 and 50 m elevation, along the border of Costa Rica and Nicaragua. The species ranges to northern South America.

Pleurothyrium trianae is recognized by its ob-

long grayish brown leaves slightly puberulent and soft to the touch beneath, the panicles with short lateral branches, the puberulent flowers with conspicuous glands around the periphery of the androecium, and the unusual modes of dehiscence. It may be that the androecium is more tightly compacted in life and dehiscence is, in effect, apical from the outer surface of the domelike androecium. This species appears similar to *Pleurothyrium zulianense* Lasser and *P. amapaense* C. K. Allen of South America.

***Pleurothyrium* sp. A.**

Small trees, ca. 8 m tall and 8 cm d.b.h., leafy branchlets appressed puberulent, 4–6 mm thick, dark brown, terete. **Leaves** alternate, petioles 15–25 mm long, 2.5–4.5 mm thick, with 2 adaxial ridges and flattened above; **leaf blades** 17–47 cm long, 8–16 cm broad, oblong to elliptic-oblong, tapering to an acuminate apex, the tip 15–30(?) mm long, rounded to obtuse at the base, drying subcoriaceous, smooth, glabrous and grayish above with the midvein raised and the secondaries impressed, glabrescent beneath and reddish brown but minutely (0.1–0.2 mm) puberulent on the midvein, with 10–17 major secondary veins on each side, a well-defined arcuate submarginal vein beginning in the lower fourth of the lamina, 2–6 mm from the lamina-margin and uniting the distal ends of the secondaries, central secondaries arising at angles of 55°–70°. **Inflorescences** and flowers unknown. **Fruits** borne in a small hemispheric cup 6–8 mm long and ca. 12 mm broad, drying dark with conspicuous (1 mm) lenticels on the outside, margin narrow and entire, pedicel 12–15 mm long and 2–3 mm thick, also lenticellate; berry ca. 2 cm long and apparently ellipsoid, dark purple when ripe.

This species is only known from *G. Proctor Cooper 539*, near Almirante, Bocas del Toro, Panama. This fruiting specimen is labeled Jan.–March 1928. The specimen differs from all our other Costa Rican Lauraceae by the large leaves with clearly developed, arcuate, submarginal veins. Except for *Pleurothyrium*, such venation is rare in Lauraceae (but compare our material assigned to *Endlicheria* sp., with much smaller, thinner leaves). The lenticellate cups strongly suggest that *Pleurothyrium* is the correct genus for this collection (Bernardi in herb.; Rohwer, pers. comm.).

***Povedadaphne* Burger**

Medium-sized trees, bisexual, sparsely puberulent, evergreen. **Leaves** alternate, pinnately veined and with pit domatia. **Inflorescences** lacking an involucre of bracts in early stages, solitary and axillary to distal leaves, pani-

culate. **Flowers** bisexual, perianth of 6 equal parts in 2 whorls of 3; **androecium** of 9 fertile stamens, the outer 6 stamens (series I-II) appearing as a single whorl, the 3 inner stamens (series III) similar to the outer in size and form, stamens thick and the filament not clearly differentiated, puberulent, with a flattened glabrous distal surface and 4 minute valves dehiscing apically from this distal surface. 6 glands present between the inner and outer stamens, staminodes absent, a shallow floral cup present; **pistil** slightly narrowed at the base, ovary ellipsoid, style slender and equaling or exceeding the ovary in length, stigma simple. **Fruits** borne on a thickened pedicel, the receptacle only slightly expanded beneath the base of the fruits; berry becoming globose or pyriform, seed large.

The single species is very similar to some of our species of *Ocotea* (such as *O. whitei*) in the form of its flowers, panicles, and foliage. However, the nine stamens dehiscing apically by four minute distal pores is a unique condition in Lauraceae, and the poorly developed cup beneath the large fruits is also unusual. This unique species and genus is only known from Costa Rica. (Compare *Williamodendron*, which has only three stamens of rather similar form.) The genus is named in honor of Luis Poveda, who has added much to our understanding of the Lauraceae in Costa Rica and whose knowledge of Costa Rican trees is unequalled.

Povedadaphne quadriporata W. Burger, Brittonia, 40: 277. 1988. Figure 22.

Trees 6–20 m tall, trunks to 45 cm thick, sometimes with sprout-shoots from the base, leafy branchlets 1.5–4 mm thick, glabrous or minutely appressed puberulent with thin ascending hairs, at first with narrow longitudinal ridges but becoming terete, dark grayish. **Leaves** alternate, petioles 4–10 mm long but poorly defined because of the decurrent lamina-base, 1.2–2.3 mm broad, usually glabrous, with thin lateral margins and sulcate near the base; **leaf blades** 4–12.5 cm long, 2–4(–5.5) cm broad, elliptic-obovate to elliptic-oblong or oblong-obovate, short acuminate at the apex or occasionally obtuse, gradually narrowed to the cuneate or attenuate base and usually decurrent on the petiole, drying subcoriaceous (stiffly chartaceous) and often olive green or brown, glabrous above with the major veins slightly elevated, glabrous or very sparsely puberulent beneath, axils of larger secondary veins usually with conspicuous pit domatia ca. 1 mm broad and filled with minute whitish hairs, with 3–6 major secondary veins on each side, central secondaries arising at angles of 30°–45°, tertiary veins slightly raised beneath. **Inflorescences** solitary in axils of distal leaves, 9–13 cm long, paniculate with short (3 cm) lateral branches, peduncles 4–7 cm long, minutely appressed puberulent, flowers often in 3-flowered distal cymules, pedicels ca. 2 mm long. **Flowers** 2.5–3 mm long and equally broad, apparently urceolate (campanulate in

appearance when pressed), minutely sericeous on the outside, tepals broadly obtuse and glabrous within; fertile **stamens** 9, thick and hairy (a slender filament absent), all stamens dehiscing by 4 small pores at the top, stamens 1.2–1.4 mm long and 0.6 mm broad at the top, the 6 short-stipitate glands arising exterior to the inner stamens, ca. 0.6 mm high and equally broad, staminodes absent; **pistil** ca. 2 mm long, ovary ellipsoid and 0.7 mm thick, style narrow and 0.9 mm long, stigma simple. **Fruits** borne on a thickened (8 mm) pedicel with the receptacle slightly expanded (10–17 mm broad) and 1–3 mm deep below the mature fruits; berry oblong in development (3 × 2 cm in *Chacón 201*) with an unusual warty surface but becoming globose to pyriform, to 8 cm long and 6 cm in diameter, seed reddish purple in cross section.

Trees of the very wet premontane rain forest formations of the Caribbean slope, between 200 and 1000 m elevation. Flowers were collected in June (*Poveda & Castro 3561*, CR, USJ, the types), immature flowers in July (*Chacón et al. 1980*, CR). Small fruits were collected in January (*Chacón 201*, CR), large fruits in February (*Poveda & Holdridge 2360*, CR, NY) and August (*D. Smith et al. 1202*, DUKE, F). The species has been collected in the Reserva Forestal de San Ramón, near San Carlos, and near Ciudad Quesada in Alajuela Province, and just east of the Río Sarapiquí in Heredia Province. It is not known outside of this restricted area in Costa Rica.

Povedadaphne quadriporata is recognized by the small stiff slightly lustrous brownish or olive green leaves (dry), with conspicuous small pit domatia (filled with white hairs) in the vein axils of the lower surfaces, and the decurrent leaf base. The large fruits with poorly developed receptacle, and flowers with nine hairy stamens dehiscing by four little pores at the top, make this species unique among known Lauraceae. The foliage resembles *Ocotea bijuga*, *O. oblonga*, and when dried, *O. whitei*.

Williamodendron Kubitzki & Richter

REFERENCE—K. Kubitzki & H. G. Richter, *Williamodendron* Kubitzki & Richter, a new genus of Neotropical Lauraceae. Bot. Jahrb. Syst. 109: 49–58. 1987.

Moderate-sized to tall trees, branchlets at first puberulent, becoming grayish. **Leaves** alternate or closely congested (whorled), usually clustered at the ends of branchlets, petioles rounded or slightly canaliculate above; leaf blades usually large and obovate, pinnately veined. **Inflorescences** solitary and axillary, paniculate with short lateral branches (thyrsopaniculate), bracts present, brac-

teoles subtending the pedicels. **Flowers** small and subglobose, bisexual, perianth of 6 parts in 2 whorls, tepals unequal, the outer tepals broadly triangular and the inner more obtuse; **androecium** of 3 fertile stamens (series III), stamens sessile (a narrow filament absent), each anther dehiscing distally and extrorsely with 4 small rounded valves, glabrous on the exterior and pilose within, staminodia 3 (series IV), small and lanceolate, floral cup subglabrous; **pistil** glabrous, style absent or short, stigma minute. **Fruits** and fruiting receptacle unknown.

A genus of two species, one found in Colombia and the Amazon basin, and the other in Costa Rica. The genus is distinguished by its androecium of three functional stamens, each dehiscing by four small distal valves. The relatively large obovate leaves clustered at the ends of branchlets is also distinctive. *Williamodendron* is related to *Mezilaurus* but differs in having 4-valved stamens and different bark structure, and in lacking the silica grains in seriated ray cells unique to the wood of *Mezilaurus*. While flower structure may resemble *Licaria*, that genus has very different wood (see reference cited above). The genus was named in honor of William Rodriguez for his achievements in Amazonian forest botany.

Williamodendron glaucophyllum (van der Werff) Kubitzki & Richter, Bot. Jahrb. Syst. 109: 58. 1987. *Mezilaurus glaucophylla* van der Werff, Ann. Missouri Bot. Gard. 74: 164. 1987. Figure 19.

Trees 8–25 m tall, bark smooth and grayish, leafy branchlets 5–8 mm in diameter, becoming glabrous and grayish, petiole scars 3–4 mm broad and conspicuous. **Leaves** alternate to subopposite (whorled) and often closely clustered at the ends of stems, petioles 2–8 cm long, 1.5–3 mm thick, grayish with minute (0.1–0.2 mm) appressed hairs, flat or slightly rounded above, the lateral (or adaxial) margins weakly developed, thickened near the base; **leaf blades** 14–29 cm long, 6.5–15 cm broad, obovate to oblong-obovate, abruptly narrowed or rounded at the obtuse to acute (short-acuminate) apex, gradually tapering to the acute and often unequal base, drying chartaceous, minutely puberulent on the veins above but glabrous on the other surfaces above, very minutely (0.1 mm) puberulent on the lower surface (especially on the veins), conspicuously grayish glaucous on the lower surface, with 9–14 major veins on each side, central secondaries arising at angles of 50°–80°, tertiary veins obscure beneath. **Inflorescences** axillary to leaves, 12–20 cm long, paniculate with short lateral branches to 2.5 cm long, the flowers often borne in small cymes of 1–3 flowers, peduncle to 3 cm long, ca. 1 mm thick, minutely grayish puberulent, pedicels 1–2 mm long, slender, slightly puberulent. **Flowers** ca. 1.5 mm long and 1.5–2 mm broad, white, perianth essentially glabrous, outer perianth whorl shorter than the inner whorl, outer

tepals broadly ovoid or deltoid; fertile **stamens** 3 (but 1 sometimes poorly developed), ca. 1 mm long and 0.8 mm thick, puberulent, free, 4-theous but the thecae sometimes difficult to see on the apex of the anther, opening by 4 small circular valves, 3 staminodia present with sagittate apices and ca. 0.8 mm long, puberulent; **pistil** ca. 1.2 mm long, ovary 0.5–0.8 mm long, glabrous, stigma simple and acute. **Fruits** and fruiting receptacles unknown.

Trees of evergreen rain forests on the Pacific slope of Costa Rica, from about 50 to 500 m elevation. The first collection was made at Masatal de Puriscal (*Zamora & Poveda 1014*, CR, F, MO, the type) with flowers in July. Two additional collections from the Osa Peninsula are *Hammel et al. 15214* (CR, MO) and *Burger et al. 12348* (CR, F, MO, NY). The species is only known from these three collections in south-central and southernmost Costa Rica, in the provinces of San José and Puntarenas.

Williamodendron glaucophyllum is recognized by its large thin obovate leaves, glaucous on the undersurfaces and clustered near the ends of branchlets, long petioles, and the very small flowers on longer racemose panicles. The small flowers with only 3 thick stamens are like those of *Licaria*, but differ in having 4-valved anthers. The small-flowered inflorescences in among the clustered leaves on tall trees may be why this species had not been collected before 1985. These new discoveries are being made by skilled botanists using binoculars and special equipment to collect the tall trees of the rain forest.

