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FLORA COSTARICENSIS

WILLIAM BURGER, Editor

FAMILY #40, CASUARINACEAE

FAMILY #41, PIPERACEAE

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NOVEMBER 29, 1971

Families of seed plants known or expected to occur in Costa Rica and adjacent areas, listed alphabetically and numbered according to the sequence of Engler's *Syllabus der Pflanzenfamilien*, edition 11, reworked by L. Diels (1936).

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Flora Costaricensis[1]

INTRODUCTION

This publication initiates a new "Flora of Costa Rica." The parts will be issued either as individual families or in the sequence of Engler and Diels. No continuing volume number has been designated for the Flora; families or sequences of families will be published as they are ready. These will be identified within the *Fieldiana: Botany* series by volume number and title. While authorship will be largely the responsibility of the staff at Field Museum, we hope to enlist the contributions of specialists whenever possible.

This project continues Field Museum's interest in Costa Rica; it was here that Standley wrote and published his "Flora of Costa Rica," the first complete listing of Costa Rica's flowering plants. Standley's work was essentially an annotated check-list, while this new flora will include full descriptions and keys covering the native, naturalized, and more conspicuous cultivated plants. The flora is intended for a wide variety of users, but a working knowledge of botanical terminology is assumed. Genera and difficult species-groups will be illustrated. Synonomy will be restricted to names based on Costa Rican collections or names commonly employed in Central America. Collections seen will be listed only for poorly known species. The descriptions and ecological data apply to the species as they are now known in Costa Rica; these may differ elsewhere and may require corrections as more information becomes available.

We shall endeavor to develop biologically meaningful species-concepts, but paucity of collections and poor field data often make this difficult. Since the area under study is very small and many taxonomic problems will require broad-range monographic analysis, we will borrow material from European herbaria only occasionally. This may result in incomplete synonymies, the use of later synonyms,

[1]Supported in part by National Science Foundation grants GB-698, GB-3106, and GB-7300.

and perhaps in overlooked species—nothing very unusual considering the state of our knowledge in these tropical areas. Many problems, both biosystematic and nomenclatural, will have to await more intensive field work and monographic analysis. We believe that one of the functions of the Flora will be to identify problems as well as plants within the area.

Preparation for beginning this Flora has included intensive field work over the last eight years. This work would not have been possible without grants from the National Science Foundation. The grants were prepared and supervised by Louis O. Williams who enlisted the co-operation of the Museo Nacional of Costa Rica and the Escuela Agrícola Panamericana of Honduras. These grants have provided support for extensive field work by resident botanists: Alfonso Jiménez in Costa Rica, Antonio Molina in all the Central American republics, and others. This recent work augments more than a century of botanical exploration by such eminent collectors as Anders Oersted, Henri Pittier, Adolfo Tonduz, Paul Standley, Alberto Brenes, Austin Smith, and Alexander Skutch. Thus, the flowering plants are much better known in Costa Rica than in adjacent areas and there are now sufficient collections of most groups to begin a fully descriptive flora. Though the geographic area is delimited on two sides by national boundaries, the region is a natural biogeographical unit if one includes western Panama. This phytogeographic unity is strongest for the montane elements of the flora; the lowland species are more often widespread. This flora shall include species collected in closely adjacent areas of Nicaragua and western Panama.

A more elaborate introduction to this flora with keys to families and bibliography is planned. In the meantime, the reader is referred to the excellent introduction by Standley in his "Flora of Costa Rica" (Field Mus. Bot. 18:5–63. 1937). Standley has written of Costa Rica's rich flora and gracious people with eloquence and enthusiasm. This is an enthusiasm shared by all of us who have studied this wonderful diversity of plants and been privileged to work with Costa Rica's friendly people.

CASUARINACEAE

Evergreen trees or shrubs, branchlets slender and green with longitudinal ridges as many as the scale-leaves and thickened nodes, leaf-like in function and the majority eventually deciduous. Leaves reduced to minute appressed scales borne in whorls of 4 to 12 at each node, simple and entire with an acute apex, the leaves of each whorl united below to form a sheath around the stem; stipules absent. Flowers unisexual and the plants usually monoecious; male flowers borne in a spike-like inflorescence at the end of the branchlets, individual male flowers in whorls of 4 to 12 on the stem-like axis of the inflorescence, each male flower reduced to a single stamen borne in the axil of a scale-leaf and subtended by 2 small bracts and 2 bract-like perianth-parts that are pushed off by the expanding stamen at anthesis, filament inflexed in bud, filiform, anther 4-thecous and basifixed, dehiscing longitudinally; female flowers borne in cone-like heads at the ends of short lateral shoots, each female flower composed of a single pistil subtended by a bract and 2 bracteoles, ovary superior and 2-locular or becoming 1-locular at maturity, with only 1 fertile locule and 2 to 4 ovules on a parietal placenta, style very short with 2 long slender stigmas, the bracts and bracteoles surrounding the ovary becoming woody at maturity and forming what appears to be an individual fruit within the cone-like infructescence; fruit a small samara with a thin wing at the apex, seed solitary, endosperm absent.

A family of about 40 species originally ranging from Australia and the islands of the Western Pacific to South-east Asia and the shores of the Indian Ocean. The species have long been placed in a single genus but a segregate genus, *Gymnostoma,* has recently been proposed. Our species belong to the genus *Casuarina* in the strict sense. These trees are widely planted for ornament and as hedges and wind-breaks and they have become naturalized in many tropical areas. The slender green branchlets with longitudinal grooves resemble the stems of *Equisetum* and, to a lesser extent, the needles of the long-leaved pines, hence the name: *pino de Australia.* A number of species are strand plants tolerant of saline soils. The Casuarinaceae are one of the very few families in which the rootlets may possess nodules of nitrogen-fixing bacteria. This very unusual family has no close relatives among living angiosperms but a relationship with the Hamamelidaceae has been suggested.

CASUARINA Adanson

Characters of the family. Two species are commonly planted in Central America and although they are easy to distinguish

these species have generally been placed under the name *C. equisetifolia*.

Fruiting cones less than 11 mm. in diameter; male spikes with the slender bracts usually visible between the scale leaves; green internodes 0.4–0.6 mm. thick when dry ..... *C. cunninghamiana.*

Fruiting cones more than 11 mm. in diameter; male spikes with the bracts not visible between the scale leaves; green internodes 0.6–0.8 mm. thick when dry. *C. equisetifolia.*

Casuarina cunninghamiana Miq., Rev. Crit. Casuar. 21. 1848.

Trees to over 20 m. tall, often planted at higher (1,000–2,000 m.) altitudes; green branchlets with internodes averaging 3–6 mm. long, 0.4–0.6 mm. thick, very sparsely puberulent with minute whitish hairs 0.03–0.1 mm. long. Leaves scale-like, in whorls of usually 8 (7 to 10), free distal portion 0.3–0.5 mm. long, acute. Male spikes about 2 cm. long and 1 mm. thick; female cones 6–10 mm. thick at maturity; the samara 3–5 mm. long, grayish brown, with the wing becoming twice as long as the body of the fruit.

Casuarina equisetifolia L., Amoen. Acad. 4:143. 1759.

Trees to 20 m. tall, tolerant of saline soils and capable of growing near the ocean shore; green branchlets often drooping, with internodes averaging 6–8 mm. long and 0.6–0.8 mm. thick, sparsely puberulent with very minute whitish hairs 0.03–0.1 mm. long. Leaves scale-like, in whorls of usually 7 (6 to 8) at each node, free distal portion 0.5–0.8 mm. long, acute. Male spikes to 3 cm. long and about 1.5 mm. thick; female cones 12–16 mm. in diameter at maturity; the samara 5–8 mm. long, brown and with a wing about twice as long as the body of the fruit.

PIPERACEAE

REFERENCES: W. Trelease, The Piperaceae of Costa Rica, Contr. U.S. Nat. Herb. 26:115–226. 1929. P. C. Standley, Flora of Costa Rica, Field Mus. Bot. 18:306–370. 1937; 1,543–1,548, 1938. W. Trelease & T. G. Yuncker, The Piperaceae of Northern South America, Univ. Illinois Press, 1950. T. G. Yuncker *in* Woodson & Schery, Flora of Panama, Ann. Mo. Bot. Gard. 37:1–120. 1950.

Herbs, shrubs, small trees or rarely climbers, terrestrial or epiphytic, stems with separate vascular bundles; prophyll solitary and lateral when present. Leaves alternate, opposite, whorled or basal, simple, petioles often sheathing the stem with stipule-like margins; laminae entire and unlobed or lobed only at the base (in Costa Rica), often spicy aromatic when crushed, glabrous or with unbranched multicellular hairs. Inflorescence basically a simple spike, axillary, terminal, leaf-opposed, or variously arranged in compound inflorescences (in *Peperomia* and *Pothomorphe*) as racemose, spicate, umbellate, or paniculate but never cymose; spikes pedunculate and usually with a thick rachis; flowers bisexual (in Costa Rican species) and each subtended by a single peltate or subpeltate bract broad and usually flattened at the apex, perianth absent; stamens usually borne on the base of the pistil, 2, 4, or 6, filaments generally short and not exceeding the pistil in length, anther 1-, 2-, or 4-thecous, dehiscing laterally or apically; pistil simple and sessile or rarely pedicellate, 1-locular with a single basal ovule, styles absent or 1 or as many as the stigmas, stigmas 1, 2, 3, or 4 (very rarely 5); fruit drupaceous and fleshy or dry.

A tropical family of about eight genera absent in drier regions and recognized by the simple leaves and the very small flowers lacking a perianth and borne on a thick spike. The genus *Peperomia* stands apart within the family; all our other species have often been placed in the single genus *Piper* but I have recognized *Pothomorphe* and *Sarcorhachis*. A third genus, *Trianaeopiper*, occurs in Panama. The Piperaceae are very closely related to the Saururaceae of North America and Eastern Asia. These families have both Ranalian and monocotyledonous affinities. The monocotyledonous characters are: separate vascular bundles, sheathing leaf-base, single prophyll, and flower parts in multiples of three or four. In Costa Rica the only plants likely to be confused with Piperaceae are Araceae and a few Euphorbiaceae. Four species of *Peperomia* and all our species of the other genera have been illustrated; the figures are at the end of the family.

I believe that the treatment of *Peperomia* will require many more corrections and additions than the treatment of *Piper*. The reasons for this are three. First, our sampling of peperomias is much inferior to our collections of the shrubby pipers. Because of this we are likely to find many more peperomias new to Costa Rica. Second, the populations of *Peperomia* are much more variable than those of *Piper*. This, together with the poor sampling, make many species concepts very tentative in *Peperomia*. Third, because of effective dispersal of their small sticky seeds, peperomias are generally much more widespread than pipers. Thus, many of the names used here will prove to be synonymous with earlier names from distant areas. I have attempted to reduce this latter problem (in both genera) by using early names wherever possible, often on very tenuous evidence.

KEY TO PIPERACEAE

1A. Plants herbaceous, very often succulent and usually epiphytic, the nodes not usually thickened; leaves alternate, opposite, whorled, or basal; flowering parts often separate on the rachis, floral bracts usually round and flat above, rarely puberulent; anthers 2 per pistil, stigma one and often minutely fimbriate.....PEPEROMIA.

1B. Plants mostly woody, rarely succulent and very rarely epiphytic, the nodes usually thickened; leaves never opposite, whorled, or basal; flowering parts rarely separate on the rachis, floral bracts usually triangular to V- U- or Y-shaped above, rarely completely glabrous; anthers usually 4 (rarely 2 or 6) per pistil; stigmas 2, 3, or 4 or rarely poorly differentiated, never fimbriate. 2A.

2A. Inflorescence leaf-opposed, a solitary spike.....PIPER.

2B. Inflorescence axillary, a solitary spike or an umbellate cluster.....3A.

3A. Spikes in an umbellate cluster; common shrubby plants of open sites. POTHOMORPHE.

3B. Spikes solitary in each leaf-axil or terminal; climbing plants of wet evergreen forests.....SARCORHACHIS.

PEPEROMIA Ruiz & Pavon

REFERENCES: Hugo Dahlstedt, Studien über Süd- und Central-Amerikanische Peperomien, Svensk. Vet. Akad. Handl. 33, no. 2:1–218. 1900. Arthur W. Hill, A revision of the geophilous species of *Peperomia*, Ann. Bot. 21:139–160. 1907.

Herbs, only rarely over 1 m. tall, terrestrial or more often epiphytic, erect, repent, or scandent, the stems often succulent. Leaves alternate, opposite, or whorled, simple and usually petiolate, estipulate but the petiole occasionally deeply vaginate with thin adaxial margins clasping the stem; lamina entire and often succulent, glabrous or with simple multicellular hairs. Inflorescences axillary, terminal, or leaf-opposed, simple and of a single spike or compound with the spikes variously arranged on a leafless branched or unbranched axis, the

spike with a succulent glabrous or puberulent rachis, the flowers sessile and subtended by a peltate usually orbicular bract; stamens 2 and borne at or on the base of the pistil, anthers 2-thecous, the filament usually shorter than the anther; pistil usually borne in a depression in the rachis, stigma simple and usually fimbriate, often borne in the center of translucent tissue which will develop to form a beak; fruit drupaceous with a single seed, rarely pedicellate or more often exserted on a pseudopedicel in late stages, the pseudopedicel flattened longitudinally and articulate at the base of the ovary; stigma sessile or on a style and apical but more often subapical on the abaxial side of the usually oblique beak, the surface of the fruit usually viscid and becoming verrucose and pellucid when dry, the beak of viscid often translucent tissue formed during the development of the fruit, usually oblique and anterior.

A pantropical genus of over a thousand described species richly represented in the American tropics. In Costa Rica the genus is best represented in the evergreen forest formations of the Caribbean slope and the central highlands to an altitude of 2,000 m. Very few species are adapted to the seasonally very dry deciduous forest formations of lowland Guanacaste (*P. cyclophylla* and *P. pereskiaefolia*) or the subalpine formations above 2,800 m. (*P. alpina, P. esperanzana, P. galioides, P. quadrifolia,* and *P. saligna*). The genus is of no economic significance but many species are attractive succulents grown as ornamentals.

Most species of *Peperomia* have a viscid surface on the fruit; an adaptation for dispersal in this largely epiphytic genus. This character which allows peperomias to reach high tree-tops has resulted in many geographically widespread species. Populations may be very local but endemism, I believe, will prove to be uncommon when the genus is better understood. Of our 66 species, 14 are endemic and I am sure that the number of endemics will be reduced with further collecting. The viscid fruit-surface dries in a variety of ways and has given rise to Dahlstedt's "pseudocupule." I believe that the pseudocupule is not a morphological structure but rather due to the differential drying of the lower part of the fruit-surface in contact with the enclosing rachis. Thus the presence or absence of the pseudocupule is of little value, it varies on the same spike. However, there are many species that never exhibit this phenomenon, and those that do appear to be related.

The beak (rostrum or scutellum) is produced by viscid tissue that develops as the fruit matures and undoubtedly aides in dispersal. It differs from a true style in developing late and being anterior to the stigma. The fruit are usually angled upward (ascending) on the spike and the stigma is abaxial to the beak in this position. I believe it is incorrect to state that the stigma is anterior in this position

(Yuncker, 1950; Trelease and Yuncker, 1950). The attachment of the fruit is often subbasal (assuming that the beak and stigma are apical). In a few species the attachment is almost lateral but this is difficult to see in this small round fruit and it has not been mentioned by previous workers. This lateral attachment of the fruit is characteristic of a difficult complex of species including *P. alata*, *P. glabella*, and *P. angularis*.

I believe that the species as here circumscribed are quite natural, with the exception of the *P. alata—glabella—angularis* complex. The individuals of a species are often extraordinarily variable. This is not unusual in an herbaceous genus but I believe that many species have the ability to flower when only a fraction of their typical size at maturity. This has produced many names based on what I prefer to call depauperate specimens. In addition, differential drying of the succulent tissues adds to this apparent variability. There are many problems in the peperomias of Costa Rica (see the discussions under the species) but most will have to be solved by examining living populations in nature and not desiccated specimens on herbarium sheets.

1a. Leaves peltate.....2a.

1b. Leaves never peltate.....8a.

2a. Plants acaulescent with both the leaves and roots emerging from the upper part of a small globose tuber.....3a.

2b. Plants with definite stems or rarely acaulescent in *P. lanceolato-peltata* and these lacking a globose tuber.....4a.

3a. Inflorescence compound, usually of 2 spikes; leaves tapering to the acute or obtuse apex.....*P. claytonioides*.

3b. Inflorescence simple; leaves usually orbicular and rounded at the apex. *P. gracillima*.

4a. Inflorescence simple, the peduncle without a bract or node, the flowering rachis often minutely papillate-puberulent; fruit smooth with apical stigma; leaves usually drying thin.....5a.

4b. Inflorescence compound or if simple the peduncle with a bract or node, the flowering rachis glabrous or hidden by the congested flowering parts; fruit pellucid-verrucose, a beak often developed beyond the subapical stigma; leaves usually drying thickly chartaceous or subcoriaceous.....6a.