A Species of Uncertain Generic Position

Trees to over 10 m tall, leafy branchlets 2–4 mm thick, densely pale grayish tomentulous with curved and matted hairs ca. 0.2 mm long, remaining puberulent for some time, terete. **Leaves** alternate, distant, petioles 18–30 mm long, 1.9–2.7 mm thick, densely grayish tomentulous; **leaf blades** 10–19 cm long, 5–7.5 cm broad, narrowly ovate to ovate-elliptic or ovate-oblong, tapering to a short-acuminate apex, obtuse to rounded at the base, the sides of the lamina unequal at the base with the sides 2–6 mm distant on the petiole, drying stiffly chartaceous or subcoriaceous, the upper surface becoming glabrous and lustrous but with hairs above the slightly impressed major veins, tertiary venation slightly elevated, lower surface densely yellowish gray or whitish gray tomentulous, the hairs minute (0.1–0.3 mm) and curved, with 3–5 major secondary veins on each side, the basal secondaries often strongly ascending, central secondaries arising at angles of 35°–50°. **Inflorescences** not seen at maturity (only 5 cm long), solitary and axillary to distal leaves or undeveloped leaves near the shoot tip, paniculate with short lateral branches subtended by con-

spicuous (4–7 mm) oblong bracts, peduncle, rachis and bracts densely brownish gray tomentulous. **Flowers** not seen at anthesis, flower buds ca. 3 mm long, the outer tepals only sparsely puberulent distally, apparently with a normal floral configuration of 6 tepals and 9 fertile stamens; a dissection by C. K. Allen showed stamens with *Nectandra*-like arrangement of the thecae with a prolonged connective and 3 staminodes, another dissection by Burger failed to confirm these observations because the flower was immature. **Fruits** borne in a well-developed cup about 12 mm broad at the top; berry ellipsoid-oblong (measurements not available).

Trees of montane evergreen forest formations from 1600 to 2300 m elevation, presently known only from the Pacific slope of the Cordillera de Talamanca and adjacent Chiriquí highlands. Immature flowers were collected in July (*Stern et al. 1122*, NY), and fruits were collected in March (*Comacho 7/3/85*, seen at CR). The species ranges from near División, in the west, to Boquete, Panama.

This species is distinguished by the dense grayish tomentum on the underside of the leaves; no other species of Lauraceae in our area has such an indumentum. The long petioles and relatively few major secondary veins also make the leaves distinctive. If C. K. Allen's dissection is correct, this species would be placed in *Nectandra*, but we need better material to be sure.

NOTE ADDED IN PROOF: Gerardo Herrera has recently collected a very unusual, apparently monocious, species in northern Costa Rica (*1228*, CR, F. MO). The male flowers have a slender puberulent staminal column with 3 valves on the 3-sided apex; a pistillode and staminodes are absent.

List of Accepted Species

Newly described species are in boldface.

Aiouea costaricensis (Mez) Kosterm. AIO cost
Aiouea obscura van der Werff AIO obsc
Aiouea talamancensis W. Burger AIO tala
Aiouea ?sp. AIO ?sp.
Aniba venezuelana Mez ANI vene

Beilschmiedia anay (Blake) Kosterm. BEI anay
Beilschmiedia brenesii C. K. Allen BEI bren
Beilschmiedia ovalis (Blake) C. K. Allen
. BEI oval
Beilschmiedia pendula (Sw.) Hemsley
. BEI pend
Beilschmiedia sulcata (Ruiz & Pavón) Kosterm.
. BEI sulc

Caryodaphnopsis burgeri Zamora & Poveda
. CAR burg
Cassytha filiformis L. CAS fili

Endlicheria sp.? ?END sp.

Licaria brenesii W. Burger LIC bren
Licaria cufodontisii Kosterm. LIC cufo
Licaria excelsa Kosterm. LIC exce
Licaria multinervis Kurz LIC mult
Licaria pergamentacea W. Burger LIC perg
Licaria sarapiquensis Hammel LIC sara
Licaria triandra (Sw.) Kosterm. LIC tria
Licaria sp. A LIC sp. A
Litsea glaucescens H.B.K. LIT glau

Nectandra belizensis (Lundell) C. K. Allen
. NEC beli
Nectandra cissiflora Nees NEC ciss
Nectandra cufodontisii (Schmidt) C. K. Allen
. NEC cufo
Nectandra globosa (Aubl.) Mez NEC glob
Nectandra hypoleuca Hammel NEC hypo
Nectandra kunthiana (Nees) Kosterm.
. NEC kunt
Nectandra latifolia (H.B.K.) Mez NEC lati
Nectandra longipetiolata van der Werff
. NEC long
Nectandra martinicensis Mez NEC mart
Nectandra membranacea (Sw.) Griseb.
. NEC memb
Nectandra nitida Mez NEC niti
Nectandra ramonensis Standl. NEC ramo
Nectandra reticulata (Ruiz & Pavón) Mez
. NEC reti
Nectandra salicifolia (H.B.K.) Nees NEC salif
Nectandra salicina C. K. Allen NEC sali
Nectandra sinuata Mez NEC sinu
Nectandra turbacensis (H.B.K.) Nees
. NEC turb

Ocotea atirrensensis Mez & J. D. Smith OCO atir
Ocotea aurantiodora (Meissner) Mez
. OCO aura
Ocotea austinii C. K. Allen OCO aust
Ocotea babosa C. K. Allen OCO babo
Ocotea sp. aff. *bijuga* (Rottboel) Bernardi
. OCO biju
Ocotea brenesii Standl. OCO bren
Ocotea calophylla Mez OCO calo
Ocotea sp. aff. *caracasana* (Nees) Mez
. OCO cara
Ocotea cernua (Nees) Mez OCO cern
Ocotea dendrodaphne Mez OCO dend
Ocotea dentata van der Werff OCO dent

Ocotea endresiana Mez. OCO endr
Ocotea floribunda (Sw.) Mez. OCO flor
Ocotea glaucosericea Rohwer OCO glau
Ocotea gomezii W. Burger OCO gome
Ocotea hartshorniana Hammel OCO hart
Ocotea helicterifolia (Meissn.) Hemsl.
. OCO heli
Ocotea holdridgeana W. Burger OCO hold
Ocotea insularis (Meissn.) Mez. OCO insu
Ocotea laetevirens Standl. & Steyerlm.
. OCO laet
Ocotea lentii W. Burger OCO lent
Ocotea leucoxydon (Sw.) Laness. OCO leuc
Ocotea meziana C. K. Allen OCO mezi
Ocotea mollicella (Blake) van der Werff
. OCO molc
Ocotea mollifolia Mez & Pittier OCO molf
Ocotea monteverdensis W. Burger OCO mont
Ocotea nicaraguensis Mez OCO nica
Ocotea oblonga (Meissn.) Mez OCO oblo
Ocotea paulii C. K. Allen OCO paul
Ocotea pittieri (Mez) van der Werff OCO pitt
Ocotea pseudopalmana W. Burger OCO pseu
Ocotea puberula (Rich.) Nees OCO pubr
Ocotea rivularis Standl. & L. O. Williams
. OCO rivu
Ocotea skutchii C. K. Allen OCO skut
Ocotea stenoneura Mez & Pittier OCO sten
Ocotea tenera Mez & J. D. Smith ex Mez
. OCO tene
Ocotea valeriana (Standl.) W. Burger
. OCO vala
Ocotea valerioides W. Burger OCO valo
Ocotea veraguensis (Meissner) Mez OCO vera
Ocotea viridiflora Lundell OCO viri
Ocotea wedeliana C. K. Allen OCO wede
Ocotea whitei Woodson OCO whit
Ocotea sp. A aff. *laetevirens* OCO sp. A
Ocotea sp. B OCO sp. B

Persea albida Kosterm. PER albi
Persea americana Miller PER amer
Persea brenesii Standl. PER bren
Persea caerulea (Ruiz & Pavón) Mez. PER caer
Persea obtusifolia Kopp PER obtu
Persea povedae W. Burger PER pove
Persea rigens C. K. Allen PER rige
Persea schiedeana Nees PER schi
Persea silvatica van der Werff. PER silv
Persea veraguasensis Seem. PER vera
Persea vesticulata Standl. & Steyerlm. PER vest
Phoebe brenesii Standl. PHO bren
Phoebe chavarriana Hammel PHO chav
Phoebe cinnamomifolia (H.B.K.) Nees
. PHO cinn

Phoebe hammeliana W. Burger PHO hamm
Phoebe neurophylla Mez & Pittier PHO neur
Pleurothyrium golfodulcense W. Burger & N.
Zamora PLE golf
Pleurothyrium hexaglandulosum van der Werff
. PLE hexa
Pleurothyrium palmanum (Mez & J. D. Smith)
Rohwer PLE palm
Pleurothyrium trianae (Mez) Rohwer PLE tria
Pleurothyrium sp. A PLE sp. A
Povedadaphne quadriporata W. Burger
. POV quad

Williamodendron glaucophyllum (van der Werff)
Kubitzki & Richter WIL glau

A species of uncertain generic position
. SP. ?gen

Index to Exsiccatae

Lauraceae of Costa Rica and Adjacent Panama

Acronyms refer to genera and species (see p. 120).

Allen, P. H.: 1001 PER vera; 1015 PER caer; 1211
OCO paul; 1486 OCO whit; 1570 OCO insu;
1572 OCO glau; 1611 OCO vera; 1740 OCO
sp. A; 3439 OCO atir; 3482 LIC exce; 4672 NEC
cufo; 4846 OCO glau; 4856 PER vera; 4883
PER obtu; 5038 PER vera; 5251 NEC salf; 5503
OCO nica; 5552 PER amer; 5590 OCO rivu;
5629 NEC salf; 5645 OCO insu; 5651, 5658 LIC
cufo; 5824 OCO molf?; 5861 OCO cern; 5885
PLE golf; 5950 LIC perg; 6654 LIC cufo.
Almeda, F., et al.: 3146 NEC salf; 3762 OCO pitt;
3776 OCO aust; 4024 OCO dend; 4138 NEC
memb; 4517 PER schi.

Baker, R. & W. Burger: 117 OCO atir.
Barbour, W. R.: 1011, 1012 PLE palm; 1019 BEI
pend?; 1032 LIC mult; 1033 OCO sten.
Bawa, K. S.: 127 OCO vera; 2055 NEC glob.
Bernardi, L.: 10498, 10512 NEC memb; 10626
PHO pitt; 10631 NEC memb.
Biolley, P.: 1081, 1282 OCO vera; 2226 NEC sinu.
Blum, K. E.: 336 NEC sali; 1409 NEC turb.
Brenes, A. M.: s.n. (1902) NEC glob; 337 (178)
PER pove; 353 (478) NEC ramo; 362 OCO vera;
371 (515) NEC sali; 377 (538) PHO bren; 3617
OCO tene; 3850 NEC memb; 4059 OCO insu;
4061 NEC memb; 4160 OCO vera; 4185 OCO
vala; 4200 OCO tene; 4206, 4262, 4272 NEC
sali; 4344 NEC memb; 4533 OCO tene; 4626

- OCO insu; 4439 OCO tene; 4628 OCO insu; 4661 (446) NEC sali; 4672 NEC reti; 4762 PHO bren; 4769 PER pove; 4780 NEC memb; 4793 PER amer; 4794 NEC memb; 4877, 4889 LIC tria; 4896 PHO bren; 4954 NEC sinu; 4961 LIC tria; 5017 NEC sinu; 5018 NEC reti; 5019 NEC memb; 5023, 5066 LIC tria; 5067 NEC sinu; 5068 NEC memb; 5075 PER amer; 5206 OCO insu; 5317 PER amer; 5334, 5384 OCO pitt; 5389 PER amer; 5393 NEC sali; 5405, 5416 OCO pitt; 5443 NEC memb; 5455 NEC sinu; 5489 LIC tria; 5518 PHO bren; 5535 OCO bren; 5590 OCO paul; 5714 NEC memb; 5719 PHO cinn; 5733 NEC memb; 5826 NEC mart; 5831 NEC memb; 5846 OCO mezi; 5927 PER rige; 6099 OCO vala; 6214 BEI pend; 6314 PER pove; 6317 OCO endr; 6342 PER pove; 6346 OCO mezi; 6578, 6586 NEC reti; 6603 OCO vera; 6605 BEI pend; 6612 NEC ramo; 6650 NEC sali; 6660 NEC ramo; 6675 PHO bren; 6704 NEC sali; 6714 NEC memb; 6729 OCO insu; 6770 PER amer; 6810 PHO bren; 6817 NEC sinu; 6825 NEC sali (or N. smithii); 6834, 9287 NEC ramo; 9713 NEC memb; 12163 NEC salif (or N. niti?); 12262 LIC cufo; 12278 NEC glob?; 12314 NEC niti; 12628 OCO vera; 13506 PER amer; 13523 LIC bren (the type); 13653 OCO bren; 13664 NEC glob?; 14288 OCO vera; 14296 NEC mart; 14403 LIC tria; 14988 NEC ramo; 15090 NEC sinu; 15534 OCO vera; 15617 NEC mart; 15658 OCO insu; 16202 PER amer; 16224, 16227 OCO endr; 16824 NEC mart; 16833 NEC memb; 16943 PHO bren; 17005 NEC reti; 17018 NEC ramo; 17048 PHO bren; 17172 OCO endr; 17173 PER amer; 17457 OCO vera; 17722 NEC reti; 18942 NEC sali; 19203 NEC mart; 20332 OCO whit?; 20499 OCO insu; 20539 OCO atir; 20560 PHO cinn; 21644 OCO atir; 21990 NEC ramo; 22563 OCO insu; 22644 OCO atir.
- Brown, C. A.: 138 NEC turb; 17393 OCO hold.
- Bunting, G., & L. Licht: 838, 866 OCO cern; 872 PLE tria; 1083 OCO aura (Nicaragua).
- Burch, D.: 4589 OCO dend.
- Burger, W., et al.: 3890 NEC memb; 4069, 4101 OCO vera; 4199 OCO atir; 4236 OCO tene; 4448 LIC exce; 4690 PLE golf; 4792 PER amer; 5394 NEC memb; 5851 OCO dend; 5912 OCO dend; 6102 OCO pitt; 6955 NEC memb.; 7045 OCO vala; 7311 OCO nica; 7405 PER vest; 7698, 7720 NEC cufo; 7904 OCO cufo; 8602, 8611 OCO insu; 8665 OCO viri; 8726, 8776 OCO insu; 8871 OCO cern; 8881 OCO heli; 9091 PHO cinn; 9282 OCO dend; 9669 OCO insu; 9684 PHO cinn; 9852, 10368 OCO atir; 10501, 10645 PER amer; 10688 NEC sali; 10718, 11170 LIC bren; 11181, 11248 OCO dend; 11690 OCO atir; 11730 OCO molf; 11966 NEC sali; 11979 PER amer; 12026 ?END sp.; 12028 OCO dend; 12032 OCO cern; 12043 OCO dend; 12045 OCO cern; 12060 OCO pitt; 12063 OCO aust; 12085 PER vera; 12086 NEC sinu; 12088 BEI pend; 12096 OCO whit; 12097 OCO vala; 12098, 12099 OCO glau; 12101, 12103 OCO laet; 12104 OCO endr; 12106 OCO bren; 12110, 12118 OCO atir; 12121 OCO paul; 12128 OCO insu; 12144 OCO gome; 12150 OCO pseu?; 12164 OCO endr; 12172 PER vest; 12173 PER schi?; 12174 OCO dent; 12176 PHO cinn; 12177 OCO skut?; 12178 BEI oval; 12180 NEC cufo; 12181 OCO insu; 12182 PER albi; 12183 NEC cufo; 12184 BEI oval; 12185 PHO cinn; 12186 NEC cufo; 12187 NEC ciss; 12189 BEI oval; 12190 PHO cinn?; 12191 OCO insu; 12193 PHO cinn; 12197 ?GENUS?; 12199 OCO whit; 12200 OCO vera; 12201 NEC ramo; 12203, 12206 NEC salif; 12207 LIC exce; 12221 OCO atir; 12256 OCO leuc; 12334, 12336 LIC cufo; 12337 OCO pubr; 12341 NEC glob; 12348 WIL glau; 12356 PHO neur; 12366 LIC perg; 12376, 12377 OCO sp. B; 12416 OCO mezi; 12418 LIC sara; 12430 POV quad; 12451, 12467 OCO pseu?.
- Carlson, M.: 3228, 3384, 3392 PER amer; 3584, 3623 OCO pitt.
- Carvajal, A.: 50 OCO insu; 94 OCO mezi; 103 OCO insu; 208 NEC sali; 210 PHO cinn.
- Chacón, I.: 426 OCO dend; 600 NEC memb; 704 OCO hart; 724 OCO dend; 1101 NEC hypo; 1113 OCO dend; 1129 NEC memb; 1242 OCO nica; 1295 OCO molf; 1327 OCO tene; 1348 OCO dend; 1418 OCO cern; 1557 OCO vala; 1574 AIO tala; 1587 AIO cost; 1622 OCO atir; 1634 OCO valo; 1680 OCO dend; 1722 AIO ?sp.; 1798 OCO whit; 1804 OCO glau; 1812 OCO whit; 1894 OCO nica; 1980 POV quad; 2051 NEC sali; 2086 OCO dend; 2122 PER amer; 2279 OCO whit.
- Cook, O. F., & C. R. Doyle: 3 PHO cinn; 647 OCO vera.
- Cooper, G. P., et al.: 262 OCO cern; 458 PER rige; 488 NEC memb; 498 NEC kunt; 512 NEC reti; 532 OCO insu; 539 PLE sp. A; 551 NEC salif?; 603 OCO atir; 612 OCO nica.
- Cooper, J. J.: 10220 OCO nica; 10286 OCO cern.
- Córdoba, J.: 109 OCO dend; 357 OCO cern; 369 NEC glob; 821 PER amer; 1008 NEC memb; 5107 PHO hamm; 5108 NEC cufo.
- Croat, T.: 10430 OCO glau; 13573 NEC memb;

- 13677 OCO whit; 22388 PHO hamm; 22484 NEC mart; 26550, 26560 OCO insu; 26555 NEC memb; 26775 PER rige; 26778 PHO cinn; 26934 OCO whit; 27032 PHO cost; 35242 NEC salif; 35526 PLE palm; 43304 OCO nica; 43361 OCO atir; 44480 NEC memb; 46913 OCO vala; 59707 OCO nica.
- Cufodontis, G.: 187 LIC cufo; 315 NEC cufo.
- D'Arcy, W. G., & J. J. D'Arcy: 6293 OCO vera.
- Daubenmire, R.: 135, 459 OCO vera; 486 NEC glob; 515 PER amer; 562 NEC glob; 677 OCO vera.
- Davidse, G., et al.: 1510 OCO viri; 23310 NEC sali; 23356 NEC sali?; 23390 OCO tene; 24206 NEC memb; 24222 BEI oval?; 24246 NEC cufo?; 24287 OCO insu; 24359 OCO flor; 24447 PER amer?; 24457 OCO whit; 24482 OCO endr; 24518 NEC cufo; 24551 PER vera; 24564 OCO whit; 24579 PHO cinn?; 24628 PER vera; 25210 NEC cufo?; 25259 OCO pitt; 25529 AIO cost; 25542 PER obtu; 25575 PHO cinn?; 25586 OCO insu; 25600 NEC kunt; 26063, 26109 PER vest; 28226 BEI oval; 28401 PER amer?; 28505 PHO cinn?; 28520 OCO whit; 28547 OCO pitt; 28551 OCO pseu; 28555 OCO molc; 28809 OCO pitt; 29106 OCO hold; 29178 AIO tala; 29213 BEI pend; 29381 PER vest.
- Davidson, C.: 6726, 6758, 6779, 6887 OCO atir.
- Davidson, M. E.: 268 OCO whit; 361 LIC exce; 427 PER schi; 435 OCO insu; 516 PER vera; 531 OCO glau; 566 NEC ramo; 576 PER vera; 583, 641 PHO cinn; 753 PER vera.
- Dayton, W. A.: 3093 OCO vera; 3123 BEI pend; 3124 OCO nica?; 3126 BEI oval.
- Dodge, C. W., et al.: 6269 OCO tene; 6312, 6361, 6471 OCO vera; 9761 PER amer.
- Dryer, V. J.: 390, 425, 470 OCO insu; 509 OCO leuc; 734 OCO insu; 862 OCO endr; 939 BEI pend; 943 PER amer; 954 NEC sali; 992 OCO mezi; 1011 OCO tene; 1032 PER amer; 1050 OCO insu; 1052 OCO mezi; 1076 PHO cinn; 1081 BEI pend; 1154 PER schi; 1179 BEI pend; 1200 OCO mezi; 1201 PER schi; 1203 OCO insu; 1241, 1300 PER amer; 1315 NEC sali; 1332 OCO mont; 1333 NEC sali; 1334 BEI pend; 1335 PHO cinn; 1336 OCO vala; 1362 OCO insu; 1422 OCO mezi; 1466 PHO cinn; 1591 OCO mont; 1599 OCO flor; 1609 NEC memb; 1612 OCO pseu?; 1613 OCO tene.
- Echeverria, J. A.: s.n. AIO cost; 526 NEC memb; 1197 AIO cost.
- Englesing, F.: 65, 123 NEC reti; 162 PER amer.
- Folsom, J.: 8776, 8974, 9062 OCO atir; 9112 OCO biju; 9283 OCO atir; 9288 OCO dend; 9512 OCO mezi; 9529 OCO atir; 9864, 9904 OCO cern; 9930 OCO hart.
- Foster, R.: 730 NEC glob; 4114 OCO insu (Cocos Is.).
- Fournier O., L. A.: 389, 390 LIC tria; 400 NEC ramo; 649 OCO molc; 821 OCO vera; 868 PER amer; 873 PHO cinn; 905, 906 NEC ramo; 925 OCO vera; 929 PER caer; 935 PHO bren; 941–943 PHO cinn; 945, 946 PER caer; 949 NEC ramo; 957 PER caer; 958, 960, 961 PHO cinn; 966 PER caer; 967, 968, 1004 PHO cinn; 1010, 1011, 1040 PER caer; 1053 PHO cinn; 1067 PER schi; 1071 OCO glau; 1102 OCO cufo; 1104 AIO cost; 1156 PHO bren; 1179 PHO cinn; 1190 PER amer; 1191 PER schi; 1233 PHO cinn; 1235 PHO bren; 1245 OCO molc; 1263 PHO bren; 1291 PER caer; 1330 OCO pitt; 1356 OCO vera; 1409–1419 PHO bren; 1499 OCO aust; 1519 NEC memb; 1649 OCO dend; 1668 NEC mart; 1684, 1685 BEI pend; 1728 OCO atir; 1771 OCO cern; 1796 OCO hold; 1797 NEC cufo; 1799 AIO cost; 1800 NEC cufo.
- Frankie, G. W.: 34c OCO dend; 52c NEC hypo; 58c OCO atir; 412 OCO atir.
- Gentry, A.: 1118 OCO glau; 2024 OCO nica; 5918 OCO whit; 5991 OCO glau; 6035 OCO paul; 48524, 48567 NEC hypo; 48711 BEI pend; 48736 OCO mont; 48762 OCO insu; 48771 PER amer; 48811 OCO endr.
- Godfrey, R. K.: 66480, 66486 PHO bren; 67049 NEC glob; 67078 OCO vera; 67200 PER caer.
- Gómez, L. D., et al.: 20768 OCO dend; 20851 OCO nica; 20951 OCO atir; 20957 OCO bren?; 20977, 21007 OCO atir; 21102 OCO nica; 21130 PER schi; 21143 LIC sara; 21175 NEC sinu; 21496 OCO tala; 21654 OCO obtu; 22697, 22705 NEC ramo; 22722 OCO dend; 22864 NEC cufo; 23064 NEC kunt; 23208 OCO tene; 23216 PHO hamm; 23227 BEI oval; 23304 NEC reti; 23344 NEC reti; 23445 OCO atir; 23619 OCO valo; 23653 OCO dent; 23875 OCO whit; 23977 PHO hamm; 24101 NEC mart.
- Gómez-Laurito, J.: 79 ANI vene; 82 OCO flor; 87 OCO molf; 571 OCO nica; 588 OCO dend; 1207 PER vest; 1558 PHO pitt; 2711 LIC bren?; 3066 OCO pseu; 3113 NEC memb; 3610 NEC glob; 4580 OCO vera; 4590 OCO pseud; 4743 PER vest; 4945 PLE palm; 5178 OCO insu; 5262 PHO cinn; 5287 OCO endr; 6307 PER amer;

6372 OCO atir; 6609 OCO dend; 6613 OCO atir; 6938 OCO insu; 6946 OCO insu (Cocos Is.); 7632 OCO atir?; 7645 OCO molf; 7669 OCO heli; 7836 OCO dend; 7957 OCO insu; 8113 PER amer; 8141 OCO mezi; 8812, 8864 OCO insu; 9304 OCO atir?; 9619 OCO insu; 9716 OCO atir; 9785 OCO endr; 9800 BEI oval?; 9849 OCO bren?; 9897 OCO pseu; 9900 ANI vene; 9906 NEC ramo; 9911 NEC memb; 9989 OCO cern; 10216 NEC salf; 10217 NEC memb; 10255 OCO atir; 10316 NEC sali; 10459 OCO cern; 10611 OCO paul; 11086 OCO endr; 11098 OCO leuc; 11262 NEC memb; 11237 OCO laet; 11272 NEC memb; 11329 NEC sali; 11385 OCO pitt; 11390 OCO bren; 11400 OCO paul; 11447 OCO pseu; 11450 OCO gome; 11453 OCO endr; 11464 AIO cost; 11467 PHO hamm.