5a. Internodes 2–6 cm. long, stems usually over 15 cm. long; edge of the lamina glabrous.....*P. amphitricha*.

5b. Internodes less than 1 cm. long, stems usually less than 10 cm. long; edge of the lamina minutely puberulent.....*P. lanceolato-peltata*.

6a. Plants usually erect on the forest floor; lamina 8–25 cm. long with the petiole attached within 1 or 2 cm. of the edge.....*P. maculosa*.

6b. Plants climbing and rooting at most nodes.....7a.

7a. Plants usually more than 25 cm. long; lamina 5–18 cm. long; flowering rachis becoming 3–20 cm. long.....*P. hernandiifolia*.

7b. Plants usually less than 25 cm. long; lamina 3–7 cm. long; flowering rachis 1–2.5 cm. long ..... *P. peltilimba.*

8a. Leaves opposite or whorled along the main stem ..... 9a.

8b. Leaves alternate along the stems but occasionally opposite at flowering and branching nodes ..... 31a.

9a. Leaves usually less than 20 mm. long, erect flowering stems rarely more than 15 cm. tall ..... 10a.

9b. Leaves usually more than 25 mm. long, erect flowering stems more than 15 cm. tall (if present) ..... 19a.

10a. Leaves 2 to 10 per node, lamina small and very narrow (up to 8×3 mm.); flowering rachis glabrous, the fruit distinctly pedicellate ..... *P. pittieri.*

10b. Leaves 2 to 6 per node, fruit usually sessile in a depression in the rachis or rarely borne on a pseudo-pedicel ..... 11a.

11a. Peduncle with 2 to 4 small bracts or subtended by undeveloped leaves, the leaves 2 per node and usually orbicular; plants of the deciduous forest formation of the Pacific slope ..... *P. cyclophylla.*

11b. Peduncle without bracts and only rarely subtended by undeveloped leaves, the leaves 2 to 4 per node; plants of evergreen forest formations. 12a.

12a. Inflorescences terminal and solitary on short erect or repent stems; the plants usually less than 15 cm. tall; flowering rachis glabrous or puberulent ..... 13a.

12b. Inflorescences terminal or axillary, with 1 to 8 spikes per node; flowering rachis glabrous ..... 17a.

13a. Flowering rachis puberulent; anthers 0.1–0.4 mm. long ..... 14a.

13b. Flowering rachis glabrous; anthers 0.1–0.2 mm. long ..... 15a.

14a. Lamina 3–10 mm. long, usually rounded at the apex, pubescence of stems and rachis usually about 0.05 mm. long; anthers 0.2–0.4 mm. long; plants of lower (0–1,500 m.) altitudes ..... *P. deppeana.*

14b. Lamina 8–22 mm. long, usually narrowed to the apex, pubescence of stem and rachis usually about 0.1 mm. long; anthers 0.1–0.2 mm. long; plants of higher (1,200–2,800 m.) altitudes ..... *P. tetraphylla.*

15a. Lamina 3–7 mm. long, rounded and often emarginate at the apex; flowering rachis 6–15 mm. long on a peduncle 6–15 mm. long. *P. hoffmannii.*

15b. Lamina 5–30 mm. long; flowering rachis usually much longer than the peduncle ..... 16a.

16a. Lamina 5–15 mm. long, usually rounded and retuse at the apex; plants of the higher (1,000–3,000 m.) elevations ..... *P. quadrifolia.*

16b. Lamina usually more than 15 mm. long, usually narrowed above the middle or narrowly oblong ..... 17a.

17a. Plants usually with several lateral branches on the erect flowering stems, common between 1,000 and 2,500 m. elevation; lamina often dimorphic, thin and often narrowly oblong in immature specimens ..... *P. galioides.*

17b. Plants usually with few lateral branches, rare in collections and only known from the Caribbean slopes below 1,500 m.; lamina usually drying subcoriaceous and grayish in color, rhombic to elliptic or ovate ..... 18a.

18a. Floral bracts 0.3–0.4 mm. long; fruit paler in color in the lower half; erect stems with few roots, leaves mostly in whorls of 4 ..... *P. rhombea.*

18b. Floral bracts 0.5–0.7 mm. long; fruit uniform in color in the lower half; roots present at most nodes, leaves 2 to 4 per node ..... *P. emiliana.*

19a. Internodes densely or conspicuously puberulent, the hairs 0.05 mm. long or longer; plants of higher elevations ..... 20a.

19b. Internodes glabrous or very minutely (0.03 mm.) puberulent or with longer hairs only at the nodes.....24a

20a. Flowering rachis puberulent, upper leaves alternate...*P. carpinterana.*

20b. Flowering rachis glabrous, leaves opposite.....21a.

21a. Plants few-branched, the hairs usually conspicuous, 0.5 mm. or longer. 22a.

21b. Plants with widely branching main stems or if few-branched with whorls of spikes as many as the leaves or twice as many.....23a.

22a. Petioles 1–6 mm. long, leaves obovate, internodes densely hairy; floral bracts about 0.4 mm. long; 500–2,000 m. elevation..*P. olivacea.*

22b. Petioles 3–20 mm. long, leaves elliptic to orbicular, internodes sparsely hairy; floral bracts 0.6–0.7 mm. long; 2,200–3,200 m. elevation.....*P. esperanzana.*

23a. Petioles to 6 mm. long, lamina usually tapering to an acute apex, ovate to lanceolate, the plants usually few-branched and not shrub-like in appearance.....*P. palmana.*

23b. Petioles to 3 mm. long, lamina often dimorphic, usually rounded at the apex, narrowly obovate to very narrowly oblong, the plants usually with much-branched stems and shrub-like in appearance..*P. galioides.*

24a. Nodes with conspicuous hairs about 0.5 mm. long, lamina drying thin and often translucent, with minute hairs on the veins above and at the apex, 800–2,000 m. elevation.....*P. barbinodis.*

24b. Nodes glabrous or very minutely puberulent.....25a.

25a. Leaves of the main stem alternate and very narrow, the leaves of secondary or axillary branches opposite; plants of very high (2,600–3,300 m.) elevation.....*P. saligna.*

25b. Leaves of the main stem opposite.....26a.

26a. Longest leaves less than 4 cm. long.....27a.

26b. Longest leaves more than 4 cm. long.....29a.

27a. Lamina drying thin and often translucent; stems usually branched, plants of higher altitudes (1,000–2,800 m.).....*P. palmana.*

27b. Lamina drying thickly chartaceous or subcoriaceous and often gray; few-branched plants of lower altitudes.....28a.

28a. Floral bracts 0.3–0.4 mm. long; stems erect and with few roots; leaves mostly 4 per node.....*P. rhombea.*

28b. Floral bracts 0.5–0.7 mm. long; stems with roots at most nodes; leaves 2 to 4 per node.....*P. emiliana.*

29a. Floral bracts oblong to 1 mm. long, anthers 0.3–0.4 mm. long, flowers usually distant on the rachis; plants of deciduous or seasonally very dry forests (0–100 m.) of the Pacific drainage.....*P. pereskiaefolia.*

29b. Floral bracts orbicular to 0.5 mm. long, anthers 0.2–0.3 mm. long, flowers usually congested; plants of evergreen forest formations.....30a.

30a. Leaves drying thick-chartaceous or subcoriaceous and gray in color, venation often obscure; plants of lower (0–1,500 m.) altitudes...*P. seemannii.*

30b. Leaves usually drying thin-chartaceous and dark in color (the lower surface paler), with the venation prominent; plants of higher (1,200–2,000 m.) altitudes.....*P. angustata.*

31a. Larger leaves usually less than 25 mm. long; the plants usually less than 15 cm. tall when erect.....32a.

31b. Larger leaves more than 25 mm. long; the plants usually becoming more than 15 cm. tall.....43a.

32a. Leaves consistently less than 10 mm. long and very thin (dried), usually as wide as long; slender repent plants.....33a.

32b. The larger leaves more than 10 mm. long.....35a.

33a. Floral bracts with small marginal hairs or cilia, spike to 16 mm. long; fruit globose-ovoid on a flattened pseudopedicel in late stages, stigma subapical.....*P. ebingeri.*

33b. Floral bracts glabrous.....34a.

34a. Fruit on a definite pedicel articulate at the rachis, stigma apical; spike to 40 mm. long, flowers few and distant on the rachis....*P. emarginella.*

34b. Fruit sessile or borne on a flattened pseudopedicel articulate at the base of the ovary.....35a.

35a. Peduncle nodose or with a small bract or the spike apparently subtended by a leafless node, peduncle often longer than the flowering rachis; leaves usually as broad as long; fruit narrowly ellipsoid with style-like beak. *P. serpens.*

35b. Peduncle without a node or bract, the spike only occasionally subtended by a leafless node, peduncle usually shorter than the flowering rachis...36a.

36a. Repent plants, the erect flowering stems usually unbranched with leaves in a spiral and solitary terminal spike, erect stems to 10 (15) cm. tall; fruit attached at or near the base.....37a.

36b. Stoloniferous or occasionally repent plants, the erect flowering stems branched or if unbranched usually with the leaves distichous, erect stems to 25 cm. tall.....38a.

37a. Fruit globose ovoid and often becoming exserted; anthers 0.1–0.3 mm. long; leaves drying membranaceous to thin-chartaceous, rarely becoming 2 cm. long.....*P. rotundifolia.*

37b. Fruit turbinate and partly immersed in the rachis (during development); anthers 0.2–0.4 mm. long; leaves drying chartaceous and opaque, occasionally 2 cm. long.....*P. panamensis.*

38a. Flowering shoots usually unbranched, the leaves distichous, laminae usually narrowly ovate.....39a.

38b. Flowering shoots usually branched, the leaves usually in a spiral; fruit pedicellate only in *P. hispidula*.....41a.

39a. Fruit pedicellate and narrowly obovoid, the pedicel articulate at the rachis; floral bracts 0.5–0.8 mm. long, laminae 8–35 mm. long; usually between 1,000–2,500 m. elevation.....*P. tenella.*

39b. Fruit globose-ovoid, sessile or becoming raised on a flattened pseudopedicel articulate below the ovary, fruit attached at or near the side (relative to the beak); floral bracts 0.3–0.5 mm. long.....40a.

40a. Stems usually glabrous, laminae narrowed toward the apex, usually between 1,000 and 1,800 m.....*P. tenellaeformis.*

40b. Stems densely puberulent, laminae usually rounded at the apex, usually between 0 and 1,200 m.....*P. oerstedii.*

41a. Stems usually densely puberulent; plants with erect shoots not more than 15 cm. tall, fruit attached on the side.....42a.

41b. Stems sparsely puberulent or glabrous; plants with erect shoots exceeding 15 cm.....43a.

42a. Spikes terminal and solitary, laminae often rounded at the apex, elliptic to obovate.....*P. oerstedii.*

42b. Spikes axillary or terminal, 1 or 2 at a node; laminae usually narrowed to the apex.....*P. candelaber.*

43a. Inflorescence simple, of a single spike borne on a peduncle without a node or bract (but occasionally appearing nodose or bracteate when subtended by a leafless node) ..... 44a.

43b. Inflorescence compound, of 2 or more spikes on a common peduncle, or if simple, the peduncle with a node or bract; the laminae often with pinnate venation and the fruit usually beaked ..... 66a.

44a. Internodes densely and generally puberulent (at least on the younger stems), the hairs 0.1–2 mm. long ..... 45a.

44b. Internodes glabrous or with scattered hairs 0.03–0.1 (0.5) mm. long .. 49a.

45a. Leaves alternate on the upper part of flowering stems but opposite and whorled on the lower parts and new shoots; flowering rachis puberulent, floral bracts glabrous ..... *P. carpinterana.*

45b. Leaves alternate in the lower parts, occasionally opposite below the inflorescences ..... 46a.

46a. Floral bracts ciliate, 0.3–0.5 mm. long; flowers and fruit congested on the rachis ..... *P. costaricensis.*

46b. Floral bracts glabrous ..... 47a.

47a. Flowers and fruit usually congested on the rachis; floral bracts 0.3–0.5 mm. long; plants usually drying dark in color ..... *P. tuisana.*

47b. Flowers and fruit becoming distant on the rachis; floral bracts 0.5–0.7 mm. long; plants usually drying thin and pale colored ..... 48a.

48a. Leaves obtuse to acute at the apex, 0–1,500 m. altitude. *P. montecristana.*

48b. Leaves acuminate at the apex, 1,500–2,500 m. altitude ..... *P. elata.*

49a. Leaves pinnately veined ..... 50a.

49b. Leaves palmately veined ..... 54a.

50a. Spikes only produced on the axillary or lateral branches, leaves of the main stem differing in size and form from the usually opposite leaves of the lateral branches; fruit obovoid; plants of high (2,600–3,200 m.) altitudes ..... *P. saligna.*

50b. Spikes produced on terminal and lateral branches, fruit globose-ovoid; plants of lower (0–2,000 m.) altitude ..... 51a.

51a. Stems with bark-like texture and drying grayish, unbranched; leaves usually crowded at the apex of the stem; fruit basally attached and with apical or subapical stigma; often conspicuously punctate on many parts. 52a.

51b. Stems lacking a bark-like surface when dried; fruit attached on or near the side, stigma subapical on the side of the beak ..... 53a.

52a. Lamina subcordate to obtuse at the base, 2–6 cm. broad .. *P. lignescens.*

52b. Lamina acute at the base, 1–2 (3) cm. broad; (not reported from Costa Rica) ..... *P. petrophila.*

53a. Peduncle of the spike 8–25 mm. long; stems usually unbranched with internodes to 10 mm. long, laminae 1–2 cm. broad ..... *P. reptabunda.*

53b. Peduncle of the spike 2–10 mm. long; stems often branched with internodes to 80 mm. long, laminae 1.5–5 cm. broad ..... *P. alata.*

54a. Laminae cordate to truncate at the base; the stigma usually apical and the fruit usually attached at or near the base ..... 55a.

54b. Laminae acute to obtuse at the base, rarely rounded or truncate ..... 59a.

55a. Stems usually short (–10 cm.) and weak, unbranched; petioles 3–12 cm. long, laminae 2.5–6 cm. broad, stigma apparently apical. *P. pseudo-dependens.*

55b. Stems usually longer, mostly erect and often branched; petioles to 3 cm. long ..... 56a.

56a. Fruit becoming distant on the rachis, stigma apical; weak plants with leaves and stems drying thin and often translucent.....57a.

56b. Fruit usually remaining crowded, stigma usually subapical on an oblique beak.....59a.

57a. Laminae and nodes glabrous; fruit sessile and longitudinally ridged in late stages; 0–1,500 m. altitude.....*P. pellucida.*

57b. Lamina and nodes with short hairs; fruit slightly pedicellate in late stages, not ridged.....58a.

58a. Hairs broad at the base, 0.1–1 mm. long; spikes becoming 5 cm. long; 1,500–2,800 m. altitude.....*P. hispidula.*

58b. Hairs thin, 0.03–0.2 mm. long; spikes to 20 cm. long; 800–2,000 m. altitude.....*P. cooperi.*

59a. Fruit narrowed at the base and basally attached on a conspicuous or very small pedicel articulate at the rachis, fruit becoming 1–2 mm. distant (longitudinally) on the rachis.....60a.

59b. Fruit rounded at the base and attached on or near the side (relative to the beak), a pedicel absent but a flattened pseudopedicel articulate beneath the ovary sometimes present, fruit 0.4–0.7 mm. long; succulent plants with the petiole often decurrent on the stem.....61a.

60a. Fruit with a very short pedicel, body of the fruit 0.6–0 7 mm. long, ellipsoid to ovoid; laminae drying thin and almost as broad as long, to 5 cm. long, the petiole not decurrent on the stem.....*P. cooperi.*

60b. Fruit with a pedicel 0.5–2 mm. long, body of the fruit 1–1.5 mm. long, obovoid; laminae drying stiff and usually half as broad as long, rarely to 35 mm. long, the petiole decurrent on the stem.....*P. tenella.*

61a. Plants conspicuously black-punctate on all parts; flowers and fruit usually separate on the punctate rachis; petiole usually with two adaxial rows of cilia.....*P. glabella.*

61b. Plants lacking conspicuous black dots, the flowers and fruit usually crowded or approximate on the rachis; petioles not ciliate.....62a.

62a. Erect plants 30–120 cm. tall with spreading branches, leaves usually drying thin with 5 (3) conspicuous veins and acuminate tip; spikes axillary or terminal (rarely leaf-opposed); montane forests (1,500–2,500 m.).
P. elata.

62b. Erect, repent, or pendant, plants rarely more than 30 cm. tall (leaves thin and with 5 conspicuous veins only in *P. alata* with spikes often leaf-opposed). The following species are a closely related group of very variable plants; they are capable of flowering in a depauperate condition and these smaller plants may be impossible to identify with certainty....63a.