González Meza, R.: 23 OCO aust; 24 NEC cufo; 34 PER vest.

Grayum, M., et al.: 1007 OCO atir; 1290 OCO dend; 1398 OCO molf; 1480 OCO tene; 1482 NEC hypo; 1818 OCO dend; 2201 OCO mont; 2388 OCO leuc; 2767 PHO chav; 3030 NEC memb; 3416 OCO atir; 3845 OCO pitt; 3875 OCO tene; 3969 NEC niti; 3995 OCO atir/nica; 4069 OCO rivu; 4091 OCO atir; 4374 OCO cern; 4525 NEC reti; 4702, 4709 LIC cufo; 4749 OCO nica; 4775 NEC niti; 4894, 4947 OCO vera; 5104 PHO cinn; 5123 PER schi; 5151 OCO laet; 5266 OCO cern; 5286 OCO wede; 6101 OCO nica; 6260 NEC sali; 6263 OCO tene; 6355 OCO nica; 6876, 6888 OCO atir; 6923 LIC sara; 6995 OCO dend; 7169 OCO hold; 7589 OCO whit; 7605 LIC cufo; 7970 PHO cinn; 8060 NEC memb; 8064 CAS fili.

Haber, W. H.: 161 OCO mont; 191 OCO insu; 198 OCO flor; 222 NEC sali; 238, 249 OCO mezi; 250, 252 PHO cinn; 259 OCO mezi; 262 NEC glob; 268 NEC sali; 276 PER amer; 289 NEC sali; 314 OCO vala; 318 NEC sali; 321 PHO cinn; 324 OCO whit?; 346 OCO pitt?; 385 OCO whit; 390 PER vera; 439 NEC sinu; 494 BEI pend; 525, 526 OCO whit; 579 PER vera.

Hammel, B., et al.: 1218 OCO hart; 5623 PER obtu; 7013 OCO pitt; 7823, 7844 OCO atir; 7950 OCO dend; 7957 OCO mezi; 8034A OCO dend; 8075, 8201 OCO mezi; 8131, 8223 OCO atir; 8299 OCO dend; 8390 OCO cern; 8663 LIC sara; 8864 NEC hypo; 8914 OCO flor; 9111 NEC hypo; 9192 OCO dend; 9705 OCO flor; 9807 OCO atir; 10073 NEC hypo; 10146 OCO atir; 10229 OCO biju; 10348 NEC hypo; 10479 NEC reti; 10491 OCO dend; 10501 OCO atir;

10503 OCO dend; 10532 LIC sara; 10538 OCO insu; 10561 OCO mezi; 10618 OCO atir; 10630 OCO hart; 10657 NEC reti; 10670 LIC sp. A; 10693 NEC kunt; 10736 OCO molf; 10871 OCO babo; 10912 OCO leuc; 11034 OCO insu; 11036 LIC tria; 11058 OCO leuc; 11095, 11164 OCO mezi; 11168 NEC ciss; 11170 OCO flor; 11212 OCO atir; 11221 OCO mezi; 11226 NEC kunt; 11252 OCO atir; 11522 OCO molf; 11530 OCO babo; 11663 OCO biju; 11665 NEC ciss; 11679 PHO chav; 11762 OCO dend; 11928 OCO leuc; 11932 OCO hart; 11981 OCO leuc; 11995, 12018, 12080 OCO dend; 12163 OCO atir; 12198 OCO dend; 12235 LIC sara; 12332 OCO dend; 12397 OCO atir; 12409 NEC lati; 12738 NEC lati; 12762 OCO atir; 12786 NEC memb; 12840, 12848 NEC hypo; 12893 NEC memb; 12909 OCO dend; 12922 PHO chav; 12957 OCO leuc; 12961, 13029 NEC memb; 13036 OCO mezi; 13074 NEC hypo; 13111 ANI vene; 13123 OCO leuc; 13144 OCO tene; 13249 NEC memb; 13366 ANI vene; 13771 NEC niti; 13797 OCO whit; 14086 OCO endr; 14088, 14090 NEC cufo; 14091 PHO hamm; 14111 LIC exce?; 15044 OCO pseu?; 15214 MEZ glau.

Hartshorn, G.: 926, 949 OCO cern; 950 NEC hypo; 970 NEC reti; 1005 OCO hart; 1043 NEC memb; 1063 OCO tene; 1080 OCO dend; 1082 NEC kunt; 1103 OCO molf; 1121 AIO cost; 1122 PER schi; 1125 PHO hamm; 1127 BEI oval; 1140 OCO hart; 1156 PER caer; 1169 PHO cinn; 1179 PHO chav; 1209 PHO cinn; 1218 OCO hart; 1229 PHO insu; 1234 NEC lati; 1252 NEC memb; 1256 NEC kunt; 1258 OCO tene; 1276 NEC hypo; 1284 PHO cinn; 1289 PHO chav; 1300 OCO dend; 1333 OCO atir; 1347 OCO insu; 1351 OCO flor; 1388 NEC hypo; 1414 OCO mezi; 1426 OCO atir; 1441 OCO nica; 1445 OCO cern; 1456 PHO hamm; 1463 OCO vala; 1465 BEI pend; 1469 NEC sali; 1472 OCO mezi; 1514 NEC memb; 1518 OCO dent; 1519 BEI sulc; 1530 OCO valo; 1543 OCO dent; 1550 OCO mezi; 1563 OCO flor; 1567 OCO molf; 1576 OCO insu; 1585 OCO biju; 1588 LIC sara; 1589 OCO mezi; 1590 LIC tria; 1595 OCO atir; 1600 NEC reti; 1628 OCO nica; 1635 OCO tene; 1636 OCO insu; 1638 OCO hart; 1751 NEC hypo; 1753 NEC memb; 1819 PER schi; 1865 NEC salf; 1874 PHO neur?; 1885 OCO vera; 1900 OCO mont; 2115 OCO insu; 2117, 2123 OCO tene; 2126 OCO insu; 2130 PHO vala; 2159 BEI pend; 2161 OCO skut; 2164 NEC ramo; 2165 OCO flor; 2166 BEI oval; 2167 NEC memb; 2182 OCO vera.

Hatheway, W. H.: 1423 AIO cost; 1427 PER caer; 1463 NEC cufo; 1466 AIO cost; 1478 OCO molc; 1678 NEC cufo.

Hazlett, D.: 2781 OCO cern; 5242 OCO whit.

Herrera, G.: 504 OCO gome.

Hill, S. R.: 11958 OCO atir.

Holdridge, L. R.: 5126 OCO tene; 5128 NEC reti; 5138 OCO vera; 5145 OCO atir; 5150 NEC cufo; 5151 PHO hamm; 5153 OCO dend; 5155 NEC glob; 5156 NEC reti; 5157 OCO oblo; 5159 NEC cufo; 5164 OCO dend; 5168 NEC ramo; 5172 NEC sinu; 5173, 5175 OCO aust; 5179 NEC sinu; 5217, 5227 OCO vera; 6328 OCO cern; 6336 OCO dend; 6339 NEC niti; 6544 PER caer; 6545 NEC sinu; 6546 PHO cinn; 6547 NEC mart; 6548 PHO bren; 6549 OCO vera; 6550 NEC reti; 6551 NEC memb; 6552 PER schi; 6553 PER amer; 6554 NEC cufo; 6555 OCO pseu; 6558 PHO hamm; 6559 AIO cost; 6560 PHO hamm; 6562 PER vera; 6564 OCO leuc?; 6565 NEC cufo; 6569 OCO endr; 6570 OCO hold; 6571 OCO laet; 6572 OCO endr; 6574 NEC turb; 6575 OCO pseu; 6576 OCO vala; 6578 OCO leuc?; 6580 OCO endr; 6581 OCO insu; 6583 OCO nica?; 6584 NEC memb?; 6586 OCO oblo; 6587 NEC kunt; 6588 OCO dend; 6590 ?END sp.; 6591 OCO leuc; 6594 OCO cern; 6595 BEI oval; 6639 OCO oblo; 6646 OCO insu; 6649 OCO cern; 6650 OCO leuc; 6652 OCO atir; 6654 OCO leuc; 6655 NEC salf; 6663 OCO vala; 6671 OCO pitt; 6687 NEC cufo; 6688 NEC sali; 6690 PLE palm; 6691 OCO insu; 6696 OCO dend; 6700 OCO hart?; 6701 NEC sali; 6702 OCO atir; 6704, 6706 OCO hart; 6713 PHO cinn; 6714 NEC memb; 6715 OCO oblo; 6719 OCO valo; 6724 OCO endr; 6739 OCO flor; 6758 PHO vale; 6767 NEC sali; 6779 OCO oblo; 6783 OCO pseu?; 6808, 6813 OCO flor; 6814 OCO oblo; 6815 NEC cufo; 6819 PER rige; 6820 OCO oblo; 6821 LIC mult; 6825 PER rige; 6826 OCO aust; 6827, 6829 OCO pseu?; 6831 NEC sali; 6868 NEC turb?; 6872 NEC glob; 6873 OCO atir.

Holm, R., & H. Iltis: 212 OCO dend.

Jacobs, B.: 2540 NEC lati; 2876 OCO atir; 2966 NEC memb; 2967 OCO mezi.

Jiménez, A.: 63 OCO atir; 124 PHO cinn; 302 NEC glob; 303, 304, 355 OCO vera; 371 NEC glob; 379 OCO nica; 404 PHO vala; 479 AIO cost; 487, 491 OCO vera; 822 LIC tria; 1166 OCO insu; 1190 OCO tene; 1192 OCO insu; 1242 OCO mezi; 1333 OCO atir; 1461 OCO laet; 1506 NEC glob; 1568 OCO vera; 1671 NEC

reti; 1722 NEC kunt; 1723 OCO dent; 1744 NEC memb; 1864 OCO atir; 1867 NEC memb; 1971 OCO pitt; 2001 LIC tria; 2142 NEC mart; 2334 OCO atir; 2544 PER schi; 2552 PHO hamm; 2720 NEC glob; 2746 OCO atir; 2752 OCO leuc; 2905 OCO dend; 3006 OCO cern; 3117, 3125 OCO vera; 3183 OCO insu; 3219 OCO glau; 3440 OCO endr; 3540 OCO vera; 3548 PER schi; 3567 OCO endr; 3673 OCO vera; 3682 NEC sinu; 3801 PHO cinn; 3835 PHO neur; 3868 PHO bren; 3942 PER caer; 3977 OCO dend; 3989 OCO pitt; 4116 AIO cost; 4125 NEC memb.

Jiménez, Otón: 379 NEC glob; 822 LIC tria; 1298 PER amer.

Jiménez-Saa, H.: 88 OCO insu; 98 OCO hart.

Kirkbride, J., & J. Duke: 997 PER caer.

Lankester, C.: 260 OCO tene; 1335 OCO aura; 1340 NEC glob.

Lao, E. A.: 326 PER schi; 337 PER vera; 342 OCO whit; 350 PER amer; 351 NEC cufo; 395 BEI oval; 599 PER caer.

Lawton, R.: 1043 OCO tene; 1197 PHO cinn; 1225 OCO pitt; 1265 BEI pend.

Lellinger, D., & J. White: 1641 OCO atir.

Lems, K.: s.n. & 5067 PER amer; 5164 BEI pend; 5168 PER amer; 5174 OCO nica?; 5345 OCO endr; 5352 OCO calo; 5552 PER amer.

Lent, R.: 727 OCO endr; 794 OCO lent; 1677 OCO hold; 1678 PHO hamm; 1679 OCO pseu; 1735 OCO insu; 1737 PER caer; 2070 OCO lent; 2351 LIC tria?; 2467 NEC salf; 2705 OCO flor; 2878 OCO atir; 3116 OCO insu; 3181 OCO atir; 3297 NEC sali; 3386 OCO atir; 3490 NEC sinu; 3660 AIO cost; 3884 OCO insu.

León, J.: 481 OCO insu; 528 NEC sinu; 543 PER schi; 578 NEC sinu; 868 LIC tria?; 895 OCO vera; 1047 OCO dend; 1104 LIC mult; 1168 OCO laet; 1237 OCO vera; 1599, 1644 NEC glob; 1679 NEC mart; 1720 NEC memb; 1762 OCO endr; 1861 OCO dend; 2066 OCO tene; 2166 OCO calo; 2391 OCO pitt; 2452 NEC memb; 2477 OCO dend; 2509 OCO cern; 2511 OCO dend; 2744 OCO cern; 3119 OCO vera; 3203 LIC mult; 3319 NEC reti; 3378 OCO dend; 3429 OCO cern; 4262 PER amer?; 4266 OCO vera; 4344 OCO glau; 4533 OCO cern.

Liesner, R.: 1789 PHO heli; 1982 OCO nica; 2151 OCO cern; 2162 NEC reti; 3034, 3048 NEC salf; 3166 OCO nica; 4494, 4775, 4941, 4943, 4972 OCO vera; 5021 NEC reti; 5022 NEC glob; 5106 NEC sali; 5123 OCO atir; 5189 OCO dend;

- 14310, 15052 OCO atir; 15319, 15394 OCO dend; 15580 OCO insu.
- Little, E. L.: 6007 OCO aust; 6012 AIO cost; 6013 NEC cufo; 6023 AIO cost; 6047, 6056 OCO whit; 6057, 6058 PER rige; 6059, 6062, 6069 OCO whit; 6078 LIC exce?; 20013 OCO mezi; 20059 NEC memb; 20060 BEI sulc?; 20088 NEC memb; 20093 OCO aust; 20125 PHO cinn; 20174 NEC reti; 20276 NEC sinu; 20336 PHO cinn; 20412 PHO hamm; 20415 NEC cufo.
- Luteyn, J., & R. Wilbur: 4548 OCO pitt.
- Madriz V., A.: 2 OCO pitt; 3 PER amer; 7 OCO aust; 12 OCO calo; 20 OCO insu; 34 OCO hold; 42 PER vest; 44 PHO hamm; 45 PER schi; 65 OCO mezi?; 69 AIO cost.
- Maxon, W., & A. D. Harvey: 8196 PER schi.
- McDowell, T.: 159 OCO dend; 316 OCO tene; 401 OCO dend; 509 OCO atir; 582 NEC reti; 601 NEC hypo; 667 OCO atir; 854 OCO babo; 1050, 1052 OCO atir; 1102 NEC memb.
- Menzies, A.: 1794 OCO insu (type, Cocos Island).
- Molina, A., et al.: 17436 OCO nica; 17524 PER amer; 17526, 17734 NEC memb; 17893 OCO pitt; 18069 OCO atir; 18140 NEC reti; 18272 NEC sinu; 18359 AIO tala; 20606 PER caer.
- Mora V., C.: 13 PER amer; 15 OCO endr; 17 OCO pseu; 19 PER schi.
- Mori, S., et al.: 5625, 5678 OCO whit; 5787 OCO viri; 7829 OCO flor.
- Neill: 5030 OCO mont; 5030B OCO insu; 5122 OCO hart.
- Oersted, A.: Laur. No. 10 LIT glau; 270 PER caer; 14938 PHO hamm?
- Opler, P.: 88, 114, 346, 610 OCO atir; 623 OCO cern; 648 OCO vera; 1592 OCO tene; 1929 PER amer.
- Orozco, J. M.: 38 OCO vera; 341 PER vera; 467 OCO vera.
- Pittier, H.: 409 OCO vera; 1739 OCO endr; 2040 BEI oval; 2259 OCO pitt; 2288 PHO vala; 2998 PHO cinn; 3132 PER schi; 3146 PHO cinn; 3201 OCO whit; 3633 OCO tene; 3644 OCO vera; 3984 NEC reti; 5145 NEC glob; 5278 OCO vera; 5395 OCO paul; 9179 OCO atir; 9184 OCO tene; 9663 NEC mart; 10351 OCO atir; 10605 NEC reti; 11102 NEC ciss?; 11107 PHO cinn?; 11111 PER albi; 11251, 12016 OCO cern; 11282 NEC niti; 11283 NEC turb; 11489 OCO insu?; 11490 NEC mart; 12018 NEC reti; 12348 NEC sinu; 13396 OCO tene; 16030, 16031 OCO molf; 16140 BEI sulc; 16257 OCO insu; 16428 OCO vera.
- Popenoe, W.: 987, 989 PER schi; 993 NEC mart; 996 PER schi; 1001 NEC sinu; 1003 PER vera.
- Poveda, L.: 104 OCO valo?; 111 OCO flor; 112 OCO leuc; 116 NEC reti; 158 OCO oblo; 170 OCO atir; 391 OCO endr; 392 OCO pseu; 429 OCO insu; 455 OCO molc; 500 LIC cufo; 514 OCO calo; 527 NEC memb; 589 POV quad; 631 OCO long; 669 OCO insu; 740 PER pove; 753 OCO oblo?; 764 OCO molf; 783 OCO tene; 845 PHO bren; 868 OCO pitt; 926 PER schi; 931 LIC bren; 933 OCO heli; 947 OCO pseu?; 956 PHO chav; 998 NEC salf; 1021 ANI vene; 1061 PHO hamm; 1065 PER vera; 1068 BEI pend; 1076 PHO cinn; 1079 OCO laet; 1086 OCO glau; 1091 OCO insu; 1108 OCO mont; 1130 NEC sali; 1158 PER rige; 1202 PER vest; 1299 NEC mart; 1519 OCO pseu?; 1524 BEI oval?; 1606 OCO pitt; 1635 OCO dend; 1712 NEC salf; 1771 OCO insu; 2291 OCO aura; 2360 POV quad; 2999 OCO pitt; 3000 OCO molc; 3019 BEI pend; 3020 PHO cinn; 3021 OCO endr; 3049 LIC cufo; 3398 NEC sinu; 3399 PHO bren; 3487 NEC memb; 3488 OCO oblo; 3489 LIC sara; 3491 OCO nica; 3492 NEC sinu; 3493 OCO mezi; 3493A OCO dend; 3494 NEC kunt; 3495 OCO leuc; 3496 LIC bren; 3497 PHO cinn; 3498 ?END sp.; 3499 OCO skut; 3500 LIC mult; 3501 OCO ?sp. A; 3554 OCO nica; 3561 POV quad; 3566 OCO molc; 3577 LIC exce?; 3637 LIC exce; 3687 NEC memb; 3688 NEC reti; 3795 ?END sp.; 3887 PHO cinn; 3908 CAR burg; 3913 OCO vala; 3916 AIO cost; 3920 OCO calo; 3994 OCO molc; 3996 NEC sinu; 4042 CAR burg.
- Primack, R., et al.: 254 PER bren; 332 OCO vala; 438 NEC cufo; 457 NEC sali.
- Procter, G., et al.: 27421 NEC niti; 32355 OCO aust.
- Procter-Cooper, G.: 399, 449 OCO wede; 539 PLE sp. A; 603 OCO wede.
- Raven, P.: 21003 OCO atir; 21630 OCO heli; 21891 PER albi; 21916 NEC memb; 21954 PER albi?.
- Rodríguez, R. L.: 345 AIO cost.
- Rosbach, G. B.: 3171 OCO pseu; 3714 OCO tene.
- Rowlee, W. W., & H. E. Rowlee: 210, 233 PLE palm.
- Salas, S.: 54 LIC tria; 116 OCO hold; 138 NEC mart; 219 NEC memb; 240 AIO cost; 293 NEC glob; 319 NEC memb; 343 OCO vera; 462 AIO

- cost; 478, 628 OCO pseu; 1189 NEC sinu; 1377 LIC tria; 1382 NEC cufo.
- Sánchez, P., et al.: 23 OCO insu; 113 NEC salf; 377 OCO mezi; 428 OCO mezi; 430 OCO dend; 1228 PLE golf.
- Schatz, G., et al.: 613 OCO dend; 970 NEC ciss; 1102 OCO dend.
- Schubert, B., et al.: s.n. OCO cern; 627, 627a,b NEC niti; 801 OCO atir; 874 OCO cern; 1004 PER caer; 1031 OCO vera; 1091 NEC glob; 1301 OCO atir; 1141, 1306 OCO dend.
- Seibert, R. J.: 307 OCO whit; 308 NEC cufo; 1603 OCO dend.
- Shank, P. J., & A. Molina: 4275 OCO atir.
- Shimek, B., & C. L. Smith: s.n. NEC glob; 176 OCO vera.
- Skutch, Alexander: 2007 OCO dend; 2490 NEC reti; 2605 NEC ciss; 2634 NEC mart; 2668 NEC memb; 2813 OCO nica; 2821 OCO skut; 3014 OCO sten; 3117 PER caer; 3606 PER schi; 3745 OCO mezi; 3755 OCO endr; 3836 NEC glob; 3844 PHO neur; 4042 PHO cinn; 4172 NEC salf; 4182 NEC memb; 4270 OCO cern; 4303 OCO insu; 4328 NEC salf; 4329 PHO neur; 4375 NEC mart; 4389 BEI pend; 4591 OCO atir; 4687 NEC sinu; 4738 OCO cern; 4757 NEC kunt; 4770 LIC cufo; 4812 PER caer; 4905 NEC salf; 5116 PHO neur; 5117 NEC mart; 5199 NEC memb; 5500 OCO insu.
- Smith, Austin: A125 OCO aust; A140 PER amer; 142 PHO cinn; 159 OCO tene; 164 NEC memb; 181 PER amer; 183 OCO molc; A228 OCO tene; A240 OCO vala; A243 NEC memb; H268 OCO vala; H269 PER amer; 309, 359 OCO mezi; 365 OCO laet; 367 OCO vala; A388 PER amer; H442 AIO cost; 443 OCO mezi; H469 OCO bren; 492 OCO endr; 504 OCO aust; H516 OCO bren; H522 OCO pitt?; 523 OCO vala; H541 NEC sali/smith; A556 OCO tene; 571 OCO bren; H577 OCO paul; H592 BEI pend; 593 OCO mezi; 598 OCO vala; H633 OCO paul; 675 BEI oval; 679 OCO pitt; 681 AIO cost; 732 OCO mezi; 907 OCO paul; NY964 PER vera; H969, 972 NEC cufo; P1150 BEI pend; NY1144 OCO insu; 1181 OCO aust; 1323 OCO paul; 1687 OCO bren; H1737 OCO atir; 1765 OCO dend; 1771 OCO dend; 1774 OCO mezi; 1849 OCO dend; 2036 NEC cufo; 2309 OCO molc; 2316 AIO cost; P2409 NEC sinu; 2440 PHO cinn; 2464 OCO vera; P2465 NEC ramo; 2479 PER caer; 2563 OCO atir; 2596 OCO mezi; P2615 OCO pitt; 2620, 2710 OCO bren; 2717 BEI pend; 2722 AIO cost; 2772 OCO tene; 2809 NEC memb; 2825 NEC cufo; 2842 OCO paul; 4102 OCO bren; 4168 BEI oval; 4169 AIO cost; 4171 OCO bren; 4178 OCO molc; 4182 OCO laet; 4202 OCO hold; 10007 OCO molc; 10028 PER amer; 10045 OCO flor; 10066 NEC reti; 10068 OCO molc; 10072 OCO vala.
- Smith, Damon: s.n. OCO dend; 45 OCO atir; 99 OCO dend; 245 OCO hart; 300 OCO dend; 406 NEC reti; 425 OCO mezi; 474 OCO insu; 484 OCO leuc; 507 NEC reti; 1202 POV quad; 1210 LIC sara.
- Smith, John Donnell: 4931 NEC reti; 4932 NEC salf; 5114 PER caer; 6751 OCO dend; 6752 OCO cern; 6754 NEC sinu; 6755 NEC ramo; 6756 OCO dend; 6757 NEC memb; 7352 LIT glau; 7374 PLE palm. (Note: Some of these are distribution numbers and not collection numbers.)
- Smith, Lyman B.: 15313 OCO long.
- Snow, B.: 10 OCO insu; 12 OCO whit; 13 PHO vala.
- Solano J., I.: 1 PER vera; 3 OCO aust; 4 PER vest.
- Soto, R.: 2379, 2676, 2971 OCO insu.
- Sperry, J.: 695 OCO atir; 797 OCO dend; 946 OCO dend.
- Standley, P., et al.: 25880 PER caer; 32255, 32705 PHO cinn; 33679 OCO vala; 34274 PER schi; 34579 AIO cost; 34824 PHO cinn; 35777 PER caer; 36507 OCO atir; 36541 OCO aust?; 37039, 37188, 37240 OCO atir; 37640 OCO mezi; 37949 OCO atir; 38940 PHO cinn; 39278 OCO pitt; 39289 PER schi; 39433 OCO mezi; 39989, 40029, 40036 OCO vera; 40238 LIC tria; 40243 PHO cinn; 42426 OCO molc; 42458 OCO vala; 42525 LIT glau; 42565 BEI pend; 42585 PER vest; 42935 OCO vala; 43050 OCO pitt; 43178, 43344 OCO vala; 43421 OCO molc; 43960 BEI oval; 44113 OCO vera; 44651 OCO ?sp.; 44907 OCO vera; 45238 NEC reti; 45242 OCO atir; 45283 NEC reti; 45340 OCO atir; 45469 NEC turb; 45761, 45801 OCO tene; 45887 OCO atir; 45906, 45909 NEC turb; 46121 OCO tene; 46128 NEC sali; 46167 OCO atir; 46192 NEC turb; 46253, 46368 NEC sali; 46524 OCO nica; 46749 OCO atir; 46773 NEC reti; 46924 OCO dend; 47185 OCO atir; 47344 PHO cinn; 47364 NEC niti; 47475 PER schi; 48403, 48467 OCO atir; 48784 LIC sara; 48789 OCO mezi; 50908 NEC memb; 50962 OCO mezi; 51180 OCO tene; 51201 NEC glob?; 51268 PER albi?; 51271, 51280, 51285 BEI pend; 51387 OCO pitt; 52072 AIO cost; 64785, 89348 OCO vera.
- Stern, W. L., & K. L. Chambers: 50, 51 OCO whit; 56 PER rige; 62 PHO cinn?; 95 LIC exce; 111, 111A NEC reti; 113 NEC memb.