63a. Peduncle 8–25 mm. long and about 0.5 mm. thick; leaves less than 2 cm. broad and very narrow in erect plants, the 3 major veins readily visible beneath; plants of lower (0–1,600 m.) altitudes.....*P. reptabunda.*

63b. Peduncle 4–15 mm. long or more than 1 mm. thick (dry) if longer than 15 mm.....64a.

64a. Laminae 1–3.5 cm. long, the larger broadly ovate to rhombic and nearly as broad as long; common plants of higher altitude (1,200–2,600 m.) forests.
P. hylophila.

64b. Laminae 2–11 cm. long, the larger usually elliptic to obovate or ovate and usually twice as long as broad; common plants between sea level and 2,000 m. elevation.....65a.

65a. Leaves drying subcoriaceous to chartaceous with the venation usually obscure, laminae obtuse to acute and often broadest at or above the middle, leaf-base obscurely decurrent on the stem; very common plants of usually compact form.....*P. angularis.*

65b. Leaves drying membranaceous to chartaceous with the venation always apparent, lamina tapering to the acute or acuminate apex, leaf-base obviously decurrent on the stem; plants usually few-branched, the stems with many long internodes ..... *P. alata*

66a. The inflorescence with fewer than 4 spikes or rarely with 4 spikes ..... 67a.

66b. The inflorescence with 4 or more spikes ..... 76a.

67a. Floral bracts 0.6–1 mm. long; lamina with minute hairs on the veins above; erect or creeping plants of high altitudes (1,800–3,000 m.) ..... *P. alpina.*

67b. Floral bracts less than 0.8 mm. long, leaves usually glabrous on the veins above ..... 68a.

68a. Climbing or repent plants with adventitious roots at almost all nodes, leafy internodes rarely contracted at the apex, laminae usually ovate .. 69a.

68b. Erect or occasionally repent plants not usually rooting at the upper nodes. 72a.

69a. Lamina drying chartaceous and the venation usually conspicuous, body of the fruit narrowly (0.2–0.5 mm.) ellipsoid, leafy internodes 0.7–3 mm. thick ..... 70a.

69b. Lamina drying stiff-chartaceous or subcoriaceous, the venation usually obscure, body of the fruit narrow but 0.4–0.7 mm. thick, leafy internodes 1.5–5 mm. thick, very succulent often pendulous plants ..... 71a.

70a. Inflorescence usually with 2 spikes; lamina 4–11 cm. long; fruit 0.8 × 0.4 mm. with the beak about 0.4 mm. long ..... *P. distachya.*

70b. Inflorescence with a single spike; lamina 1.8–5.5 cm. long; fruit 0.5 × 0.3 mm. with the beak about 0.5 mm. long ..... *P. serpens.*

71a. Lamina obtuse to cuneate at the base; body of the fruit cylindrical (1.7 × 0.7 mm.) with a developed (0.1–0.3 mm.) beak; anthers 0.2–0.4 mm. long ..... *P. macrostachya.*

71b. Lamina truncate to subcordate at the base; body of the fruit ovoid (1.4 × 0.5 mm.) with a poorly (0.1 mm.) developed beak; anthers 0.1–0.2 mm. long ..... *P. vinasiana.*

72a. Lamina broadly ovate, to 18 cm. long and 13 cm. broad, truncate to subcordate at the base, secondary veins prominent and arising from the lower half of the midvein; body of the fruit ovoid (about 0.8 × 0.4 mm.) with a beak to 0.6 mm. long ..... *P. syringifolia.*

72b. Lamina narrowly elliptic to obovate or ovate, if ovate and truncated at the base less than 10 cm. long, venation often obscure in large leaves .. 73a.

73a. Lamina to 30 cm. long and acute or short-acuminate at the apex; inflorescence often of a single large (+20 cm.) spike; fruit obovoid or cylindrical (1 × 0.5 mm.) and without a developed beak ..... *P. acuminata.*

73b. Lamina shorter or rounded at the apex; fruit usually with a developed beak ..... 74a.

74a. Lamina usually rounded or bluntly obtuse at the apex, drying subcoriaceous; body of the fruit ellipsoid or cylindrical (0.8 × 0.4 mm.) with unusual slender beak (0.5 × 0.05 mm.) ..... 75a.

74b. Lamina acute to obtuse at the apex ..... 76a.

75a. Larger leaves 6–16 cm. long and usually narrowly obovoid with attenuate base; flowering rachis 5–18 cm. long; sea level to 1,200 m. altitude. *P. obtusifolia.*

75b. Larger leaves 4–7 cm. long, broadly elliptic to broadly obovoid with obtuse base; flowering rachis 1–6.5 cm. long; 1,000–2,300 m. altitude. *P. pseudo-alpina.*

76a. Lamina puberulent with hairs 0.2–1.5 mm. long (at least on the young leaves) ..... 77a.

76b. Lamina glabrous or with hairs less than 0.2 mm. long; stems and petioles glabrous or puberulent..... 80a.

77a. Lamina puberulent above, secondary veins usually obscure beneath; spikes 5–18 cm. long; body of the fruit 0.8×0.6 mm. with short (0.3 mm.) recurved beak..... *P. omnicola.*

77b. Lamina glabrous above, secondary veins prominent beneath (dry); spikes 1–5 cm. long..... 78a.

78a. Fruit with a style-like beak, stigma subapical; leaves with 4–7 secondary veins, usually attenuate at the base; 0–800 m. altitude..... *P. tsakiana.*

78b. Fruit without a beak, stigma apical; leaves with 3–5 secondary veins. 79a.

79a. Lamina sparsely crisp-hairy on the veins beneath, tapering to the attenuate (acute) base..... *P. austin-smithii.*

79b. Lamina densely crisp-hairy on the veins beneath, rounded or obtuse and somewhat unequal at the base..... *P. guapilesiana.*

80a. Individual spikes usually less than 25 mm. long; fruit lacking a developed style-like beak; petioles to 4 cm. long..... 81a.

80b. Individual spikes usually more than 25 mm. long; fruit with a beak.... 82a.

81a. Inflorescence paniculate, spikes to 15 mm. long; lamina to 15 cm. long, drying chartaceous and the venation usually prominent..... *P. poasana.*

81b. Inflorescence with spikes in a racemose arrangement, spikes to 25 mm. long; lamina to 30 cm. long, drying subcoriaceous and the venation usually obscure..... *P. pernambucensis.*

82a. Petioles usually over 3 cm. long; spikes to 20 cm. long..... 83a.

82b. Petioles usually less than 3 cm. long..... 84a.

83a. Petioles and young stems minutely (0.5 mm.) puberulent, lamina to 16 cm. long, obtuse or rounded at the base; most common at middle altitudes (1,000–2,000 m.)..... *P. omnicola.*

83b. Petioles and young stems glabrous, lamina to 25 cm. long and usually attenuate at the base; plants of low altitude (0–1,000 m.) wet forests. *P. mameiana.*

84a. Body of the fruit ellipsoid to ovoid, 0.4–0.7 mm. thick, the beak 0.3–0.5 mm. long; flowering rachis drying 1–3 mm. thick, lamina usually elliptic to ovate or obovate, the secondary veins usually obscure, often drying pale in color or very pale beneath; very variable plants of higher (1,000–2,500 m.) altitudes..... *P. dotana.*

84b. Body of the fruit very narrowly ellipsoid or cylindrical, 0.2–0.3 mm. thick, the beak 0.1–0.3 mm. long; flowering rachis drying 0.7–1.5 mm. thick; lamina usually narrowly elliptic to oblanceolate and often drying dark in color. 85a.

85a. Secondary veins usually conspicuous on both surfaces (dry); anthers about 0.1 mm. long; body of the fruit 1–2 mm. long with a beak about 0.3 mm. long; plants of higher altitudes (1,000–2,500 m.)..... *P. lancifolia.*

85b. Secondary veins usually obscure on both surfaces (dry); anthers 0.2–0.3 mm. long; body of the fruit about 0.8 mm. long with a poorly developed beak; plants of lower altitude (500–1,500 m.) wet forests..... *P. lancifolioidea.*

Peperomia acuminata Ruiz & Pavon, Fl. Peruv. & Chil. 1:32. 1798. *P. queserana* Trel., Contr. U.S. Nat. Herb. 26:210. 1929. *P. cacuminicola* Trel., l.c. 215. *P. casitana* Trel., Ann. Mo. Bot. Gard. 27:301. 1940. *P. sarcodes* Trel., l.c. 304. *P. limana* Trel. & Standl., Fieldiana: Bot. 24, 3:255. 1952.

Epiphytic or terrestrial herbs, to 40 cm. tall, the stems erect or decumbent, to 20 cm. tall, leafy internodes 2–25 mm. long, 3–10 mm. thick, glabrous. Leaves alternate and usually crowded at the apex of the stem; petioles 2.5–7 cm. long, about 3 mm. thick (dry), grooved on the adaxial side and with a winged margin in the upper part continuous with the margin of the lamina, glabrous; lamina (10) 15–28 cm. long, 4–10 cm. broad, obovate to narrowly elliptic or oblanceolate, tapering to the acute or short acuminate apex, gradually tapering to the attenuate base, succulent and usually drying subcoriaceous, the margin often curled under on drying, glabrous, venation pinnate but often obscure, primary vein usually impressed above and prominent below, the 4 to 7 pairs of major secondary veins arising throughout the length of the midvein. Inflorescence terminal or leaf-opposed, simple with a nodose peduncle or compound of 2 or 3 spikes, to 30 cm. long, solitary at a node; peduncle 2–7 cm. long, 2.4–5 mm. thick, glabrous, bracteate in early stages, the bract to 15 mm. long and leaf-like, caducous, flowering rachis becoming 20 cm. long and 5 mm. thick, the flowers and fruit remaining crowded on the rachis; floral bracts 0.3–0.5 mm. long, pellucid punctate; anthers 0.2–0.3 mm. long; pistil borne on the surface of the rachis, the stigma surrounded by a ring of translucent tissue forming a disc-like structure on the ovary; fruit basally attached and erect or ascending, on the surface or in a slight depression on the rachis, body of the fruit obovoid or ellipsoid, 0.7–1 mm. long, about 0.5 mm. thick, the surface dark reddish pellucid verrucose but paler near the base, stigma apical and sessile on the paler colored tissue of the small (0.1 × 0.2 mm.) disc-like beak, the beak broad and flattened or slightly oblique.

Plants of the montane evergreen wet forests between 1,500 and 2,800 m. altitude. Ranging from Guatemala to South America and the West Indies; flowering throughout the year.

Very distinctive plants of short erect habit, larger succulent leaves, 1 or 2 spikes on a nodose peduncle, and fruit with a disc-like beak. I include here specimens ascribed by Yuncker to *P. adscendens* C.DC. Good examples of his interpretations of these taxa are to be found in the figures (403 and 404) in volume 2, *Piperaceae of Northern South America*. Despite their rather different appearance I believe that these are different forms of a single species. Only a single collection by Standley (*42637*, type of *P. cacuminicola*) among Costa Rican material conforms to Yuncker's delimitation of *P. acuminata*. In this the leaves are smaller and much thinner than the more typical material. Variation in related species (*P. mameiana*, et al.) leads me to believe that the differences between *P. acuminata* and *P. adscendens* sensu Yuncker are not of biological significance.

Peperomia alata Ruiz & Pavon, Fl. Peruv. & Chil. 1:31, pl. 48. 1798. *P. crispipetiola* Trel., Contr. U.S. Nat. Herb. 26:196. 1929. *P. rueltasana* Trel., l.c. 198. *P. niveo-punctulata* Trel., l.c. 199. *P.*

pilulifera Trel., l.c. *P. versicolor* Trel., l.c. 200. *P. martagonifolia* var. *contempta* Trel., l.c. 218. *P. alexanderi* Trel. in Standl., Field Mus. Bot. 18:307. 1937. Figure 1.

Herbaceous epiphytes, erect to 30 cm. tall or pendant or repent with few branched stems to 1 m. long, leafy internodes 1–4 cm. long, 1–3 mm. thick, usually with two longitudinal ridges continuous with the leaf-base, glabrous. Leaves alternate or sometimes opposite at the terminal flowering nodes, mostly distichous and evenly spaced along the stem; petioles 4–12 (16) mm. long, 0.7–2 mm. thick, deeply grooved adaxially, clasping the stem and decurrent at the base, glabrous; lamina 3–11 cm. long, 1.5–5 cm. broad, elliptic to obovate, gradually tapering to the acute or acuminate apex, gradually tapering to the acute or obtuse base, drying membranaceous to chartaceous, uniformly colored or somewhat paler beneath, glabrous or very minutely (0.1 mm.) puberulent at the tip, often minutely black-punctate on both surfaces, venation palmate or plinerved with 3 or 5 major veins, the 3 central veins united for as much as 1 cm. above the base, visible on both surfaces but more prominent below, the outer pair of veins usually not distinct beyond the center of the lamina. Inflorescence terminal, leaf-opposed, or axillary, solitary or 2 or 3 at the apex of a stem, simple, to 10 cm. long; peduncle 2–10 mm. long, about 1 mm. thick, glabrous, flowering rachis 1–2 mm. thick, the flowers crowded or becoming somewhat separated; floral bracts 0.5–0.6 mm. long, conspicuously pellucid-punctate; anthers 0.1–0.2 mm. long, often broader than long; pistil borne in a depression in the rachis; fruit subbasally or sublaterally attached in a depression in the rachis, a short (1 mm.) pseudopedicel sometimes produced in late stages, body of the fruit 0.5–0.6 mm. long, about 0.5 mm. broad, globose-ovoid, reddish pellucid verrucose, terminated by a short (0.1–0.2 mm.) beak of usually translucent tissue, stigma subapical on the beak.

Plants of wet or moist evergreen forest formations between sea level and 1,800 m. elevation; flowering from January to August and ranging from Mexico to northern South America and the West Indies.

Peperomia alata (in the broad or narrow sense) is closely related to *P. glabella, P. angularis, P. hylophila,* and *P. reptabunda* and this group of taxa are extremely difficult to separate on the basis of herbarium specimens. I am therefore using *P. alata* (an early name) in the broad sense to serve as a catch-all for those alternate leaved peperomias with larger, thinner laminae and small, almost laterally attached fruit that do not clearly belong to the other species mentioned above. Only studies of populations in the field can adequately deal with the problems presented by the dried herbarium material; see the discussion under *P. angularis.*

Peperomia alpina (Sw.) A. Dietrich, Sp. Pl. 185. 1831. *Piper alpinum* Swartz, Prodr. 15. 1788. *Peperomia durandi* C.DC., Bull. Soc. Bot. Belg. 30, pt. 1:225. 1891. *P. machaerodonta* Trel., Contr. U.S. Nat. Herb. 26:47. 1927. *P. pachyphlebia* Trel., l.c. 216. 1929.

Terrestrial and epiphytic herbs, stems erect or decumbent, to 40 cm. long, leafy internodes 4–40 mm. long, 2–4.5 mm. thick (dry), glabrous and often drying dark brown. Leaves alternate or occasionally subopposite, often crowded near the apex of the stem; petioles 6–35 (50) mm. long, 1–2 mm. thick, glabrous, deeply grooved adaxially, broadened at the base and clasping the stem; lamina 2.8–12 cm. long, 1.8–6 cm. broad, elliptic to obovate, usually obtuse at the apex, sometimes emarginate at the very tip, tapering to the acute or attentuate (less often obtuse to truncate) base, drying subcoriaceous and often much paler in color beneath than above, with minute pellucid dots on both surfaces, glabrous below but usually minutely (0.05–0.1 mm.) puberulent on the veins of the upper surface and near the apex, venation pinnate, raised above and often impressed beneath on drying, the 3 to 5 pairs of major secondary veins arising from throughout the length of the midvein, ascending. Inflorescences terminal, axillary, or leaf-opposed, solitary or 2 at a node, 5–20 cm. long, simple or more often compound with 2 or 3 spikes; common peduncle with 1 to 3 nodes and bracteate in early stages, to 6 cm. long, glabrous, individual spikes and their peduncles 6–15 cm. long, peduncles of the spikes 3–20 mm. long (in ours), flowering rachis 2–3.5 mm. thick, the flowers remaining crowded or becoming somewhat separated; floral bracts 0.6–1.1 mm. long, orange pellucid punctate; anthers 0.3–0.5 mm. long, surface of the thecae with a few pellucid dots; pistil borne in a depression in the glabrous rachis, the stigma edged by the translucent tissue of the slender beak; fruit basally attached within a depression in the rachis, erect, body of the fruit ellipsoid or narrowly ovoid, about 1 mm. long, and 0.6 mm. thick, reddish pellucid verrucose but with paler colored tissue at the base and beneath the beak, stigma sessile at the abaxial base of the style-like beak, the beak 0.5–1 mm. long and often recurved.

Plants of the higher mountains; collected between 1,500 and 3,000 m. elevation around the Meseta Central and the Cordillera de Talamanca in Costa Rica; flowering from January to September. Ranging from Mexico to South America (under a host of names) and the West Indies.

Very variable plants but distinctive because of the raised puberulent venation on the upper leaf-surface (otherwise glabrous), large floral bracts, usually compound inflorescences, and long-beaked fruit. This species is very closely related to *P. pseudo-alpina* and since both are very variable they are often difficult to distinguish. See the discussion under *P. pseudo-alpina* and *P. obtusifolia.*

Peperomia amphitricha Trel., Contr. U.S. Nat. Herb. 26:192. 1929. *P. amphitricha* var. *santa-rosana* Trel., l.c. *P. cerro-puntana* Trel., Ann. Mo. Bot. Gard. 27:301. 1940.

Climbing semisucculent herbs, epiphytic or terrestrial on moist slopes, stems few-branched or unbranched, rooting at most nodes, leafy internodes 2–6 cm. long, about 2–3 mm. thick (dry). Leaves alternate and peltate, evenly spaced along the stem; petioles 2.5–6.5 cm. long, about 0.8 mm. thick, attached 2–10

mm. from the basal edge of the lamina, glabrous near the base but with thin bent hairs to 0.8 mm. long near the lamina, the base clasping the stem; lamina 4–10 cm. long, 3–5.5 cm. broad, ovate and gradually tapering to the acuminate apex, rounded at the base, drying membranaceous to thin chartaceous, transculent or opaque and often paler beneath, glabrous or sparsely puberulent above, puberulent beneath but glabrous along the edge, venation palmate and visible on both sides, the 7 to 9 major veins free to the base. Inflorescence terminal or leaf-opposed, solitary at the node, to 20 cm. long, simple, peduncle about 3 cm. long and 0.5 mm. thick, crisp-puberulent with thin whitish hairs to 0.8 mm. long, flowering rachis becoming 16 cm. long and 3 mm. thick; flowers becoming separated (1 mm.) on the sparsely and minutely (0.1–0.2 mm.) puberulent rachis, floral bracts orbicular to oblong, 0.4–0.5 mm. long, occasionally acute at the apex, pellucid punctate; anthers about 0.2 mm. long, often broader than long; pistil borne on the surface of the rachis; fruit borne in a slight depression on the rachis, basally attached and ascending, about 0.7 mm. long, and 0.5 mm. thick, ellipsoid or narrowly ovoid, tapering abruptly to the apical fimbriate stigma, surface dark in color but smooth.

Plants of the evergreen oak forests between 1,500 and 2,500 m. elevation and known only from the vicinity of Sta. Maria de Dota and El Copey in Costa Rica. I include here material assigned to *P. cerro-puntana* from western Panama and Guatemalan material identified as *P. peltilimba*.

The long hairs, long inflorescences, and thin peltate leaves on climbing plants with long internodes distinguish this species. The smooth fruit with apical stigma and flowering rachis with short multicellular trichomes are unusual characteristics shared by the closely related *P. lanceolato-peltata* but the latter are small plants with short or congested internodes. *P. amphitricha* is known in Costa Rica from the following collections: *Tonduz 12225; Standley 41889, 42620,* and *43089a*.

Peperomia angularis C.DC. in DC., Prodr. 16, pt. 1:415. 1869. *P. chrysocarpa* C.DC., Bull. Soc. Bot. Belg. 29, pt. 2:70. 1891. *P. psiloclada* C.DC., Anal. Inst. Fis.-Geog. Costa Rica 9:176. 1897. *P. psiloclada* var. *magnifolia* C.DC. ex Schroeder, Candollea 3:132. 1926. *P. leucosticta* Trel., Contr. U.S. Nat. Herb. 26:46. 1927. *P. munyecoana* Trel., l.c. 197. 1929. *P. brachypus* Trel., l.c. 200. *P. stenophyllopsis* Trel., l.c. *P. achoteana* Trel. in Standl., Field Mus. Bot. 8:5. 1930. *P. incrassata* Trel. in Standl., l.c. 18:316. 1937. *P. storkii* Trel. in Standl., l.c. 326. *P. apellator* Trel. in Woodson & Schery, Ann. Mo. Bot. Gard. 27:300. 1940. *P. novae-helvetiae* Trel. in Woodson & Schery, l.c. 304. *P. rivi-vetusti* Trel. in Woodson & Schery, l.c. *P. coarctata* Trel. & Standley, Fieldiana, Bot. 24, 3:241. 1952. Figure 1.

Epiphytes or occasionally terrestrial plants, the basal stems often repent, erect stems usually less than 30 cm. tall, leafy internodes 3–45 mm. long, 0.8–3.5 mm. thick (dry), succulent and glabrous. Leaves alternate or subopposite at the apex of the shoot, often crowded near the ends of stems; petioles 2–12 (20) mm. long, 0.6–1.8 mm. thick, glabrous and with the cuticle often peeling off, deeply grooved on the adaxial side and decurrent on the stem; lamina 2–9 cm. long, 1–3.5 cm. broad, elliptic to obovate or occasionally ovate, usually broadest above the middle, obtuse to acute or sometimes rounded at the apex, acute to obtuse or attenuate at the base, glabrous or with a few minute hairs at the apex, drying chartaceous to subcoriaceous and opaque (membranaceous and translucent in newly expanded leaves), venation palmate but often obscure, the 3 major veins usually free to the base. Inflorescence terminal, axillary, or leaf-opposed, solitary at a node or 2 to 4 at the apex of the shoot, simple but rarely borne on a leafless shoot and apparently compound, 3–14 cm. long; peduncle 3–18 mm. long, 0.4–1.8 mm. thick, glabrous, flowering rachis 1.2–3 mm. thick, the flowers usually remaining closely congested on the glabrous rachis; floral bracts about 0.5 mm. long, pellucid-punctate; anthers 0.1–0.2 mm. long; pistil and fruit borne in a depression in the rachis; fruit sublaterally attached, whitish and somewhat crateriform at the point of attachment, body of the fruit 0.5–0.6 mm. long, 0.4–0.5 mm. thick, globose-ovoid and narrowed at the apex below the translucent tissue of the short (0.1 mm.) oblique beak, the stigma subapical on the abaxial side of the beak, surface of the fruit reddish pellucid verrucose, pseudopedicels absent or very short (0.2 mm.).

Very variable succulent plants ranging from 600 to 2,200 m. elevation in evergreen forest formations and collected in flower or fruit from November to June. The species is poorly defined at present but probably ranges from southern Mexico to Colombia and Ecuador.

Peperomia angularis is characterized by the very succulent alternate leaves, usually short thick flowering stems, and thick spikes crowded with fruit which appear to be attached on the side and possess a very small beak. While this is a common montane species in Central America, its circumscription and nomenclature are very uncertain. The plants placed here are closely related to a very variable species-group which includes *P. alata, P. hylophila, P. reptabunda,* and the black-punctate *P. glabella.* These plants all possess succulent alternate leaves, simple spikes, and small round fruit sublaterally attached to the rachis (with respect to the beak). Figure 1 illustrates well-developed specimens typical of four of these species. Poorly developed specimens may be impossible to identify in the dry condition. I have not seen the type and am using the name in a broader sense than Trelease and Yuncker (1950); *P. pennellii* Trel. & Yuncker is conspecific with this broader concept of *P. angularis. Peperomia san-joseana* C.DC. (Linnaea 37:372. 1872)

and *P. filicaulis* C.DC. in Pittier (Prim. Fl. Costaric. 2:282. 1899) may belong to this complex of species; I have only seen photographs of the types. See the discussion under *P. alata* and compare with *P. hylophila* and *P. reptabunda*.

Peperomia angustata H.B.K., Nov. Gen. & Sp. 1:68. 1815. *P. turialvensis* C.DC., Linnaea 37:380. 1872. P. *martagonifolia* C.DC. ex Schroeder, Candollea 3:128. 1926. *P. wercklei* C.DC. ex Schroeder, l.c. 135. *P. martagonifolia* var. *torresana* Trel., Contr. U. S. Nat. Herb. 26:219. 1929. *P. martagonifolia* var. *wercklei* (C.DC.) Trel., l.c. 219. *P. tacticana* Trel. & Standl., Fieldiana: Bot. 24, 3:272. 1952.

Terrestrial or epiphytic herbs, stems erect or scandent to 40 cm. long, leafy internodes 3–12 cm. long, 1–3 mm. thick, glabrous. Leaves opposite or whorled with 2 to 4 leaves per node; usually evenly spaced along the stem; petioles 6–20 mm. long, 0.4–1.2 mm. thick, glabrous or sparsely and very minutely (0.03 mm.) puberulent, deeply grooved adaxially; lamina 3.5–9 cm. long, 1.2–3.5 cm. broad, elliptic, gradually tapering to the acute or acuminate apex, the tip often slender, tapering to the acute or attenuate base, drying membranaceous to thin-chartaceous, occasionally translucent, usually slightly paler beneath, very minutely puberulent at the margin of the apex but glabrous on the surfaces, venation palmate with the 5 major veins separate to the base, the 3 central veins visible above and below. Inflorescence terminal or occasionally axillary, 1 to 4 per node, simple, 5–22 cm. long; peduncle 8–20 (35) mm. long, 0.7–1.5 mm. thick, glabrous or sparsely and very minutely (0.03 mm.) puberulent, flowering rachis 1–3 mm. thick and deeply ridged on drying, the flowers remaining crowded; floral bracts 0.4–0.5 mm. long, conspicuously pellucid punctate; anthers 0.2–0.3 mm. long; pistil borne in a deep depression in the rachis; fruit subbasally attached within a depression in the rachis and ascending, pseudopedicels apparently (rarely?) developed in late stages and 0.5–0.7 mm. long, body of the fruit 0.5–0.7 mm. long and 0.4–0.6 mm. thick, globose-ovoid, narrowed at the apex to form a short (0.1–0.2 mm.) style, stigma apical on the style, surface of the fruit reddish pellucid verrucose but often smoother and paler in color in the lower part (pseudocupule).

Plants of moist evergreen forest formations between 1,200 and 2,000 m. elevation. Collected between December and April around the Meseta Central in Costa Rica but ranging from Guatemala to Venezuela.

Distinguished by the thin opposite or whorled usually acuminate leaves, long internodes, long spikes, and fruit imbedded in the spike and with a terminal stigma. I am using *P. angustata* in the sense of Trelease and Yuncker (1950) and not Dahlstedt (1900) who states that the floral bracts reach 1 mm. in length. On the basis of style and stigma, this species is closely related to *P. pereskiaefolia* but differs

in the smaller bracts and stamens, thinner leaves, and different habitat.

Peperomia austin-smithii W. Burger, sp. nov.

Herbae erectae vel procumbentes, usque ad 50 cm. altae, caules plerumque sine ramis et cum radicibus adventitiis. Foliae alternae, petiolis 1–3 cm. longis, laminis 8–16 cm. longis et 3–5.8 cm. latis, anguste ellipticis, sparsim puberulis in pagina infera. Inflorescentiae terminales vel folliis oppositae, usque ad 15 cm. longae, compositae 12–30 spicarum, spicae 1–4 cm. longae, in turmis alternis vel ramis alternis; bractae circa 0.3 mm. latae, antherae 0.3–0.4 mm. longae, fructus 0.5–0.7 mm. longi et 0.3–0.4 mm. crassi, anguste obovoidei vel cylindracei, absque rostro, stigmate sessili et apicali. HOLOTYPUS: *Brenes 4855*, Field Museum 853568; ISOTYPUS: NY.

Erect or procumbent herbs, to 50 cm. tall, stems usually unbranched and with adventitious roots at many nodes, leafy internodes 7–25 mm. long, 1.5–3 mm. thick, glabrous. Leaves alternate and usually evenly spaced along the stem; petioles 1–3 cm. long, 2–4 mm. broad, glabrous or sparsely puberulent near the lamina, deeply grooved and thin-margined adaxially, the margin continuous with the margin of the lamina and clasping the stem at the base; lamina 8–16 cm. long, 3–5.8 cm. broad, narrowly elliptic, gradually tapering to the acute or short-acuminate apex, gradually tapering to the attenuate (or less often acute) base, drying thin chartaceous and dark in color, only slightly paler beneath (dry), glabrous above and sparsely puberulent beneath, the hairs 0.1–0.4 mm. long, venation pinnate with the major veins usually impressed above and prominent beneath, the 3 to 5 pairs of major secondary veins arising throughout the length of the midvein, arcuate ascending, the tertiary veins often visible beneath. Inflorescence terminal or leaf-opposed, to 15 cm. long, solitary at the node, compound of 12 to 30 spikes borne in alternate groups along the rachis or on alternate branches of the rachis, 1–4 cm. long, common peduncle 3–6 cm. long, about 1.5 mm. thick (dry), glabrous, flowering rachis 1.5–3.5 cm. long, about 1 mm. thick; flowers remaining crowded on the rachis; floral bracts about 0.3 mm. broad, conspicuously pellucid punctate; anthers 0.3–0.4 mm. long; fruit basally attached in a depression in the rachis, erect, body of the fruit 0.5–0.7 mm. long, 0.3–0.4 mm. thick, narrowly obovoid or cylindrical and abruptly rounded at the apex, reddish pellucid verrucose with somewhat darker tissue near the apex, stigma sessile and apical, a little translucent tissue sometimes present at the apex of the fruit but a beak not developed.

Known only from the wet mid-altitude forests around the Meseta Central between 800 and 1,600 m. altitude. I have seen the following collections: *Brenes 4855* and *13469* near San Ramon, *Austin Smith P.C. 151, H 343*, and *1600* near Zarcero. Of these, the type (*Brenes 4855*) was chosen because it possesses fruit and is duplicated in NY.

An unusual species distinguished by the compound inflorescence with short spikes and the unusual leaves with prominent venation and scattered hairs. Very closely related to *P. guapilesiana* and differing in the more glabrous parts, somewhat different leaf-form,

and higher altitude habitat. I have not seen altitudinal clines in other peperomias of this area and the lack of intermediates leads me to believe that these are distinct species. These species, together with such striking species as *P. pernambucensis* and *P. poasana*, seem to form a natural group characterized by complex inflorescences with short spikes and the form of the fruit.

Peperomia barbinodis Trel., Contr. U.S. Nat. Herb. 26:220. 1929. *P. turialvensis* var. *brachystachya* Trel., l.c. 219. *P. rata* Trel. in Standl., Field Mus. Bot. 18:323. 1937. *P. chiqueroana* Trel. in Woodson & Schery, Ann. Mo. Bot. Gard. 27:301. 1940.

Erect herbs, terrestrial or epiphytic, to 80 cm. tall, the stems usually widely branching, leafy internodes 3–9 cm. long, 1–3 mm. thick, glabrous but with short (0.5 mm.) hairs at the nodes and leaf-bases. Leaves opposite or whorled, 2 to 6 at a node, usually widely spaced along the stem; petioles 2–8 cm. long, 0.6–1.2 mm. thick, glabrous but with small crooked hairs at the base, grooved and slightly winged adaxially; lamina 3–6 cm. long, 0.8–2.8 cm. broad, elliptic, acute to short-acuminate at the apex, acute at the base, drying membranaceous to thin-characeous, with minute (0.2 mm.) hairs on the veins above and around the margin of the apex, glabrous and often glandular punctate beneath, venation palmate or plinerved with 3 major veins and a pair of smaller outer veins near the base, the major veins visible on both surfaces and united for as much as 5 mm. from the base, tertiary veins sometimes visible. Inflorescences terminal or axillary, 2 to 10 per node and often twice as many as the leaves, simple, 3–6 cm. long; peduncle 2–10 mm. long; 0.2–0.6 mm. thick, glabrous, flowering rachis 0.4–0.8 mm. thick, the flowers becoming separate on the glabrous rachis; floral bracts about 0.4 mm. long, thin-translucent and pellucid punctate, often becoming bent in the middle on drying; anthers 0.1–0.2 mm. long; pistil borne in a depression in the rachis; fruit subbasally attached on the rachis and eventually borne on a flattened pseudopedicel 0.3–0.5 mm. long, body of the fruit about 0.7 mm. long and 0.6 mm. thick, globose-ovoid, the surface pellucid verrucose, with paler translucent tissue forming a very short (0.1 mm.) oblique beak at the apex, stigma subapical on the beak.

Plants of wet evergreen forest formations between 800 and 2,000 m. altitude. Known only from a few collections in Costa Rica and a single collection in Panama. The specimens I have seen are: *Tonduz 10419* (US, the type), from near Juan Viñas; *Standley 41544*, Finca Las Concavas, Cartago; *Skutch 2675*, vicinity of El General (type of *P. rata*); and *Woodson, Allen, & Seibert 1025* (type of *P. chiqueroana*).

Very distinctive peperomias of tall habit, with thin opposite or whorled leaves, slender spikes with distant flowers, and fruit with a poorly developed beak. Closely related to *P. blanda* (Jacq.) H.B.K. and perhaps no more than a subspecific element of that wide-ranging species.

Peperomia candelaber Trel., Contr. U.S. Nat. Herb. 26:207. 1929. *P. gleicheniaeformis* Trel. in Standl., Field Mus. Bot. 18:315. 1937. *P. lankesteri* Trel. in Standl., l.c. 317.