- Stern, W. L., et al.: 1026, 1096, 1121 OCO whit; 1122 SP. ?gen; 1143 NEC cufo; 1988 PHO cinn.
- Stevens, W. D.: 14131 OCO insu; 23757 OCO leuc; 23802 OCO insu; 23838 OCO atir; 24100 NEC salif.
- Stone, D. E.: 1957 NEC sali; 3195 OCO palm; 3204 NEC cufo; 3224 NEC mart; 3296 OCO insu; 3394 OCO vala.
- Stork, H. E.: 1110 PER caer; 1399 AIO cost; 1570 PER caer; 1713 BEI pend; 1735 AIO cost; 2328 PER vera; 2332 LIC tria; 2404 PHO hamm; 2405 OCO vala; 2416 PER caer; 2807 OCO babo; 2809 OCO whit?; 3059 NEC mart; 3121 BEI pend; 3177 OCO molc; 3377, 3577 NEC cufo; 4102, 4171 OCO bren.
- Taylor, C. M.: 82 AIO cost; 3117 PHO vala.
- Taylor, R. John: 4460 OCO pitt.
- Todzia, C.: 813 OCO atir; 1854, 1907 OCO pseu; 1961 OCO atir; 2022 OCO mezi.
- Tonduz, Adolfo: 1794 AIO cost; 1873 NEC reti; 1883 OCO laet; 2226 NEC sinu; 2234 PER caer; 3598 OCO pitt; 3934, 4876 NEC reti; 6637 OCO vera; 6680 PER caer; 7153 NEC glob; 7271 NEC niti; 7374 OCO palm; 7648 OCO vera; 7770 NEC sinu; 7796 LIT glau; 8555 OCO nica; 8772 NEC mart; 9005 OCO oblo; 9020 OCO dend; 9179 OCO atir; 10047 NEC glob; 10104 NEC niti; 10999 PER amer; 11489 OCO whit?; 11612 LIC tria; 11638 LIT glau; 11651 NEC sinu; 11676 OCO molc; 11713 BEI pend; 11735 PHO cinn; 11746, 11755 OCO vala; 11893 OCO pitt; 11896 PER amer?; 11939 NEC cufo; 12652 PLE palm; 12772 OCO atir; 12875, 12878 OCO oblo; 12913 NEC reti; 12953 OCO sten; 12978 OCO atir; 13366 OCO cern; 13377 OCO sten; 13794 PER amer; 13806 NEC glob; 13809, 13845, 13863, 14914 OCO vera; 16108 PER caer; 17689 LIC tria; 17692 NEC reti.
- Torres, R.: 7 NEC memb.
- Tyson, E. L.: 7221 NEC ramo; 7410 PER vera.
- Utley, J., & K. Utley: 2779 OCO endr; 2782 OCO insu; 3012 NEC cufo; 3015 OCO aust; 3040 AIO cost; 3238 OCO nica; 3333 NEC turb; 3338 OCO cern; 3648 PHO hamm; 3699 NEC mart; 3787 OCO endr; 3853 OCO laet; 4046 NEC beli; 4180 OCO laet; 4653 BEI pend; 4750 OCO glau; 4760 OCO vera; 4889 NEC salif; 5140 OCO atir; 5220 AIO cost; 5356, 5397 OCO atir; 5407 OCO mont; 5577 NEC cufo; 5782 OCO vala; 5788 OCO aust; 5795 OCO pitt; 6087 OCO vera.
- Valerio, Juvenal: 21 NEC sali; 23 OCO atir; 33 AIO cost; 34 OCO vala; 46 OCO atir; 101, 105 OCO vera; 114 NEC memb; 397 OCO cern; 495 NEC glob; 675 OCO atir.
- Valerio, Manuel: 101 OCO vera; 114 NEC memb; 675 OCO atir; 914 OCO vera; 1326 NEC memb; 1327 NEC mart; 1451 NEC cufo; 1655 OCO atir; 1745 OCO vera.
- Von Hagen, C. & W.: 2031 OCO pitt; 2046 OCO viri; 2070 OCO pitt; 2120 NEC cufo; 2128 OCO leuc; 2140 NEC cufo; 2178 OCO viri?.
- Walker, J.: 188 OCO atir; 414 OCO laet.
- Webster, G., et al.: 12395 OCO aura; 12455 NEC sali.
- Wedel, H. von: 388 OCO wede?; 1399 OCO atir; 2264 OCO valo; 2431 NEC salif; 2889, 2967 NEC memb.
- Wheelwright, N.: 0/F OCO whit; 1 OCO mont; 3 OCO flor; 4B PHO cinn; 8 NEC memb; 12B OCO tene; 13A PHO cinn; 13C PER caer; 13D PER amer; 14B, 15 PHO cinn; 16B PER vera; 19C OCO whit; 20 NEC sali?; 23 PER amer; 25 OCO viri; 27A, 30A PHO cinn; 30B OCO mont; 31E, 31F PER caer; 33 OCO mont; 34 OCO whit; 36A PHO cinn; 44 OCO tene; 52 BEI pend; 53A OCO whit; 55 BEI pend; 56 OCO insu; 58 OCO whit; 59 PHO cinn; 70 BEI pend; 75 OCO mont; 79 OCO whit; 80 PER amer; 80C NEC sali; 83 OCO insu; 85, 91 OCO mezi; 97 PHO cinn; 112 OCO whit; 115 OCO insu; 125A OCO mezi; 125B PER amer; 126B BEI pend; 126D PHO cinn; 133 OCO insu; 136A OCO mezi; 140A PHO cinn; 141A NEC sali; 143A, 144B OCO insu; 162 PER amer; 165 OCO endr; 167 OCO insu; 169 OCO mezi; 176 OCO insu; 188A BEI pend; 201 OCO flor; 206 ??; 207 NEC sinu; 209 OCO vala; 214 PER schi; 214B OCO insu; 219 BEI pend; 220 ?LIC; 223 PHO pitt; 224 NEC sinu; 230 NEC sali?; 250 PHO cinn; 251 OCO atir.
- White, P.: 213 PER caer; 225 OCO insu; 334 PER vera.
- Wilbur, R., et al.: 9760 OCO vera; 9945 NEC glob; 10701 NEC sali; 10894 OCO glau; 16714 OCO palm; 16762 OCO pitt; 19751 OCO laet; 20133 NEC salif; 20836 AIO cost; 21726 OCO endr; 21801 AIO cost; 22076 NEC salif; 22982 NEC sali; 24556, 24724 OCO pitt; 24852 OCO endr; 25407 NEC memb; 30053, 30220 OCO dend; 30373 OCO atir; 31563B AIO cost; 33575 OCO atir.
- Williams, L. O., et al.: 13888 OCO pitt; 13943

PER caer; 16064, 16147 PHO cinn; 16155 PER caer; 16160 PHO cinn; 16168 PER schi; 16169 PER vera; 16235 PER schi; 16236 PER caer; 16238 AIO cost; 16239, 16240 PER amer; 16344 OCO insu; 16419, 16421 AIO cost; 16443 PER caer; 16462 PHO cinn; 16469 OCO vala; 16470 PER schi; 16476 OCO pitt; 16556 PHO cinn; 16582, 16587 PER caer; 16588 AIO cost; 16598, 16612 NEC cufo; 18916 PER caer; 20146 PER schi; 20147 PER amer; 24110 OCO vala; 24144 PER vest; 24275 OCO insu; 24307 LIC mult; 24487 OCO vera; 24488 NEC glob; 24540 OCO vera; 24584 OCO nica; 24593 NEC glob; 26512 OCO vera; 26527 OCO flor; 26600 NEC glob; 26612 NEC sali; 28570 PHO cinn; 28623 OCO vala; 28706 OCO oblo; 28732 OCO aura; 28910 PER schi; 28911 PER amer; 28996 OCO vala; 29044 OCO gome.

Williams, R. S.: 319 NEC glob.

Woodson, R. E., et al.: 1022 OCO glau; 1099 PHO cinn.

Woodworth, R. H., & P. A. Vestal: 471 OCO cern.

Zamora, N., et al.: 367 NEC niti; 394 NEC reti; 399 LIC sp. A; 410 OCO tene; 442 OCO atir; 674 OCO valo; 719 OCO cern; 729 PHO cinn; 735 PER schi?; 770 NEC memb; 824 NEC sali; 879 OCO hold; 880 OCO pitt; 915 OCO vera; 1014 WIL glau; 1157 NEC sali; 1177 NEC glob; 1208 CAR burg; 1215 BEI oval; 1287 OCO heli; 1300 OCO leuc.

HERNANDIACEAE

By William Burger

REFERENCE—K. Kubitzki, Monographie der Hernandiaceen. Bot. Jahrb. Syst. 69: 78–209. 1969.

Small to medium-sized trees, less often shrubs or lianas, usually monoecious (bisexual), rarely dioecious, evergreen or deciduous, nodes unilacunar, oil cells often

present; stipules absent. Leaves alternate in a spiral, simple (in Central America) or palmately compound with 3–5 leaflets, petiolate, leaf blades entire or 3–5-lobed, venation palmate or pinnate. Inflorescences axillary to distal leaves or rarely terminal, dichasial or thyrselike, often with a well-developed primary peduncle and much branched distally, with or without bracts and bracteoles. Flowers usually very small, unisexual or bisexual, radially symmetrical; tepals (sepals) 4–10 in 1 or 2 whorls, free or united at the base; stamens 3–6 in 1 whorl (often opposite the outer whorl of tepals, filaments free, often with 2 basal and lateral or abaxial “glands” (usually narrowed at the base and often cordate), anthers 2-the-cous, opening by large flaps from the bottom upward (often remaining attached near the apex of the anther), staminodes absent or glandlike (relationship to glands and interpretation problematical), pollen inaperturate; pistil 1 (carpel apparently 1), ovary inferior and 1-locular, ovule solitary and pendulous from near the apex of the locule, style slender with capitate or broad stigma. Fruits 1-seeded nuts or drupes, with distal wings (in *Gyrocarpus*), lateral wings (in *Illigera*), or without wings (enclosed in a cupule of similar texture as the fruits in *Hernandia*); embryo large, straight, the cotyledons folded or rolled up.

A family of four genera and about 65 species. They are pantropical but with some very unusual, apparently relict, distributions. Many species occur on oceanic island-groups, but the species are not adapted to seaside or littoral vegetation (see Kubitzki, 1969). Costa Rican species are recognized by their unusual fruits (very different in the three different genera), variable and often long petioles, palmately veined leaves (in most) that often vary greatly in size, small or very small flowers with anthers opening by two flaps, and narrow inferior ovary with single locule and ovule. The family appears to be closely related to the Lauraceae with which it shares features of androecial morphology; it differs in the inferior ovary. These plants also resemble some Menispermaceae, both morphologically and in the rarity with which they are collected. While Kubitzki's monograph is excellent, the paucity of collections may require reassessment of species, if and when additional material becomes available.