Epiphytic or terrestrial, the erect flowering stems to 15 cm. tall, usually with several divergent lateral branches, leafy internodes 3–15 mm. long, 0.6–1.2 mm. thick, minutely (0.03–0.3 mm.) and usually densely puberulent. Leaves alternate or opposite at the flowering nodes, often slightly crowded at the ends of stems, occasionally distichous; petioles 2–10 mm. long, about 0.3 mm. thick, very minutely puberulent, deeply grooved adaxially but not usually decurrent on the stem; lamina 8–20 (26) mm. long, 5–10 mm. broad, rhombic to ovate or occasionally narrowly elliptic, usually tapering to the obtuse or acute apex, the tip often emarginate, obtuse or acute at the base, drying chartaceous and yellowish in color and somewhat darker above, opaque, minutely (0.05–0.2 mm.) puberulent at the apex but glabrous on the proximal surfaces, venation palmate with the 3 major veins usually obscure, the midvein with secondary veins. Inflorescences axillary or terminal, 1 or 2 at a node, simple, 15–40 mm. long, spikes often persisting on leafless nodes; peduncles 3–10 mm. long, 0.3–0.6 mm. thick, glabrous, flowering rachis 0.6–1 mm. thick, the flowers remaining congested or approximate on the rachis; floral bracts 0.4–0.5 mm. long, pellucid punctate; anthers 0.1–0.2 mm. long, often broader than long; pistil borne in a depression in the rachis; fruit laterally or sublaterally attached in a slight depression in the rachis and ascending, body of the fruit 0.4–0.6 mm. long, 0.4–0.5 mm. thick, globose-ovoid, reddish pellucid verrucose but whitish near the crateriform point of attachment, a very short (0.1 mm.) oblique beak of translucent tissue present at the apex of the fruit, stigma subapical on the abaxial side of the beak, the fruit usually becoming exserted on a short (0.3 mm.) flat pseudopedicel.

Plants of moist evergreen forest formations between 600 and 1,600 m. altitude. Endemic to Costa Rica; probably flowering throughout the year.

The small, alternate leaves, short, erect habit with divergent branches, and short spikes with laterally attached fruit distinguish this species. The axillary spikes and branching distinguish *P. candelaber* from the closely related *P. tenellaeformis*. Both species are related to a very difficult complex of peperomias characterized by alternate leaves, simple spikes, and more or less laterally attached small beaked fruit: see the discussion under *P. alata* and *P. angularis*.

Peperomia carpinterana C.DC., Anal. Inst. Fis.-Geog. Costa Rica 9:175. 1897, ex char. *P. dodgei* Trel. in Standl., Field Mus. Bot. 18:312. 1937.

Epiphytes with weak succulent stems to 25 cm. tall, leafy internodes 6–25 mm. long, 0.8–2 mm. thick and with longitudinal ridges when dry, short (0.1 mm.) puberulent. Leaves alternate on the upper part of the flowering stems but opposite or whorled on the lower parts or on the immature shoots, dimorphic with the upper alternate leaves conspicuously longer than the lower, usually

evenly spaced along the stem; petioles to 4 mm. long and about 1 mm. thick, grooved adaxially; lower lamina 8–18 mm. long, 3–6 mm. broad, obtuse or rounded at the apex, often subsessile, the upper (alternate) laminae 2–9 cm. long, 5–25 mm. broad, narrowly elliptic, tapering to the acute or short-acuminate apex, acute at the base, drying thin chartaceous or membranaceous and often translucent, minutely (0.1 mm.) puberulent on both surfaces, venation palmate and usually visible on both surfaces in larger leaves, the 3 major veins free to the base. Inflorescence axillary or terminal, usually solitary at the node, simple, 2–9 cm. long; peduncle 3–10 mm. long, about 0.5 mm. thick, puberulent, the flowers remaining approximate or becoming slightly separate on the rachis, conspicuously but minutely (0.1 mm.) puberulent; floral bracts 0.3–0.5 mm. long, thin and pellucid punctate, occasionally with minute marginal hairs; anthers about 0.1 mm. long and 0.2 mm. broad; pistil borne in a depression in the rachis; fruit apparently subbasally attached in a slight depression in the rachis, mature fruit not seen, body of the fruit about 0.5 mm. long and 0.5 mm. thick in the stages observed, probably becoming globose ovoid at maturity, the surfaces reddish pellucid verrucose, a short (0.1–0.2 mm.) beak of yellowish translucent tissue present at the apex of the fruit, stigma subapical in the center of the beak (or style?).

Known from only three collections in Costa Rica: *Pittier 6903* (the type, not seen), *Dodge & Thomas 4782* (Nov. 1, 1929), and *Quiros 772* (Nov. 13, 1937); all from between 1,400 and 1,800 m. elevation on Cerro Carpintera, Pica. Cartago. *Standley 58878* from Antigua, Guatemala, also appears to be this species.

This is the only Central American peperomia with a consistent transition of whorled to alternate leaves on the flowering stems. The very thin narrow leaves and the minutely puberulent flowering rachis further distinguish this species. It is not possible to suggest relationships in the abscence of mature fruit but the puberulent rachis suggests some affinity with *P. tetraphylla.*

Peperomia claytonioides Kunth, Ind. Sem. Hort. Bot. Berol. 11. 1847. *P. sciaphila* C.DC., Anal. Inst. Fis.-Geog. Costa Rica 9:175. 1897. *P. schizostachya* Trel., Bot. Gaz. 73:138. 1922.

Small acaulescent herbs developing from a usually globose hypogean tuber, the tuber becoming about 1 cm. thick (dry), the roots emerging from the upper part of the tuber near the leaf-bases. Leaves borne directly from the apex of the tuber, 2 to 7 per plant; petioles 4–15 cm. long, about 0.6 mm. thick and deeply ridged on drying, glabrous, attached at or just below the center of the lamina; lamina 3–9 cm. long, 2–6.5 cm. broad, ovate and tapering to the obtuse or acute apex, round to subcordate at the base, drying membranaceous to thin chartaceous and often translucent, glabrous on both surfaces, venation palmate, obscure above and prominulous beneath, the 7 to 9 major veins arising directly from the petiole attachment. Inflorescence borne at the apex of the tuber and apparently axillary, 1 to 8 per plant, 10–25 cm. tall, compound (rarely simple) of 2 or 3 spikes borne close together at the apex of the common peduncle, common peduncle

6–20 cm. long, about 0.5 mm. thick and furrowed when dry, glabrous; spikes 1–6 cm. long, often without a distinct peduncle, the flowering rachis about 0.4 mm. thick; the flowers becoming distant on the glabrous rachis; floral bracts 0.5–1.0 mm. long, oblong and acuminate distally; often bent in the center with the proximal part appressed to the rachis, membranaceous and translucent; stamens with short filaments, anthers 0.2–0.3 mm. long, often broader than long; pistil borne on the surface of the rachis, ellipsoid and narrowed at the base and apex, stigma terminal; fruit basally attached and ascending, 0.8–1.2 mm. long, 0.4–0.8 mm. thick, apparently ellipsoid or narrowly ovoid at maturity, gradually tapering to the style-like apex, stigma terminal on the style, about 0.1 mm. broad, surface of the fruit apparently smooth and not pellucid.

Plants of the forest floor and on moist rocks in wet evergreen forests between 500 and 1,500 m. elevation. Thus far collected only from the Meseta Central but ranging to Guatemala and flowering from May to August. The collections seen are: *Tonduz 9630* and *10106, Leon 842* and *858, A. Jimenez 3956*.

Closely related to *P. gracillima* and differing primarily in the compound inflorescences and leaf-form. Both species were placed by Hill in his subsection *Geophila* under subgenus *Tildenia* Miq., section *Eutildenia* Dahlst. These are the only species of *Peperomia* in Costa Rica in which both leaves and roots arise from the upper part of a globose tuber; both have peltate leaves. *Peperomia ovato-peltata* C.DC. (Jour. Bot. 4:132. 1866) is probably this species; I have only seen a photograph of the type.

Peperomia cooperi C.DC., Bull. Soc. Bot. Belg. 30, 1:226. 1891. *P. filispica* C.DC., Anal. Inst. Fis.-Geog. Costa Rica 9:177. 1897. *P. virillana* Trel., Contr. U.S. Nat. Herb. 26:198. 1929. *P. santanana* Trel. in Standl., Field Mus. Bot. 18:325. 1937.

Epiphytic or terrestrial herbs, usually erect and growing to a height of 35 cm., the main stem usually with a few divergent lateral branches, leafy internodes 1–8 cm. long, 1–3 mm. thick, with scattered minute (0.03–0.1 mm.) hairs especially at the nodes. Leaves alternate or sometimes opposite at the flowering nodes, rarely crowded at the ends of shoots; petioles (4) 8–30 mm. long, 0.3–0.8 mm. thick, grooved adaxially, minutely (0.03–0.1 mm.) puberulent; lamina 1.5–5 cm. long, 1–4 cm. broad, ovate to broadly elliptic or rhombic, usually broadest below the middle, tapering to the obtuse or acute apex, obtuse or rounded to truncate at the base, drying membranaceous or thin-chartaceous, opaque or translucent, glabrous or sparsely puberulent on the central surfaces but the margin and major veins more densely puberulent with hairs about 0.1 mm. long, the hairs usually ascending, venation palmate but the midvein with a pair of secondary veins, the 5 major veins free to the base and visible on both surfaces, the lower surface often somewhat paler in color when dried. Inflorescence terminal or leaf-opposed, solitary or paired, simple but occasionally borne on a leafless node and apparently compound, (3) 5–20 cm. long; peduncle 3–30 mm. long, 0.5–1.5 mm. thick, glabrous

or minutely puberulent, flowering rachis 0.4–1.5 mm. thick, the flowers becoming widely (1–2 mm.) separate longitudinally on the glabrous rachis; floral bracts 0.3–0.4 mm. long, often dark pellucid punctate; anthers about 0.2 mm. long; pistil borne in a depression in the rachis, narrowed at base and apex; fruit basally attached in a slight depression in the rachis, narrowed at the base and with a short pedicel articulate 0.1–0.2 mm. below the body of the fruit, body of the fruit 0.6–0.7 mm. long, 0.4–0.5 mm. thick, ellipsoid to ovoid, the surface pellucid verrucose or apparently pitted, stigma apical in the center of the short (0.1 mm.) beak-like apex of translucent tissue.

Plants of moist cloud forests between 800 and 2,000 m. elevation; collected primarily on the Caribbean side of the Meseta Central in Costa Rica and flowering between August and January. Ranging from Costa Rica northward to Guatemala.

Erect plants often growing on rocks; distinct because of their long thin spikes with distant flowers, fruit narrowed at the base and slightly pedicellate, and thin broad leaves with minute hairs. Apparently quite succulent and shrinking considerably on drying. I am assuming that the collection of J. J. Cooper distributed as *5927* by J. D. Smith is identical to Cooper's *141* and *192* cited by C. De Candolle. This material (and other specimens placed here) does not agree with Dahlstedt's placement of the species in the subgenus *Sphaerocarpidium* near *P. alata*. The fruit, as I interpret it, indicates a relationship with *P. pellucida* and *P. pseudo-dependens*.

Peperomia costaricensis C.DC., Bull. Soc. Bot. Belg. 30, pt. 1:228. 1891, ex char. *P. fimbribractea* Trel., Contr. U.S. Nat. Herb. 26:196. 1929. *P. fimbribractea* var. *sparsipila* Trel. l.c. *P. disparifolia* Trel. in Standl., Field Mus. Bot. 18:312. 1937. *P. tenuinervis* Trel. in Standl., l.c. 327.

Epiphytes or occasionally terrestrial, stems repent and rooting at the lower nodes or erect to 35 cm. tall, leafy internodes 1–5 cm. long, 0.7–3 mm. thick, densely puberulent, the hairs slender and yellowish in color but becoming brownish, about 0.5 mm. long. Leaves alternate or opposite beneath the inflorescences, usually evenly spaced along the stem; petiole 4–35 mm. long, 0.5–1.8 mm. thick, densely puberulent with slender hairs 0.3–1 mm. long; lamina 2–6.5 cm. long, 1.5–4 cm. broad, elliptic to ovate or rhombic, rarely orbicular, broadest at or just below the middle, tapering to the obtuse or acute apex, the tip often blunt or rounded, tapering to the obtuse base or occasionally rounded, drying thin to stiff chartaceous and opaque, often dark on both surfaces, puberulent with slender appressed hairs to 1 mm. long on both surfaces, venation palmate with the 3 central veins united near the base or pinnate with the single pair of secondary veins arising from the lower third of the mid-vein, the major veins usually obscure. Inflorescences terminal or axillary, solitary or rarely 2 at a node, simple, 6–14 cm. long, 0.8–2 mm. thick, densely puberulent, flowering rachis about 2.5 mm.

thick and puberulent or sometimes glabrous, the flowers and fruit remaining closely congested; floral bracts 0.3–0.5 mm. broad with a margin of conspicuous (0.1–0.2 mm.) cilia, dark pellucid punctate centrally; anthers about 0.2 mm. long; pistil borne in a depression in the rachis; fruit basally or subbasally attached in a depression in the rachis and ascending, body of the fruit 0.7–0.8 mm. long, 0.5–0.6 mm. thick, globose ovoid to obovoid, the upper surface with conspicuous (0.05 mm.) reddish dots but the lower half smoother and paler in color, a short (0.1–0.2 mm.) oblique beak of darker pellucid tissue present at the apex of the fruit, stigma subapical in the center of the beak.

Plants of the wet evergreen forest formations on the Caribbean slopes and around the Meseta Central between 500 and 1,700 m. elevation. Ranging from Guatemala to Costa Rica; flowering from July to March.

Very distinctive peperomias with dense puberulence (at least on the younger parts), usually solitary spikes on unbranched stems with alternate leaves, and puberulent flowering rachis with ciliolate floral bracts. Closely related to *P. tuisana* but differing in the bracts and with a slightly different fruit. These two species are very similar in their overall appearance and it may be that they are not specifically distinct. In Costa Rica *P. costaricensis* is by far the more common.

Peperomia cyclophylla Miq. in Mart. Fl. Bras. 4(1):219. 1852, name only; in Seemann, Bot. Voy. Herald, 198. 1854.

Small repent herbs rooting at most nodes, erect flowering stems less than 5 cm. tall, leafy internodes 5–25 mm. long, 0.4–1 mm. thick, sparsely puberulent with erect hairs 0.1–0.2 mm. long, becoming strongly ridged on drying and with the cuticle peeling off, epidermal cells readily visible (0.03 mm.) with a hand lens. Leaves opposite and evenly spaced along the stem; petioles 0.5–2 mm. long, about 0.5 mm. thick, minutely puberulent or with the cuticle flaking off, slightly grooved adaxially; lamina 4–12 mm. long, 4–12 mm. broad, orbicular, rounded and slightly emarginate at the apex, rounded to obtuse at the base, the lower margin sometimes continuous over the petiole and the lamina subpeltate, succulent but drying thin to stiffly chartaceous, usually opaque and grayish with the margin curled under, sparsely puberulent with bent hairs 0.1–0.3 mm. long, the hairs conspicuous along the edge. Inflorescence terminal and solitary or on a short leafless axillary branch and apparently axillary, 1.5–3.5 cm. long, simple but with a nodose peduncle, the peduncle 6–18 mm. long, puberulent, with a whorl of 2 to 4 bracts (undeveloped leaves?), the bracts about 2 mm. long, flowering rachis about 1 mm. thick and glabrous, the flowers remaining approximate on the rachis; floral bracts 0.3–0.4 mm. long, pellucid punctate and thin-translucent; anthers about 0.2 mm. long; pistil deeply immersed in a depression in the rachis, stigma apparently apical; fruit not seen, probably lacking a beak.

Creeping epiphytes of the seasonally dry deciduous forests (0–1,000 m. elevation) on the Pacific slope of Costa Rica. Ranging from Guatemala (as *P. lenticularis*) to Brazil and the West Indies.

Very distinctive plants by virtue of their seasonally dry habitat and the node or bracts on the peduncle. Differing from other small opposite-leaved peperomias with rounded laminae in the bracteate peduncle and puberulent leaf-margin. I have seen none of the type material and am following Yuncker's interpretation. This species is closely related to *P. quadrangularis* (Thomps.) A. Dietr. and may be a smaller form adapted to drier conditions.

Peperomia deppeana Schlecht. & Cham., Linnaea 5:75. 1830. *P. rothschuhii* C.DC. ex Loes., Engl. Bot. Jahrb. 26:95. 1900. *P. compaginata* Trel., Contr. U.S. Nat. Herb. 26:223. 1929. *P. imbricata* Trel., l.c. 224. *P. pseudo-hoffmannii* Trel., l.c. 225. *P. pseudohoffmannii* var. *lenticularis* Trel., l.c.

Epiphytic herbs, repent and with erect flowering stems usually less than 10 cm. tall, leafy internodes 3–15 (20) mm. long, 0.4–0.9 mm. thick, glabrous or very minutely (0.05 mm.) puberulent. Leaves in whorls of 3 or 4 or rarely opposite, usually evenly spaced along the stem; petioles 0.5–2 mm. long, about 0.4 mm. thick, glabrous or very minutely (0.05 mm.) puberulent, often with the cuticle flaking off, slightly grooved on the adaxial side; lamina 3–10 mm. long, 3–7 mm. broad, broadly obovoid, ovoid, or orbicular, usually broadest above the middle, rounded and often emarginate at the apex, obtuse to rounded at the base or apparently cuneate when folded up on drying, stiffly chartaceous or subcoriaceous and yellowish when dry, upper and lower surfaces glabrous but minutely (0.05–0.1 mm.) ciliolate along the margin near the apex, the margin revolute when dried, venation palmate but obscure, small pellucid dots in crateriform depressions sometimes visible (10×) on the surfaces. Inflorescence terminal and solitary, simple, to 35 mm. long; the peduncle 4–12 mm. long, 0.4–1 mm. thick, glabrous or very minutely (0.05 mm.) puberulent, flowering rachis 6–22 mm. long and about 1.5 mm. thick, very minutely hispidulous, the hairs about 0.03 mm. long but occasionally to 1.2 mm., the rachis prominently ridged on drying, the flowers remaining approximate on the rachis; floral bracts 0.2–0.3 mm. long, somewhat concave with reddish pellucid dots in the center surrounded by a peripheral rim (this distinction very striking in some specimens but obscure in others); anthers 0.2–0.4 mm. long, 0.1–0.2 mm. broad; pistil borne in a deep depression in the rachis; fruit basally attached and erect within the depression in the rachis (a pseudopedicel not seen in our material), body of the fruit about 0.6 mm. long and 0.3 mm. thick, ovoid to cylindrical, surface reddish pellucid verrucose but smoother and often yellowish in the lower thicker half (pseudocupule), tapering to a short (0.2–0.3 mm.) conical style of yellowish translucent tissue, stigma terminal on the style.

Plants of the wet evergreen forest regions between sea level and 1,500 m. elevation and presently known only from the Caribbean slope, the Meseta Central and the Cerro de Guanacaste in Costa Rica. Ranging from Mexico southward to Brazil (fide Dahlstedt); apparently flowering throughout the year.

This species differs from the closely related *P. tetraphylla* in the smaller parts and fruit with definite style. Together, these species are distinctive among Costa Rica's peperomias because of their puberulent flowering rachis and the succulent little leaves in whorls. A photo of *Deppe 12* (FM negative 10783), reputed to have been the type in the Berlin herbarium, matches our material rather well.

Peperomia distachya (L.) A. Dietrich, Sp. Pl. 1:156. 1831. *Piper distachyon* L., Sp. Pl. 30. 1753. *Peperomia calvicaulis* C.DC., Bull. Soc. Bot. Belg. 30, pt. 1:231. 1891. *P. calvicaulis* var. *perexigua* Trel., Contr. U.S. Nat. Herb. 26:214. 1929. *P. calvicaulis* var. *hydnostachya* Trel., l.c. *P. calvicaulis* var. *ovata* Trel., l.c. *P. antennifera* Trel. in Standl., Field Mus. Bot. 18:308. 1937.

Epiphytic herbs, stems climbing or repent and rooting at most nodes, leafy internodes 1.5–7 cm. long, 1–3 mm. thick (dry), glabrous or sparsely puberulent, the hairs thin and twisted on drying, 0.1–0.3 mm. long. Leaves alternate and occasionally subpeltate, usually well spaced along the stem; petioles 1.5–8 cm. long, 0.6–2 mm. thick, glabrous or sparsely and minutely (0.1–0.3 mm.) puberulent, deeply grooved and the margins slightly winged on the adaxial side, clasping the stem at the base; lamina 3.8–11 cm. long, 1.5–5 cm. broad, ovate or elliptic, gradually tapering to the usually short-acuminate apex, abruptly narrowed or rounded at the obtuse to truncate base but occasionally tapering gradually to an acute base, rarely with the marginal tissue united across the petiole and the lamina subpeltate; drying thin- to stiffly-chartaceous and usually much paler in color beneath, sparsely puberulent beneath and at the base of the lamina, venation pinnate or subpalmate and often obscure, usually with 3 or 4 pairs of major secondary veins arising from the lower half of the midvein, arcuate ascending. Inflorescence terminal or leaf-opposed, to 12 cm. long, solitary or paired at the node, compound of 2 (rarely 1, 3, or 4) spikes on a common bracteate peduncle, the bract caducous, common peduncle 14–40 mm. long, 0.7–2 mm. thick, sparsely and minutely puberulent or glabrous, peduncles of the spikes often unequal in length, 5–20 mm. long, flowering rachis 22–52 mm. long, about 1.8 mm. thick, the flowers remaining crowded; floral bracts about 0.3 mm. long, pellucid punctate; anthers 0.2–0.3 mm. long; pistil borne in a depression in the rachis; fruit basally attached within a depression in the rachis, ascending, to 1.5 mm. long, body of the fruit narrowly ellipsoid or cylindrical, 0.7–1 mm. long, 0.3–0.5 mm. thick, surface pellucid verrucose, stigma borne at the abaxial base of the style-like beak, the beak 0.3–0.5 mm. long.

Plants of wet evergreen forests between sea level and 2,200 m. altitude but collected most often between 800 and 1,200 m. in Costa Rica and flowering between November and May. Ranging from Mexico to South America and the West Indies and to be expected throughout the moister regions of Costa Rica.

The species is recognized by the usually 2-parted inflorescence, with beaked ascending fruit, long petiolate leaves of medium size,

and climbing habit. Closely related to *P. serpens;* the placement and illustration of this species appears to be incorrect in Dahlstedt's (tab. 2, fig. 32. 1900) study.

Peperomia dotana Trel., Contr. U.S. Nat. Herb. 26:215. 1929. *P. isidroana* Trel., l.c. *P. navarrana* Trel., l.c. *P. venabulifolia* Trel., l.c. 26:209. 1929. *P. venabulifolia* (?) var. *amplectens* Trel. in Standl., Field Mus. Publ. Bot. 18:329. 1937. *P. duricaulis* Trel. in Woodson & Schery, Ann. Mo. Bot. Gard. 27:302. 1940.

Succulent herbs, epiphytes or terrestrial, stems erect or procumbent, to 25 (35) cm. tall, leafy internodes 3–40 mm. long, 1.5–7 mm. thick (dry), succulent and reddish when alive but deeply furrowed on drying, glabrous. Leaves alternate and often crowded at the shoot apex; petioles 0–30 mm. long, 1–4 mm. thick, grooved and often winged on the adaxial side, clasping the stem at the base, glabrous; lamina 5–17 cm. long, 1.8–5 cm. broad, elliptic to obovate or oblanceolate, short acuminate or acute at the apex, tapering to the obtuse to attenuate base, succulent but drying thin- to thick-chartaceous and usually much paler in color beneath, glabrous or occasionally minutely (0.1 mm.) ciliolate on the margin, venation pinnate but often obscure, the 3 to 7 pairs of major secondary veins arising throughout the length of the midvein. Inflorescence usually axillary and solitary, occasionally 1 to several and terminal, to 35 cm. long, compound of 3 to 15 divergent (in age) spikes on an unbranched or few branched axis, the spikes usually in alternate pairs along the main axis and 2 to 4 spikes terminally, common peduncle 3–18 cm. long, about 2 mm. thick and glabrous, peduncles of the spikes 4–20 mm. long, the spikes 4–16 cm. long, flowering rachis 1–3 mm. thick, the flowers remaining approximate or becoming slightly separated on the rachis; floral bracts 0.4–0.7 mm. long, pellucid punctate; anthers 0.2–0.3 mm. long; pistil borne in a depression in the rachis; fruit basally attached and borne within a depression in the rachis, erect or somewhat ascending, body of the fruit 0.7–0.9 mm. long, about 0.4 mm. thick, narrowly ovoid or ellipsoid, the surface reddish pellucid verrucose, stigma sessile at the abaxial base of the style-like beak, the beak 0.3–0.5 mm. long, usually recurved.

Plants of wet forests between 1,000 and 2,500 m. altitude; flowering throughout the year. The species ranges from Costa Rica southward to Panama and possibly as far as Ecuador (as *P. ternata* C.DC.) and Venezuela (as *P. decurrens* C.DC.).

A very variable group of specimens that I believe represent a single species. Characterized by the glabrous succulent vegetative parts, compound inflorescences with spreading spikes (in age), and beaked fruit. The leaves are strikingly different in different collections; from lanceolate and sessile with clasping base to long (3 cm.) petiolate and elliptic. Likewise, the inflorescences vary over a range that could easily encompass several species. However, the large number of collections available bridge the extremes so that segregation of meaningful taxa is impossible. Variations in drying contribute

to some of the differences seen on the herbarium sheets. I have seen my own collection of a robust and succulent inflorescence turn into a thin dried specimen very different from the original and quite different from other specimens. Closely related to *P. omnicola* as well as the species mentioned above.

Peperomia ebingeri Yuncker, Ann. Mo. Bot. Gard. 53:263. 1966.

Small repent or climbing epiphytes, rooting at most nodes, flowering stems less than 3 cm. tall, leafy internodes 3–20 mm. long, about 0.2 mm. thick (dry), hirtellous with slender hairs 0.3–0.5 mm. long. Leaves alternate and usually evenly spaced along the stem; petioles 1–3 mm. long, 0.1–0.2 mm. thick, minutely puberulent; lamina 2–5.5 mm. long and equally broad, orbicular to very broadly elliptic or ovate, rounded at the apex and base, drying membranaceous to thin-chartaceous, translucent or opaque, puberulent with hairs 0.4–0.9 mm. long on both surfaces, venation palmate with the midvein branched above the base, the major veins 3 and usually obscure. Inflorescence terminal or leaf-opposed, solitary and simple, 7–16 mm. long; peduncle 3–8 mm. long, 0.2–0.3 mm. thick, minutely (0.2–0.3 mm.) hispidulous, sometimes subtended by a leafless node, flowering rachis 4–10 mm. long, sometimes with hairs at the base or with a granular surface, 0.5–1 mm. thick, the flowers congested in early stages (in ours) and becoming separated; floral bracts 0.1–0.3 mm. long, with 1 to 5 setose hairs 0.03–0.3 mm. long and about 0.03 mm. thick, the hairs usually at the edge of the bract, obscurely punctate; anthers 0.1–0.2 mm. long; pistil borne in a slight depression in the surface; fruit subbasally attached on the surface of the rachis, body of the fruit 0.4–0.5 mm. long and 0.3–0.4 mm. thick, globose-ovoid, the surface pellucid verrucose, contracted at the apex to form a slightly oblique beak-like tip, the stigma apical or subapical, the fruit becoming exserted on a short (0.5 mm.) pseudopedicel in later stages.

Minute plants of the Caribbean lowland evergreen forest formation. The species is known to me from only four collections: *Ebinger 165* from Barro Colorado Island, Panama; *Burger & Stolze 5093* and *5103*, near Aguas Zarcas, Pcia. Alajuela; and *Jones & Facey 3350*, vicinity of Lago Izabal, Guatemala; flowering in May and June.

A species distinguished by its very small alternate round leaves, minutely setose bracts, and short inflorescences. The plants placed here are obviously closely related to *P. rotundifolia* and differ primarily in the bracts and the fruit born on pseudopedicels in late stages. These differences may not distinguish biologically valid species but they can serve to segregate these unusual little plants until they can receive more intensive study; see the discussion under *P. rotundifolia*.

Peperomia elata C.DC. ex Schroeder, Candollea 3:124. 1926. *P. parietariaefolia* Trel., Contr. U.S. Nat. Herb. 26:45. 1927. *P. carpinterana* var. *sparsipila* Trel., l.c. 197. 1929. *P. herediana* Trel., l.c. 197. *P. pseudopedicellata* Trel., l.c. 198. *P. seibertii* Trel. in Woodson & Seibert, Ann. Mo. Bot. Gard. 24:185. 1937.

Usually erect terrestrial herbs, to about 1 m. tall with a single main stem and spreading branches producing a shrub-like aspect; leafy internodes 1.5–6 cm. long, 0.8–3.5 mm. thick, often with two thin longitudinal ridges continuous with the decurrent leaf-base, glabrous or rarely puberulent. Leaves alternate and often distichous, usually well spaced along the stem; petioles 2–8 (15) mm. long, 0.6–1.5 mm. thick, deeply grooved and slightly wing-margined adaxially, decurrent on the stem at the base, usually glabrous; lamina 3–10 cm. long, 1.5–5 cm. broad, elliptic to narrowly ovate, gradually tapering to the acuminate or occasionally acute apex, tapering or rarely somewhat rounded at the acute to obtuse or attenuate base, drying membranaceous to thin-chartaceous and usually paler in color beneath, glabrous on both surfaces with minute (0.2 mm.) hairs along the edge at the apex or rarely with larger (0.4–1 mm.) crooked hairs on the lower surface and petiole, venation palmate and visible on both surfaces, the 3 to 5 major veins free or united at the base, the lower surface often minutely pellucid punctate. Inflorescence axillary or terminal (rarely leaf-opposed), 1 to 3 at a node, simple, 4–12 cm. long; small bract-like structures often present at the base of the spike; peduncle 4–14 mm. long, 0.6–1.2 mm. thick, glabrous, flowering rachis 1–1.6 mm. thick, the flowers becoming distant on the rachis; floral bracts about 0.5 mm. long, pellucid punctate; anthers 0.2–0.3 mm. long; pistil borne in a depression in the rachis; fruit subbasally attached in a depression in the rachis and elevated on a pseudopedicel (0.5–2 mm. long) in late stages, body of the fruit 0.5–0.6 mm. long and about 0.5 mm. thick, globose-ovoid, dark reddish pellucid verrucose, with a very short (0.05–0.1 mm.) beak of translucent tissue at the apex, stigma apparently subapical on the slightly oblique beak.

Distinctive terrestrial plants of erect habit in the shade of evergreen montane forest between 1,500 and 2,500 m. altitude. Ranging from Honduras to Chiriqui, Panama, and flowering from February to July.

Differing from all other Costa Rican peperomias with alternate leaves in the usually erect open-branched habit more than 30 cm. tall, thin acuminate laminae, and fruit finally borne on long pseudopedicels (rare in collections). This species is very closely related to *P. alata* but the latter has leaf-opposed spikes and is found at lower altitudes.

Peperomia emarginella (Sw.) C.DC. in DC., Prodr. 16, 1:437. 1869. *Piper emarginellum* Swartz ex Wikstrom, Vet. Akad. Handl. Stockh. 56. 1828. *Peperomia late-ovata* Trel., Contr. U.S. Nat. Herb. 26:191. 1929. *P. late-ovata* var. *glabrata* Trel., l.c. *P. delicatissima* var. *venusta* Trel. in Standl., Field Mus. Bot. 18:1544. 1938.

Delicate epiphytes with slender repent or procumbent stems, leafy internodes 2–6 mm. long, about 0.2–0.5 mm. thick (dry), glabrous or with thin bent hairs and often minutely dark punctate. Leaves alternate throughout and quite evenly spaced along the stem; petioles about 1–2 mm. long and 0.2 mm. thick, glabrous or sparsely puberulent, decurrent on the stem; lamina 2–8 mm. long, 2–8 mm. broad, ovate to orbicular or reniform, obtuse to rounded or emarginate at the apex, rounded and truncate to subcordate at the base, drying membranaceous and translucent, glabrous or with small (0.2–0.8 mm.) crooked hairs on the upper surface or along the edge, venation palmate but obscure, with 3 or 5 maior veins, a faint submarginal vein present near the edge. Inflorescence terminal or occasionally axillary, solitary or rarely paired at a node, simple, 2–4 cm. long; peduncle to 10 mm. long, about 0.3 mm. thick and translucent when dried, glabrous, flowering rachis 0.2–0.5 mm. thick, the flowers fewer than 15 on an inflorescence and distant on the glabrous rachis; floral bracts 0.2–0.5 mm. long, very thin and inconspicuously pellucid punctate, often bent in the middle with the proximal half appressed to the rachis; anthers about 0.2 mm. long; pistil borne on the rachis, ellipsoid; fruit basally attached and becoming pedicellate, the pedicel about 1 mm. long and 0.1 mm. thick, body of the fruit 1–1.2 mm. long and 0.3–0.5 mm. thick, narrowly obovoid, the surfaces smooth and pale brown or reddish in color, a disc-like conical apex of darker tissue present and abruptly narrowed to form a short (0.1–0.2 mm.) style, stigma apical on the style.

Very slender and apparently short-lived plants collected between 300 and 2,000 m. elevation in Costa Rica; flowering throughout the year. Often found on slender branchlets or in moss in wet evergreen forest formations. Ranging from Central America to northern South America and the West Indies.