Key to Species of Hernandiaceae

- 1a. Leaves deciduous, often 3- or 5-lobed (in Central America); trees of seasonally very dry and deciduous forest formations; fruits with 2 long spatulate or oblanceolate distal wings; flowers 2–4 mm long and unisexual *Gyrocarpus*
- 1b. Leaves evergreen or shortly deciduous; without lobes; trees, shrubs and lianas of evergreen forest formations below 1500 m elevation; fruits without wings; flowers unisexual or bisexual 2a



FIG. 23. Hernandiaceae: A, *Sparattanthelium amazonum*; B, *S. septentrionale*; C, *Gyrocarpus jatrophifolius*; D, *Hernandia stenura* with distal flower-pair; E, *H. didymantha*.

- 2a. Flowers ca. 5 mm long, 1 female and 1-3 male flowers borne together and subtended by a whorl of usually 4 sepaloid bracts; fruits partly enclosed within a cupule *Hernandia*
- 2b. Flowers ca. 2 mm long, apparently bisexual and not subtended by bracts or bracteoles; fruits developing at the ends of a few inflorescence branches and often becoming silvery white *Sparattanthelium*

Gyrocarpus Jacquin

Trees, rarely shrubs, deciduous, bisexual, branches often thick, puberulent or glabrous. Leaves simple, usually clustered at the ends of branches, long-petiolate, leaf blades often broader than long, entire and lobed or unlobed, venation usually palmate, glabrous or puberulent. Inflorescences developing before the leaves or with the leaves present, clustered at the ends of branchlets, flowers usually in small clusters in dichasial, thyrse-like or umbel-like arrangements, with or without bracts and bracteoles. Flowers bisexual (perfect) or male, very small, parts of the flower often early caducous, perianth usually of 7 (6, 8) parts, 2 parts (lobes) usually much larger and with 2 smaller lobes attached to each large lobe; stamens 4 or 5(-7), filaments free, puberulent or glabrous, anthers opening by 2 valves (flaps) from the bottom upward, 2-theccous; staminodes alternating with the stamens or solitary and opposing the style, clavate or thickened and flattened at the apex; ovary inferior and tomentulose, style and stigma 1. Male flowers with reduced ovary, more numerous than perfect flowers, wings not developing. Fruits drupes with 2 long apical oblanceolate wings with rounded tips (narrowly spatulate), developing from primordia within the perianth whorl, basal part (ovary) globose to ovoid or ellipsoid, puberulent to glabrous; seed with leafy cotyledons spirally twisted.

A genus with only three species: one in eastern Africa; *G. jatrophifolius* from Mexico to central Costa Rica; and *G. americanus*, with a very unusual pantropical distribution. The genus is distinguished by the unusual 2-winged fruits, inferior ovary, anthers opening by flaps, and restriction to seasonally dry areas. The wings do not develop from the perianth lobes, but rather from a pair of primordia arising interior to the perianth; see discussion in the monograph by Kubitzki (1969).

Gyrocarpus jatrophifolius Domin, *Biblioth. Bot.* 22, heft 89: 682. 1925 (1926). Figure 23.

Small to medium-sized (5-22 m) trees, occasionally a shrub, bark corrugated with corky ridges, leafy internodes (2)-4-15 mm thick, longitudinally grooved (dry), becoming glabrous and grayish. Leaves usually borne near the ends of stems, petioles 4-28 cm long, 1-5 mm thick, glabrescent and canaliculate above; leaf blades 6-20(-30) cm long, 5-25(-40) cm broad, 3- or 5-lobed, the 3 distal lobes with 2 deep sulci (more than 1/2 the length of the lobe) and acuminate apices, cordate to truncate at the base with a portion of the major lateral veins forming

part of the lamina base, margins entire, drying thin- to thick-chartaceous, glabrous or minutely (0.1-0.4 mm) puberulent on the veins above and below with thin yellowish hairs, venation palmate with 3 major veins, mid-vein with 4-8 pairs of major secondary veins. Inflorescences 4-14 cm long and growing longer in fruits, primary peduncles often 1/2 the length of the inflorescence, densely yellowish puberulent, dichasial or thyrse-like, often arising from thickened and rounded areas on the stem (these with circular peduncle scars after the infructescences fall off). Flowers small and green, 2-4 mm long; stamens usually 5 (4-7), filaments glabrous or puberulent near the base, 1-3 mm long, anthers ca. 0.6 mm long, dehiscent flaps remaining attached at the apex. Fruits with 2 apical stiffly chartaceous wings, (4.5-)7-11(-13.5) cm long and 7-14 mm broad, broadest above the middle, parallel or spreading and V-shaped, minutely puberulent or glabrescent, base of the fruits (ovary) 16-29 mm long and 6-10 mm thick, ellipsoid to narrowly ovoid, glabrescent or densely tomentulous with yellowish or gray hairs.

Trees of seasonally very dry deciduous forest and woodland formations from near sea level to 900 (1400) m elevation (rarely higher in Guatemala). Flowers have been collected in September-December and March, and fruits have been collected in December-March and May in Central America. The species ranges from Sinaloa, Mexico, southward along the Pacific slope to central Costa Rica.

Gyrocarpus jatrophifolius is recognized by its distinctive fruits with two long narrowly oblanceolate wings above an inferior ovary, the leaves with three prominent distal lobes and two smaller lateral lobes (all with acuminate apices), minute flowers with anthers dehiscent by two flaps, and the restriction to deciduous forest formations. This species is known from only a few collections in Costa Rica made in lowland Guanacaste Province and the western side of the Meseta Central. Kubitzki (1969) distinguished this species from *G. americanus* Jacq., which has more rounded fruits, leaves that are usually unlobed (in Central America), flowers with usually four stamens, and which reaches its southern limit in northern Nicaragua. Most authors previously have considered the two as parts of a single rather polymorphic species; the two species (as delimited by Kubitzki) are sympatric in northern and central Central America. The name *gallito* is commonly used for these plants

in El Salvador and Nicaragua; other names are *volador*, *volatin*, and *caballitos*.

Hernandia Linnaeus

Trees, rarely shrubs, monoecious (bisexual), usually evergreen, stems often thick and with soft wood; stipules absent. **Leaves** simple and alternate, petiolate; **leaf blades** usually with entire margins (rarely 3–5-lobed), venation pinnate or palmate. **Inflorescences** usually axillary to distal leaves, corymbiform panicles in Central America, usually with an elongate primary peduncle, inflorescence and bracts usually minutely tomentulous, the distal flower clusters often flower-like because they are subtended by a whorl of 4 sepaloïd bracts, the distal flower clusters bisexual with a central female flower (rarely 2 or 3) and 1–4 outer short-pedicellate male flowers, the female flowers subtended by and arising from within a deep cup formed by bracteoles (the cup sessile and with an entire distal margin in our species), bracteoles of the male flowers small and basal or absent. **Flowers** unisexual, outer perianth parts imbricate, the inner whorl imbricate to valvate, free; **male flowers** with 6–8 perianth parts (in whorls of 3–6 parts), stamens 3–5(–6), filaments free or united for 1/2 their length, usually each filament with 2 small appendages (glands) near the base; **female flowers** 4–6-parted, staminodia absent, 4 or 5(–10, 12) free or connate glands present at the base of the style, often opposing the outer perianth segments, ovary inferior and

slightly compressed, style well developed but not exceeding the perianth segments in length, stigma discoid-peltate. **Fruits** ovoid, ellipsoid, or subglobose drupes, or becoming hard and nutlike, often subtended and enclosed in the expanded and inflated cupule, the cupule often with 8 longitudinal ridges, usually minutely tomentulous (both cups and fruits); cotyledons folded.

A pantropical genus of 24 species best represented in the southwestern Pacific and West Indies with a few species in Africa, Madagascar, Australia, and Central and northernmost South America; see the treatment by Kubitzki (1969). Our species are recognized by the unusual partial inflorescences with two male and one female flower subtended by a whorl of four sepaloïd bracts, the female flower arising from within a cup, the anthers opening by two flaps, the inferior ovary and flattened stigma, and the drupelike fruits included within the enlarged cupule. Inflorescence, flowers, and fruits are usually covered by fine minute tomentulose (velutinous) hairs. Soft wood, thick stems, great variation in leaf size and petiole length, and restriction to wet evergreen forests further distinguish our species. These plants are poorly represented in herbaria.

Key to Species of *Hernandia*

- 1a. Leaves with the basal pair of secondary veins strongly developed and the venation often subpalmate, leaf blades usually ovate and often long-acuminate, larger leaves often slightly peltate; partial (distal) inflorescences usually 3-flowered; uncommon *H. stenura*
- 1b. Leaves with the basal pair of secondary veins not strongly developed, the venation pinnate, leaf blades often oblong, short-acuminate to acute, larger leaves not known to be peltate; partial inflorescences usually 2-flowered; rarely collected *H. didymantha*

Hernandia didymantha J. D. Smith, Bot. Gaz. 31: 120. 1901. Figure 23.

1.8–2.5 cm in diameter, subglobose, conical at the apex, enclosed within a coriaceous cup 2–3 cm in diameter.

Trees to over 15 m high, lower branches descending. **Leaves** simple and unlobed, petioles (1.5–)3–7(–9) cm long, canaliculate above (adaxially); **leaf blades** 9–18(–21) cm long, 3.5–7 cm broad, oblong to ovate-oblong or slightly obovate, bluntly acute to short-acuminate at apex, obtuse or rounded at the base, margins entire, drying subcoriaceous, glabrous above and below, venation pinnate with (4–)6–8 pairs of major secondary veins, the basal secondaries not more prominent than the distal secondaries. **Inflorescences** terminal or axillary to distal leaves, paniculate, distal flower clusters usually with only 2 flowers, bracts ca. 8 mm long and 3.5 mm broad, rounded at the apex and becoming reflexed. **Male flower** usually solitary on a long (5 mm) pedicel, parts in whorls of 3; **female flower** solitary and very short pedicellate, 4-parted, style with 4 stipitate glands at the base. **Fruits**

This species is only known from lowland evergreen rain forest formations. It has been collected from Punta Mona (*Pittier 12682*, US, the type), La Selva (*Hammel 11656*, DUKE; *Hartshorn 802, 1026*, CR, F; *McDowell 606*, DUKE), the Golfo Dulce region (*Allen 598*, F; *Q. Jiménez et al. 644*, CR, F), and near Almirante, Bocas del Toro, Panama (*Cooper 618*, MO). These flowering collections were made in January–April and November. A collection with fruits (*Hartshorn 1281*, CR, F) from La Virgen de Sarapiquí was made in August. This collection has the fruits almost entirely enclosed by a cupulate receptacle whose distal aperture is

only 3–6 mm wide; see also the photograph in P. E. Sánchez, *Florula del Parque Nacional Cahuita*, p. 141, 1983, where the fruiting season is said to be September–November.

Hernandia didymantha is recognized by the oblong leaves usually lacking strongly developed basal secondary veins, short acuminate apices, very variable petiole lengths, and characters of the genus. Additional collections may show that this species intergrades with material here treated as *H. stenura*. If that happens, *H. didymantha*, the earlier name, would have to be circumscribed more broadly to cover all our material of *Hernandia*. These trees appear to produce leaves in “flushes” of new growth and it may be that conditions at the time of the leaf flush may determine the size and form of the leaves. If this is the case, it may mean that *H. hammelii* D’Arcy of Panama is only a small-leaved (6–8 × 2.5–4 cm) growth form (Ann. Missouri Bot. Gard. 68: 224, 1981). Another recent small-leaved collection is from the Dept. of Yoro, Honduras (*Hazlett 2714*, F). All this material shows considerable variation in leaf size on the same branch, and all appear to live in the same kinds of moist forests.

Hernandia stenura Standl., Publ. Field Mus. Nat. Hist. Bot. Ser. 18: 1553. 1938. Figure 23.