This is one of the smallest and most delicate species of *Peperomia*. The minute leaves often as broad as long, slender spikes with few and distant flowers, and pedicellate fruit further characterize this species. Vegetative material is very similar to *P. rotundifolia* and differs from that species in the smaller emarginate leaves with consistently short petioles; flowering and fruiting material separates the two species easily. The unusual fruit indicate a close relationship with *P. tenella* and perhaps *P. pittieri*.

Peperomia emiliana C.DC., Anal. Inst. Fis.-Geog. Costa Rica 9:179. 1897. *P. staminea* Trel., Journ. Wash. Acad. Sci. 19:328. 1929. *P. pirrisana* Trel., Contr. U.S. Nat. Herb. 26:223. 1929. *P. bocasensis* Trel., Ann. Mo. Bot. Gard. 27:300. 1940.

Epiphytic herbs, stems repent and rooting at most nodes, flowering directly from the rooting stems, leafy internodes 15–70 mm. long, 1.2–2 mm. thick, and deeply ridged on drying, often reddish when alive, glabrous or very minutely (0.05 mm.) puberulent, the hairs usually ascending. Leaves opposite or whorled, 2, 3, or 4 at a node, evenly spaced along the stem; petioles 2–6 mm. long, 0.6–1 mm. thick, very minutely (0.05 mm.) puberulent, grooved adaxially; lamina 1.5–3.5 cm. long, 0.8–2 cm. broad, broadly elliptic to ovate or rarely suborbicular,

somewhat rounded base, drying subcoriaceous and usually pale grayish in color, essentially glabrous but with minute hairs at the apex and occasionally on the surfaces, venation palmate with the 3 major veins usually obscure and separate to the base. Inflorescence axillary or terminal, usually solitary at each node, simple, to 16 cm. long; peduncle 25–45 mm. long, 0.4–1 mm. thick, sparsely and very minutely (0.05 mm.) puberulent, flowering rachis about 1.3 mm. thick, glabrous, the flowers remaining approximate on the glabrous deeply ridged rachis; floral bracts distinctly oblong or elliptic, 0.5–0.7 mm. long and about 0.3 mm. broad, obscurely pellucid punctate but with a translucent margin; anthers 0.3–0.4 mm. long; pistil borne in a depression in the rachis; fruit subbasally attached in a depression in the rachis, ascending, (pseudopedicel rarely produced), body of the fruit 0.6–0.8 mm. long, about 0.5 mm. thick, ovoid to globose-ovoid, the surface reddish pellucid and verrucose or relatively smooth, tapering to the short (0.1–0.2 mm.) style-like apex of yellowish translucent tissue, stigma apical on the somewhat oblique style.

Plants of the lowland wet forests of the Caribbean slope. The species, as here defined, ranges from Honduras to Panama along the Caribbean watershed below 1,000 m. elevation.

This species is distinguished by the thick, medium-sized, opposite or whorled leaves on rooting stems, and inflorescences with unusual floral bracts and large anthers. It often resembles *P. rhombea* in leaf-form but its relationships appear to be with a poorly known group of species all characterized by the succulent whorled leaves drying grayish, long spikes, and unusually large anthers and oblong bracts. This group of species includes *P. victoriana* C.DC. of northern South America, *P. trifolia* (L.) A. Dietr. of the West Indies, and *P. pereskiaefolia*. The description of this species is based on *J. D. Smith 6740* (type of *P. emiliana*), *Standley 54614* (Honduras, type of *P. staminea*), and *Woodson, Allen, & Seibert 1859* (Panama, type of *P. bocasensis*). The description of *P. pirrisana* was based on sterile material (*Lankester 1166* in US).

Peperomia esperanzana Trel., Contr. U.S. Nat. Herb. 26:222. 1929. *P. stipitifolia* Trel., l.c. 220. 1929.

Epiphytic or occasionally terrestrial herbs, erect with few-branched flowering stems to 35 cm. tall, leafy internodes 1–3 cm. long, 1–4 mm. thick, crisp-puberulent with curved hairs about 0.5 mm. long. Leaves opposite or sometimes alternate, usually paired at the node; petioles 3–20 mm. long, 0.4–1 mm. thick, crisp puberulent and grooved adaxially; laminae quite variable in shape on different plants, 1–4 cm. long, 1–2.6 cm. broad, ovate or elliptic to suborbicular, occasionally acute but more often obtuse to rounded and emarginate at the apex, obtuse to rounded at the base, drying thin-chartaceous and usually paler in color beneath, sparsely puberulent on both surfaces, the hairs curved and about 0.5 mm. long, venation palmate and usually visible beneath (dry), the 3 major veins separate to the base, a pair of marginal veins sometimes visible. Inflorescences terminal or axillary,

1 to 4 per node, simple, 2.5–8 cm. long; peduncle 4–14 mm. long, 0.5–1 mm. thick, appressed puberulent, flowering rachis about 1 mm. thick, glabrous, the flowers becoming separate on the rachis; floral bracts 0.6–0.7 mm. long, yellowish or orange pellucid punctate; anthers 0.2–0.3 mm. long; pistil borne in a depression in the rachis; fruit subbasally or sublaterally attached in a slight depression on the rachis, body of the fruit about 0.7 mm. long and 0.7 mm. thick, globose-ovoid, reddish pellucid verrucose, paler in color around the crateriform point of attachment, narrowed to the paler translucent tissue of the short (0.1 mm.) beak, stigma subapical on the abaxial side of the oblique beak, pseudopedicels apparently produced in late stages.

Plants of evergreen montane forest formations between 2,200 and 3,200 m. elevation. Endemic to Costa Rica and known from only the following collections: *O. Jiménez 23* (1943), *Standley 35357* and *42802*, *Standley & Valerio 44013*, and *Taylor 4441*.

The species is readily recognizable by the opposite leaves, general pubescence, almost laterally attached fruit with very short beak, and high-altitude habitat. I have placed specimens here which differ markedly in leaf-shape but I believe that these are only individual differences. The type of *P. esperanzana* (*Standley 35357*) has short-petiolate suborbicular leaves, while the type of *P. stipitifolia* (*Standley & Valerio 44013*) has long-petiolate ovate or elliptic leaves. This interpretation is likely to include material from northern South America upon further study; it is closely related to *P. fruticetorum* C.DC. and *P. ioeides* Trel. & Yuncker.

Peperomia galioides H.B.K., Nov. Gen. & Sp. 1:71, pl. 17. 1815. *P. apoda* Trel., Contr. U.S. Nat. Herb. 26:44. 1927. *P. amphoterophylla* Trel., l.c. 225. 1929. *P. amphoterophylla* var. *glutineofructa* Trel., l.c. 226. *P. guayabillosana* Trel. in Cufod., Archivio Bot. 10:2. 1934. *P. redondoana* Trel. in Standl., Field Mus. Bot. 18:323. 1937. *P. gallitoensis* Trel. in Standl., l.c. 315. *P. garrapatilla* Trel. in Standl., l.c. 1544. 1938.

Terrestrial or epiphytic herbs, 10–35 cm. tall and often of tree-like form with a single main stem and numerous lateral branches, leafy internodes 3–30 mm. long, 0.5–1.8 mm. thick, minutely (0.1 mm.) puberulent. Leaves opposite or whorled, 2 or 4 at a node, frequently somewhat congested near the ends of the stem; petioles 0.5–1.5 (3) mm. long, about 0.4 mm. thick, very minutely (0.05–0.1 mm.) puberulent or glabrous; laminae often dimorphic with the larger just below the inflorescences, 8–30 mm. long and 2–7 mm. broad, obovoid to very narrowly oblong, the smaller laminae 3–8 mm. long and 1.5–4 mm. broad, both forms rounded at the obtuse to retuse apex, obtuse to attenuate or cuneate at the base, drying membranaceous to chartaceous and often with small (0.1 mm.) cell-like depressions forming on the upper surface, minutely puberulent at the apex and base but usually

glabrous on the central surfaces, venation pinnate but obscure in the smaller leaves, usually with 3 pairs of major secondaries. Inflorescences terminal or occasionally axillary, 2 to 10 per node, simple but rarely borne on leafless nodes and then apparently compound, 4–15 cm. long; peduncle 1–10 mm. long, 0.2–0.8 mm. thick, glabrous or minutely puberulent near the base, flowering rachis 0.4–1 mm. thick, the flowers becoming distant on the glabrous rachis; floral bracts 0.5–0.7 mm. long, conspicuously pellucid punctate and often bent away from the rachis when dry; anthers 0.1–0.2 mm. long; pistil borne in a slight depression in the rachis; fruit subbasally attached within a depression in the rachis, ascending and borne on a short (0.1–0.2 mm.) flat pseudopedicel in late stages, body of the fruit 0.4–0.5 mm. long, 0.4–0.6 mm. thick, ovoid or globose-ovoid, tapering to the yellowish translucent tissue of the slightly oblique beak, stigma subapical on the abaxial side of the short (0.1–0.2 mm.) beak, surface of the fruit becoming reddish pellucid tuberculate but pale-colored at the base.

Common plants of moist evergreen forest formations from 1,000 to 3,200 m. elevation. Collected in the Meseta Central and adjacent areas but to be expected throughout Costa Rica at higher elevations. Throughout the range of the genus in the New World; flowering throughout the year in Central America.

The erect shrubby growth form, whorled oblong leaves, separate flowers, small beaked fruit, and higher altitude habitat help to set *P. galioides* apart from other peperomias. In Costa Rica the plants of lower (1,000–1,600 m.) altitudes differ from those of higher altitude by their conspicuously dimorphic leaves, more slender spikes, and shorter petioles. These specimens from lower altitudes conform to the type of *P. amphoterophylla*. Specimens from Jamaica and elsewhere seem to be intermediate between the Costa Rican extremes but I have not seen enough material to suggest similar clinal variation elsewhere.

Peperomia glabella (Sw.) A. Dietrich, Sp. Pl. 1:156. 1831. *Piper glabellum* Sw., Prodr. Veg. Ind. Occ. 16. 1788. *Peperomia nigropunctata* Miq., Syst. Pip. 90. 1843. *P. caulibarbis* var. *jimenesana* C.DC. in Pittier, Prim. Fl. Costar. 2:284. 1899. *P. percuneata* Trel., Contr. U.S. Nat. Herb. 26:46. 1927. *P. jimenesana* (C.DC.) Trel., l.c. 196. 1929. *P. pilulifera* Trel., l.c. 199. *P. cattii* Trel. in Standl., Field Mus. Bot. 18:310. 1937. *P. flagellispica* Trel. in Standl., l.c. 314.

Erect, repent, or pendant usually epiphytic herbs, usually much branched near the base, leafy internodes 5–30 mm. long, 1–2.5 mm. thick, black punctate and with small (0.5 mm.) crooked hairs near the nodes (rarely glabrous). Leaves alternate or sometimes opposite at the flowering node, occasionally crowded at the apex; petioles 4–10 mm. long, 0.4–1 mm. thick, grooved and with 2 rows of curved cilia adaxially or occasionally glabrous, decurrent on the stem; laminae very variable

(on different plants), 1.5–9 cm. long, 0.5–3 cm. broad, usually elliptic and broadest at or near the middle, tapering to the acute apex, blunt at the tip, tapering to the acute or obtuse (occasionally cuneate) base, succulent and usually drying stiffly chartaceous, generally dark in color and slightly paler beneath, conspicuously (0.05 mm.) black punctate on both surfaces, glabrous or very sparsely puberulent, venation palmate or plinerved with 3 major veins arising from near the base of the lamina and often obscure. Inflorescence axillary, terminal or rarely leaf-opposed, 1 to 3 per node, simple, 3–14 cm. long; peduncle 5–12 (20) mm. long, 0.5–1.2 mm. thick, flowering rachis 1–2 mm. thick, peduncle and rachis often drying pale colored with conspicuous black dots, glabrous, the flowers becoming separated on the rachis; floral bracts 0.3–0.5 mm. long, dark pellucid punctate; anthers 0.1–0.2 mm. long, often broader than long; pistil borne in a depression in the rachis; fruit laterally attached in a depression in the rachis, ascending, body of the fruit 0.5–0.7 mm. long and about 0.5 mm. thick, globose-ovoid, tapering at the apex to the short (0.1–0.2 mm.) oblique beak, stigma borne on the abaxial base of the beak, surface of the fruit dark reddish pellucid verrucose, (pseudopedicels apparently absent).

A species of moist evergreen lowland and montane forest formations, flowering throughout the year. The altitudinal range of the species, from sea level to 2,400 m., is unusual in Costa Rican peperomias. The species ranges from Guatemala to northern South America and the West Indies. It is found on Cocos Island.

Though very variable in growth-form these plants are immediately recognizable (when dry) by the black dots on almost all parts, alternate somewhat succulent leaves, separate flowers, and fruit laterally attached (with respect to the beak). This species is closely related to *P. alata* and *P. chrysocarpa* among Costa Rican species; they share the unusual attachment of the fruit among other characters.

Peperomia gracillima S. Watson emend. Hill, Ann. Bot. 21:155. 1907. *P. gracillima* S. Wats., Proc. Amer. Acad. 22(14):448. 1887.

Small acaulescent herbs developing from a usually globose hypogaean tuber, the tuber about 1 cm. thick (dry); the roots emerging from the upper part of the tuber near the leaf-bases. Leaves emerging directly from the apex of the tuber, 2 to 7 per plant, peltate and erect; petioles 2–6 (10)mm. long, about 0.6 mm. thick and deeply furrowed on drying, attached at or near the center of the lamina, glabrous; lamina 12–30 mm. long and equally broad, orbicular to broadly ovate, round to bluntly obtuse at the apex, round at the base, thin- to thick-chartaceous when dried and often opaque, glabrous, venation palmate, often obscure above but visible beneath, the 7 to 9 major veins free to the base. Inflorescences borne at the apex of the tuber and apparently axillary, 1 to 7 per plant, to 20 cm. tall, simple; peduncle 3–10 cm. long, about 0.7 mm. thick and furrowed on drying, glabrous; the flowering rachis 1.2–10 cm. long, 0.7–1 mm. thick (dry); the flowers relatively few

and becoming distant on the glabrous rachis; floral bracts 0.7–1.1 mm. long, somewhat narrower than long, minutely acuminate at the apex, membranaceous and translucent, pellucid dotted, bent in the middle with the proximal half often appressed against the rachis; stamens with very short (often obscure) filaments, anthers 0.2–0.3 mm. long and often broader than long; pistil borne on the surface of the rachis, narrowly ovoid and tapering to the conspicuous stigma; fruit basally attached and ascending, borne on the surface of the rachis, becoming globose or ovoid, to 1 mm. long, tapering to the broad (0.2 mm.) apical stigma, surface verrucose (dry) but not pellucid.

Known in Costa Rica from the solitary collection by R. L. Rodriguez & A. Jiménez (*154*) on Irazu near the Lecheriá Robert at about 2,200 m. elevation. The species ranges northwards to Mexico; flowering material has been collected between July and September in Central America.

Distinguished from all other Costa Rican peperomias by the acaulescent habit with globose tuber, peltate leaves, and simple inflorescence. *P. claytonioides* with compound inflorescences is closely related; both species share the unusual root system. Our specimen keys to the area of three species, *P. gracillima*, *P. bracteata*, and *P. campylotropa*, in Hill's study of the geophilous species of *Peperomia* (Ann. Bot. 21:139–160. 1907). Applying Hill's key strictly places our specimen in *P. campylotropa*. However, I believe that these three names are probably referable to a single species with *P. gracillima* having priority.

Peperomia guapilesiana Trel., Contr. U.S. Nat. Herb. 26:210. 1929.

Erect herbs to 35 cm. tall, terrestrial or epiphytic, flowering stems usually unbranched and with the upper nodes lacking adventitious roots, leafy internodes 8–32 mm. long, 1.5–4.5 mm. thick (dry), crisp-hairy with trichomes to 1.5 mm. long. Leaves alternate and usually evenly spaced along the stem; petioles 8–36 mm. long, 1–2.2 mm. thick, conspicuously puberulent with crooked hairs, grooved adaxially and clasping the stem at the base; lamina 7–14 cm. long, 3–7 cm. broad, elliptic to ovate, obtuse to acute or short-acuminate at the apex, rounded or obtuse and often somewhat unequal at the base, drying chartaceous and somewhat paler in color beneath, glabrous above and crisp-hairy below with hairs to 1 mm. long, conspicuous (0.07 mm.) pellucid dots present on the lower surface, venation pinnate and readily visible on both sides (dry), the 3 to 5 pairs of major secondary veins usually arising from throughout the length of the midvein, arcuate ascending, the tertiary veins visible beneath. Inflorescence terminal, leaf-opposed or axillary, solitary at a node, 8–24 cm. long, compound of 4 to 30 spikes in a racemose or paniculate arrangement, spikes borne in alternate groups on the main axis or on alternate branches of the main axis, common peduncle 3.5–8 cm. long, 0.7–2 mm. thick, conspicuously crisp-hairy, spikes 1–5 cm. long, flowering rachis about 1 mm. thick, the flowers remaining crowded on the rachis; floral bracts about 0.3

mm. long, conspicuously pellucid punctate; anthers about 0.3 mm. long, the thecae often with pellucid dots; pistil borne in a depression in the rachis; fruit basally attached and erect from a depression in the rachis but sometimes on a small (0.1 mm.) pseudopedicel in later stages, body of the fruit 0.6–0.8 mm. long, 0.3–0.4 mm. thick, narrowly obovoid or cylindrical and narrowed at the base, orange pellucid verrucose and darker at the apex, stigma sessile and apical but usually surrounded by a small area of translucent slightly oblique tissue, a beak not developed.