Trees to over 25 m tall, leafy internodes 1.8–8 mm thick, glabrous or very minutely (0.1 mm) scurfy yellowish puberulent. Leaves simple and unlobed, juvenile and sapling leaves often large and slightly peltate, petioles 5–18 cm long; leaf blades 9–27(–40) cm long, 7–18(–25) cm broad, broadly ovate to ovate-elliptic or ovate-oblong, abruptly acuminate at the apex with a tip 1–3.5 cm long (rarely acute), rounded to subcordate at the base, the largest leaves sometimes peltate with the petiole attachment up to 1 cm distant from the lamina margin, drying thick-chartaceous or slightly subcoriaceous, margin entire or somewhat undulate, glabrous above, glabrous or minutely (0.1 mm) grayish puberulent on the veins beneath, venation pinnate or subpalmate with the lowermost secondaries often quite prominent, usually with 3–5 pairs of major secondary veins. Inflorescences 8–30 cm long with prominent primary peduncles 5–20 cm long, paniculate, sweet-scented, the ultimate parts flower-like with usually 4 sepal-like bracts (ca. 10 × 5 mm) subtending 1 subsessile female flower (and its cupule) and 1–4 pedicellate male flowers, all parts covered with a fine (0.1 mm) dense tomentum of soft hairs white in life but becoming grayish. Male flowers ca. 6 mm long (in bud) on pedicels 4 mm long, parts in whorls of 3, filaments with 2 minute glands; female flowers arising from within cupules ca. 3 mm long, on a short (3–4 mm) pedicel, flower buds ellipsoid, ca. 4–5 mm long, perianth 4-parted. Fruits drupes ca. 2 cm broad and included within the subglobose cupule narrowed at the round dis-

tal aperture, fruiting cupule 1.3–2.8 cm long and 1.5–2.8 cm broad (when dry), minutely grayish velutinous/puberulent on all surfaces, distal aperture 1–2 cm broad.

Trees of wet evergreen forest formations from near sea level to 1000 (1400) m altitude; flowers have been collected in November–January and March–May; fruits have been collected in March, June, and September. The species ranges from Guatemala to the province of Coclé in Panama; Costa Rican material has been collected along the Caribbean slope and coastal plain and in the General Valley.

Hernandia stenura is recognized by the long petiolate and broadly ovate leaves with subpalmate venation (sometimes peltate), thick stems with soft wood, distal flower clusters that resemble individual flowers, anthers opening by a flap, and the inferior ovary developing into a drupe that is largely surrounded within a slightly succulent cupule. The cupule is quite distinctive as its distal aperture is entire and somewhat smaller than the enclosed fruits. The dense minute grayish tomentum on all flowering parts is distinctive and reminiscent of that seen in some Lauraceae. These are infrequently collected trees, but they exhibit considerable variation, both between collections and within collections. It is possible that there is intergradation with *H. didymantha*; see the discussion under that species. Material of this species was mistakenly assigned to *H. sonora* L. by Standley in “Flora of Guatemala” (*Fieldiana*, Bot. 24(4): 346. 1946).

Sparattanthelium Martius

Shrubs, small trees, or lianas, evergreen, climbing with recurved hooks (modified short shoots) in some species. Leaves simple and entire, petiolate, leaf blades often narrowly ovate to lanceolate (ovate to obovate), venation palmately tripliveined (rarely pinnate), glabrous or puberulent. Inflorescences axillary from distal leaves, solitary at a node, much branched dichasia with many small distal flowers, bracts and bracteoles absent. Flowers very small, radially symmetrical, apparently bisexual, many are early caducous after anthesis (perhaps functionally male); perianth 4–8-parted, valvate in bud (in 4–5-parted flowers) or imbricate, free to near the base, persisting; stamens 4, 5(–7), alternating with the calyx lobes, filaments glabrous and short, anthers elongate, apiculate at the apex and opening laterally, flaps attached at the apex, both staminodes and glands absent; style straight, stigma discoid or lobed. Fruits developing only on the most distal branches of the infructescence (with very few fruits developing on an infructescence), branches of the infructescence with thickened nodes and somewhat zigzag (fracti-flexuous) in form, both the fruits and the stems

becoming silvery white or yellowish, drupes ovoid to elongate ellipsoid, often with longitudinal ribs; testa chartaceous, embryo, with inrolled cotyledons.

An American genus of 13 species ranging from southern Mexico to Peru, Bolivia, and southern Brazil. The genus is recognized by the usually tripliveined leaves on long slender petioles, the numerous very small flowers on complex inflorescences with apparently dichotomous (but

somewhat unequal) branching, the bisexual flowers with anthers opening by flaps, and the fruits apparently developing only from distal nodose inflorescence branches. Fruits and inflorescence become silvery white in some species. Specimens of this genus have been collected fewer than five times in Central America, but it seems likely that two species occur in southern Central America.

Key to Species of *Sparattanthelium*

- 1a. Leaves ovate to oblong or elliptic-oblong, abruptly short-acuminate; flowers usually with 5 perianth parts *S. septentrionale*
- 1b. Leaves narrowly elliptic and tapering gradually to the acuminate apex; flowers mostly with 4 perianth parts *S. amazonum*

Sparattanthelium amazonum Martius, *Flora* 24, Beibl 2: 42. 1841, *Denkschr. Bayer. Ges. Regensburg* 3: 303, t. 11, f. 2. 1841. *S. guatemalense* Standl., *Proc. Biol. Soc. Wash.* 37: 51. 1924. *S. amazonum* ssp. *guatemalense* (Standl.) Kubitzki, *Bot. Jahrb. Syst.* 89: 202. 1969. Figure 23.

Shrubs to 6 m tall, scandent or becoming lianas, leafy internodes 0.5–5 cm long, 1.5–4 mm thick, glabrous to densely puberulent with thin grayish straight hairs to 0.6 mm long. **Leaves** with petioles 1.2–6 cm long, 0.5–1 mm thick, glabrous or puberulent; **leaf blades** 6–16 cm long, 2.5–5.5 cm broad, lanceolate to narrowly elliptic or elliptic-oblong (rarely ovate), tapering gradually to the acuminate apex, the tip 0.4–1.5 cm long, rounded to obtuse at the base, margin entire or minutely undulate, drying thin-chartaceous, glabrous or puberulent along the major veins above and below, the hairs slender white and straight to 0.7 mm long, venation trinerved from slightly above the base of the lamina (lateral veins form the lamina margin at the very base), midvein with only 1 or 2 pairs of major secondary veins. **Inflorescences** to ca. 10 cm long, axillary to distal leaves, branches slender and grayish puberulent. **Flowers** small, ca. 2 mm long, perianth 4 (rarely 5) parted, 1.2–1.5 mm long, 0.4–0.8 mm broad, acute to obtuse at the apex, puberulent; **stamens** 4 (5), anthers subsessile; ovary (inferior) ca. 0.6 mm long, style slender 1–1.4 mm long. **Fruits** elongate ellipsoid drupes, ca. 1.7 cm long and 0.8 cm thick, fruits and inflorescences becoming white.

Lianas or shrubs in lowland rain forest formations. Only three collections of this species are known from Central America: *Standley 25066* (type of *S. guatemalensis*) from Puerto Barrios; *Contreras 8957* from Puerto Méndes, both in the Dept. of Izabal, Guatemala; and *Herrera 1210*,

CR, F, MO, from near the Nicaraguan border in Alajuela Province, Costa Rica. Flowers were collected in June and August. Immature fruits were collected by Herrera in November. The other collections of this species are from Brazil and Bolivia.

Sparattanthelium amazonum is recognized by the narrow elliptic acuminate leaves on long slender petioles, the trinerved venation, minute flowers with four perianth parts on thin-branched little inflorescences, and the anthers opening by flaps.

Sparattanthelium septentrionale Sandwith, *Kew Bull.* 1932: 226. 1932. Figure 23.

Shrubs (perhaps scandent), branchlets conspicuously and densely puberulent in early stages, the hairs slender 0.1–0.5 mm long, leafy internodes 0.8–3 mm thick. **Leaves** often very variable on the same stem, petioles 1.3–4.2 cm long, slender, puberulent; **leaf blades** 6–15 cm long, 2–8 cm broad, ovate to elliptic-oblong, abruptly acuminate at the apex with a tip 5–15 mm long, obtuse to rounded at the base, margins entire or slightly undulate, drying chartaceous, puberulent above and below in early stages with slender whitish hairs 0.1–0.8 mm long but the longer hairs falling off, trinerved from the base, the midvein with 2 or 3 pairs of distal secondary veins. **Inflorescences** said to be 5 cm long (probably becoming larger), branches of the inflorescence slender and grayish puberulent, pedicels to 4 mm long. **Flowers** about 1 mm in diameter in bud, perianth 5-(6-)lobed, perianth lobes 1.5–2 mm long and 1 mm wide, the lobes elliptic and obtuse at the apex; **stamens** 5 (4), filaments 0.5 mm long, anthers ca. 1 mm long; style 1.5–2 mm long. **Fruits** unknown.

Probably confined to lowland evergreen forest formations and known from only three collections,

ranging from Tabasco/Yucatan in Mexico to Costa Rica.

Sparattanthelium septentrionale is distinguished by the broader, more ovate or oblong leaves and the usually 5-parted perianth.

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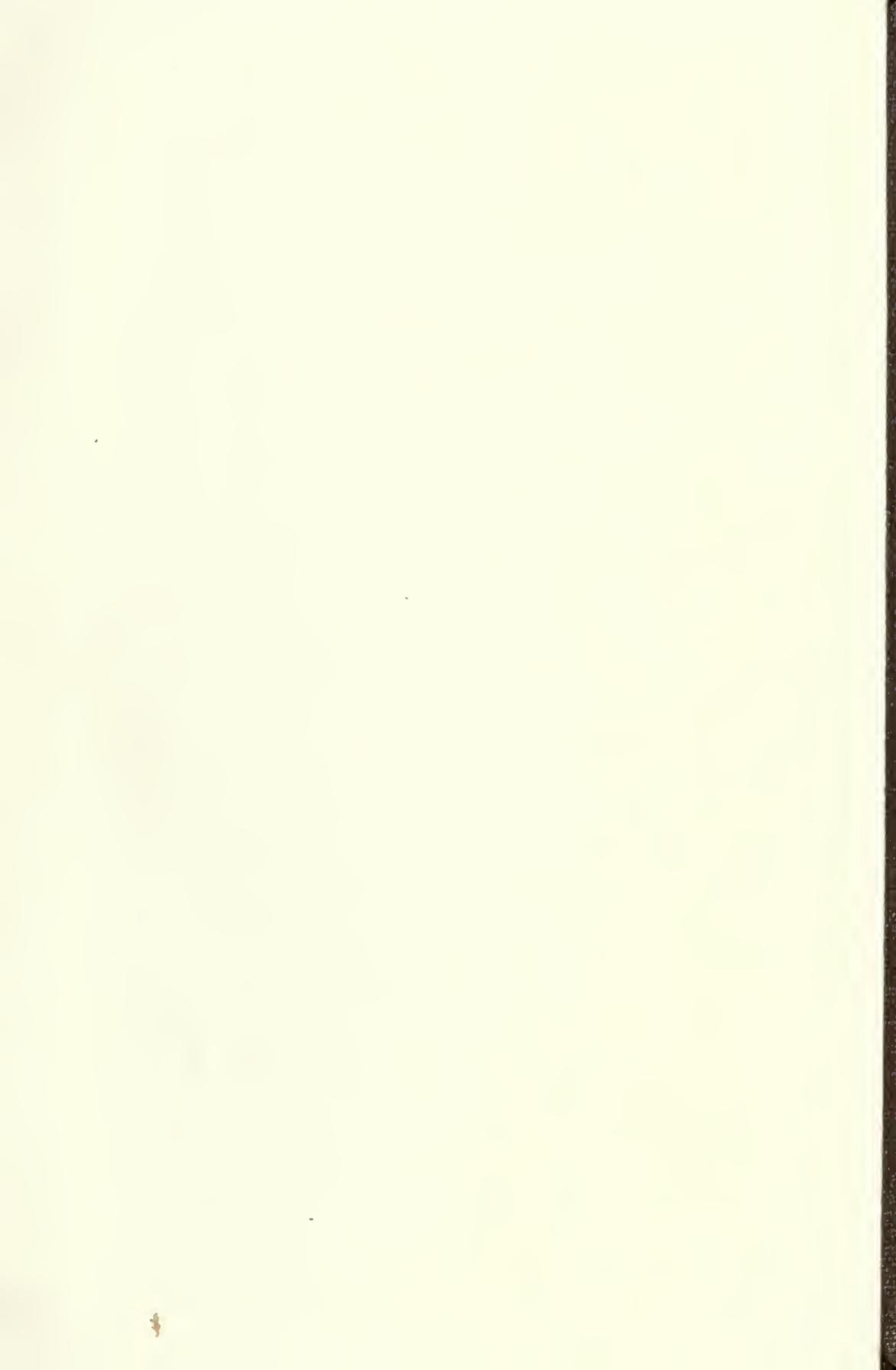
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