Plants of the wet evergreen forests between sea level and 1,000 m. altitude on the Caribbean watershed. Presently known only from the following collections: *Standley 37446 & 37549* at Guapiles; *Austin Smith P. 2605* and *Molina et al. 17351* near Ciudad Quesada; and *Pittier 16085* near Zent; flowering in February and March.

Distinguished by the puberulent parts, compound inflorescence usually branched and with many spikes, and the narrowly obovoid fruit; closely related to *P. austin-smithii*. These species are superficially similar to *P. lancifolia* and *P. lancifolioidea* but the latter have very narrow beaked fruit.

Peperomia hernandiifolia (Vahl) A. Dietrich, Sp. Pl. 1:157. 1831. *Piper hernandifolium* Vahl, Enum. 1:344. 1804. *Peperomia hernandifolia* var. *ciliifera* Trel., Bot. Gaz. 73:145. 1922. *P. hernandifolia* var. *filipes* Trel., l.c. *P. ciliifera* Trel., Contr. U.S. Nat. Herb. 26:212. 1929. *P. ciliifera* var. *filipes* Trel., l.c. *P. conserta* Yuncker, Ann. Mo. Bot. Gard. 37:114. 1950.

Terrestrial or epiphytic herbs, climbing or decumbent, the stems weak and often descending, rooting at most nodes, leafy internodes to 20 cm. long and 5 mm. thick (dry), often marked with purple but drying uniformly dark, glabrous or rarely minutely puberulent. Leaves alternate and peltate, well spaced along the stem; petioles 4–18 cm. long, 1–4 mm. thick, usually glabrous and terete, variously attached to the leaf but most often in the lower third; lamina 5–20 cm. long, 4–14 cm. broad, broadly ovate or suborbicular, tapering to the acute or short acuminate apex, rounded at the base or rarely subcordate, succulent but drying chartaceous to subcoriaceous, glabrous on both surfaces but often minutely (0.1–0.3 mm.) ciliate along the margin, venation pinnate or subpalmate, the 2 or 3 pairs of major secondary veins usually obscure. Inflorescence terminal, leaf-opposed, or occasionally axillary, usually solitary (rarely 2 or 3) at each node, to 25 cm. long, simple (rarely compound) but the peduncle with a bract or node or apparently subtended by a leafless node, peduncle 2–5 cm. long, about 2 mm. thick (dry), glabrous or minutely (0.05–0.2 mm.) puberulent, 1 or 2 bracts usually present near the midpoint of the peduncle, bracts to 12 mm. long, deciduous and leaving a scar, flowering rachis becoming 3 mm. thick in fruit, the lower half often thicker than the upper, flowers remaining crowded on the rachis; floral bracts 0.3–0.5 mm. long, pellucid punctate, forming bands around the spike in early stages; anthers 0.2–0.3 mm. long; pistil borne on the surface of the rachis; fruit basally attached and erect

or ascending, body of the fruit 0.6–0.8 mm. long, 0.3–0.4 mm. thick, narrowly ovoid or ellipsoid, surface reddish pellucid verrucose, tapering to the style-like beak, stigma sessile at the abaxial base of the beak, tissue of the beak translucent, 0.3–0.5 mm. long.

A very succulent climbing species of evergreen wet forests between 500 and 2,300 m. elevation on the Caribbean slopes and around the Meseta Central. The species ranges from Mexico to South America and the West Indies; it flowers throughout the year.

Only a few of the Costa Rican specimens match the West Indian populations of this species. The latter tend to be smaller in all respects and their short (2–4 cm.) spikes on longer (3–8 cm.) peduncles appear distinctive. However, I believe that this very diverse array of plants represents a single widespread species which is capable of growing in a wide variety of habitats, flowering in early stages of vegetative growth, and producing inflorescences greatly differing in size. *Peperomia peltilimba* may be a depauperate form of this species. Also closely related, *P. maculosa* differs in the erect habit, shorter internodes, and leaf-form. These three species are the only peperomias in Costa Rica with thick succulent peltate leaves and bracteate peduncles.

Peperomia hispidula (Sw.) A. Dietrich, Sp. Pl. 165. 1831. *Piper hispidulum* Swartz, Prodr. 15. 1788. *Peperomia barbensis* var. *alajuelana* Trel., Contr. U.S. Nat. Herb. 26:191. 1929. *P. woodsonii* Trel. in Woodson & Schery, Ann. Mo. Bot. Gard. 27:305. 1940. *P. skutchii* Trel. & Standl., Fieldiana, Bot. 24, 3:270. 1952.

Terrestrial herbs, the stems usually erect, to 30 cm. tall and with spreading branches, thin and often translucent when dried (fragile when living), leafy internodes 3–20 (55) mm. long, 0.5–2 mm. thick (dry), minutely puberulent at the nodes but often glabrous on the internodes. Leaves alternate or subopposite at the shoot-apex, often somewhat congested at the ends of branches; petioles (2) 4–18 mm. long, 0.2–0.8 mm. thick, grooved on the adaxial side and slightly decurrent on the stem, puberulent with the greatest concentration of hairs at the base and near the blade; lamina 8–36 mm. long, 6–25 (35) mm. broad, broadly ovate to rhombic, obtuse or rounded at the apex, obtuse or rounded and truncate to subcordate at the base, drying membranaceous and often translucent, with small (0.1–1 mm.) whitish hairs concentrated near the base and more sparse on both surfaces or the distal surfaces glabrous, venation palmate and visible on both surfaces, with 3 or 5 major veins, the midvein with 2 to 5 secondary veins. Inflorescence terminal or leaf-opposed near the ends of shoots, usually solitary at a node, simple, 1.5–5 cm. long; peduncle to 20 mm. long, about 0.3 mm. thick, glabrous or puberulent, drying translucent, flowering rachis about 0.3 mm. thick, the relatively few (6–20) flowers distant from early stages on the glabrous rachis; floral bracts 0.3–0.5 mm. long, thin and translucent with a few pellucid dots, the

proximal part often appressed to the rachis with the distal half bent away; anthers 0.1–0.2 mm. long and equally broad; pistil borne on the surface or in a slight depression, narrowed at the base and apex; fruit becoming pedicellate, ascending, pedicel about 0.3 mm. long, body of the fruit about 0.7 mm. long, ellipsoid, narrowed to the short (0.1–0.2 mm.) translucent style, stigma apical on the style, surface of the fruit pellucid punctate but developing short (0.03–0.1 mm.) single celled setae.

Apparently weak short-lived plants of moist montane areas between 1,500 and 2,800 m. elevation in Costa Rica; probably flowering throughout the year. Ranging from Guatemala to northern South America and the West Indies.

Peperomia hispidula is closely related to *P. pellucida* with which it shares the weak-stemmed herbaceous habit, spreading lateral branches, thin leaves, few-flowered spike, and thin bracts. The species differ in the possession of trichomes and the rather different fruit. While both species are widespread they have not been collected often in Costa Rica.

Peperomia hoffmannii C.DC., Journ. Bot. 4:133. 1866.

Repent herbs rooting at many nodes, the erect flowering stems less than 5 cm. tall, leafy internodes 5–18 mm. long, 0.3–0.8 mm. thick and becoming ridged when dry, glabrous or sparsely and very minutely (0.03 mm.) puberulent, the cuticle often flaking off in small pieces. Leaves opposite or whorled, well spaced along the stem; petioles 1–2 mm. long, about 0.3 mm. thick, glabrous or very minutely puberulent, grooved on the adaxial side and often with cuticle peeling off; lamina 3–6.5 mm. long, 2.3–5.5 mm. broad, broadly obovate to orbicular, rounded and often emarginate at the apex, obtuse or cuneate at the base, drying stiffly chartaceous and yellowish with the margin revolute, glabrous or minutely puberulent at the apex, venation palmate with the 3 major veins usually obscure. Inflorescence terminal, solitary at the node, simple, to 28 mm. long, peduncle 6–14 mm. long, 0.2–0.5 mm. thick, glabrous, flowering rachis glabrous (in ours), 6–15 mm. long and about 1 mm. thick, the flowers becoming slightly separated; floral bracts 0.3–0.4 mm. long, inconspicuously pellucid punctate; anthers 0.1–0.2 mm. long; pistil borne in a pit in the rachis; pistil basally attached within a depression in the rachis; body of the fruit 0.5–0.8 mm. long, about 0.3 mm thick, narrowly ovoid, or cylindrical, the surface orange pellucid and quite smooth, narrowed at the apex to form a conical style of translucent tissue about 0.3 mm. long, stigma terminal on the style.

Usually epiphytic plants found in regions of moist evergreen forests around the Meseta Central and on the Caribbean slopes between sea level and 2,000 m. elevation. Ranging from Guatemala to Brazil.

Distinguished from the other little peperomias with creeping stems and opposite or whorled leaves by the unusually small laminae,

short spikes on relatively long peduncles, and glabrous rachis. I have not seen the type material and the glabrous rachis does not conform to *P. hoffmannii* as described by Trelease and Yuncker (1950). The species, whatever its name, is very closely allied to *P. quadrifolia* (L.) H.B.K. and differs only in its smaller parts and much shorter flowering rachis. The pseudocupule illustrated in Dahlstedt (Tab. 3, fig. 21. 1900) is very difficult to see and not as clearly delimited as in the figure. I believe that the pseudocupule is nothing more than differential drying of the lower part of the viscose fruit-surface due to contact with the surrounding rachis.

Peperomia hylophila C.DC., Anal. Inst. Fis.-Geog. Costa Rica 9:176. 1897. *P. erythrophlebia* Trel., Contr. U.S. Nat. Herb. 26:200. 1929. *P. fissispica* Trel., l.c. 201. *P. multifida* Trel., l.c. *P. fraijanesana* Trel., l.c. 202. *P. fraijanesana* var. *subrhombica* Trel., l.c. *P. fraijanesana* var. *san-isidroana* Trel., l.c. *P. zurquiana* Trel., l.c. *P. chlorostachya* Trel., l.c. 203. *P. hylophila* var. *personata* Trel., l.c. *P. cufodontii* Trel. in Cufod., Archivio Bot. Sist. Fitogeog. & Genet. 10:26. 1934. *P. porschiana* Trel. in Cufod., l.c. 27. *P. exuberantifolia* Trel. in Standl., Field Mus. Bot. 18:313. 1937. *P. austini* Trel. in Standl., l.c. 1543. 1938. Figure 1.

Epiphytes or rarely terrestrial of either erect or repent habit, erect plants often with numerous spreading branches and bush-like in appearance, to about 20 cm. tall (above the rooting nodes), the repent forms usually with few-branched flowering shoots, leafy internodes 2–40 mm. long, 0.5–3 mm. thick, glabrous or minutely (0.05 mm.) puberulent or occasionally crisp-puberulent with hairs 0.5 mm. long. Leaves alternate or subopposite at branching nodes or below the spikes, often somewhat crowded at the apex; petioles 2–10 (20) mm. long, 0.5–1 mm. thick, grooved adaxially and somewhat broadened basally, often decurrent on the stem; lamina 10–35 mm. long, 6–20 (30) mm. broad, ovate or obovate to rhombic or elliptic, usually tapering to the obtuse or acute apex but sometimes rounded apically on broader laminae, often emarginate at the tip, rounded to obtuse at the base, drying thin to stiffly chartaceous, opaque and often paler beneath, glabrous or puberulent, often with minute (0.05 mm.) hairs at the tip, venation palmate with the 3 major veins often obscure. Inflorescences terminal or axillary, 1 to 5 per node, simple, 2–10 cm. long; peduncle 4–12 mm. long, 0.4–1 mm. thick; glabrous, flowering rachis 0.7–1.5 mm. thick, the flowers remaining congested or becoming slightly separated, floral bracts 0.3–0.6 mm. long, pellucid punctate; anthers about 0.2 mm. long; pistil borne in a depression in the rachis; fruit subbasally or sublaterally attached in a depression in the rachis and ascending, body of the fruit 0.5–0.7 mm. long, 0.4–0.6 mm. thick, reddish pellucid verrucose but whitish near the point of attachment, tapering to the short (0.1 mm.) oblique beak of translucent tissue, stigma subapical on the abaxial side of the beak, short (0.3 mm.) pseudopedicels often produced in late stages.

Plants of the montane evergreen forest formations between 1,200 and 2,800 m. elevation; collected in flower and fruit from December to August. The uncertain circumscription of this species does not permit an estimate of geographic distribution (see below).

Peperomia hylophila is characterized by the smaller or medium-sized, mostly alternate leaves, succulent, rarely puberulent, vegetative parts, montane habitat, spikes often several at the ends of branches, and the small round fruit with very short beak. I have placed a great variety of material under this name but have found no alternative to assuming that these very different specimens are forms of a single species. *Peperomia tacanana* Trel. & Standl. of Guatemala and *P. trinervula* C.DC. of northern South America are very closely related and may be conspecific. *Peperomia angularis* is also closely related but differs in the more succulent parts, shorter and thicker stems, thicker spikes with congested fruit, and the fruit more obviously attached on the side; see the discussion under *P. angularis*.

Peperomia lanceolato-peltata C.DC., Journ. Bot. 4:136. 1866. *P. tecticola* C.DC., Anal. Inst. Fis.-Geog. Costa Rica 9:175. 1897. *P. tecticola* var. *muricola* Trel., Bot. Gaz. 73:143. 1922. *P. tecticola* var. *tilirina* Trel., Contr. U.S. Nat. Herb. 26:193. 1929. *P. molithrix* Trel. & Standley, Fieldiana: Botany 24, pt. 3:259. 1952. *P. hispidorhachis* Yuncker, Ann. Mo. Bot. Gard. 37:112. 1950.

Epiphytic herbs to 25 cm. tall, acaulescent or with stems to 10 cm. long, the stems unbranched, erect or prostrate, glabrescent and succulent but becoming deeply furrowed, grayish, and about 2–5 mm. thick when dried, leafy internodes less than 1 cm. long. Leaves alternate and peltate, often crowded at the apex of the shoot; petioles 2–12 cm. long, 0.3–1 mm. thick (dry), glabrous or sparsely puberulent, attached within 2–12 mm. of the basal edge of the lamina; lamina 3–14 cm. long, 1.5–10 cm. broad, narrowly to broadly ovate, tapering to the acute or less often obtuse apex, round or truncate at the base, drying membranaceous to thin-chartaceous, usually translucent, glabrous or sparsely puberulent above and below, with a minutely (0.2 mm.) ciliolate edge, venation palmate, the 5 to 7 major veins usually visible on both surfaces, the 3 central ascending veins free but often closely parallel for about 1 cm. above the petiole attachment. Inflorescence apparently solitary in the leaf-axil, to 28 cm. long, simple; peduncle 2–8 cm. long, about 0.7 mm. thick, glabrous or sparsely and minutely (0.05–0.2 mm.) puberulent, flowering rachis 2–18 cm. long, 0.3–1.5 mm. thick; the flowers distant from early stages; the rachis very sparsely to densely papillate-puberulent, with trichomes 0.05–0.2 mm. long, floral bracts orbicular, about 0.4 mm. long, obscurely punctate; anthers 0.1–0.2 mm. long; pistil borne on the surface of the rachis, ellipsoid or ovoid, subbasally attached and ascending; fruit borne on the

surface of the rachis and basally attached, ellipsoid but becoming globose-ovoid in late stages, about 0.7 mm. long and 0.5 mm. thick, surface drying grayish and smooth or slightly verrucose but not pellucid, stigma apical.

Growing on rocks and tree-trunks (apparently also terrestrial) in wet evergreen forests and near streams between sea level and 1,500 m. altitude. Collected only around the Meseta Central in Costa Rica but ranging from Guatemala to South America. The species flowers from July to January in Central America.

Our material appears to be identical with specimens identified as this species by Yuncker from northern South America. The very small plants collected by Skutch near El General (*3801*) and annotated *P. edepilata* n. sp. by Trelease appear to be quite distinct. However, another collection by Skutch (*3022*) bridges the gap between these very little plants and the larger specimens. I believe that this is another example of the ability of some species of *Peperomia* to produce flowers and fruit over an extraordinary range of plant-size. This species is closely related to *P. amphitricha* and differs in the condensed internodes.

Peperomia lancifolia Hook, Ic. Pl. 4, pl. 332. 1841. *P. calvifolia* C.DC., Candollea 1:290. 1923, *nomen subnudum*. *P. calvifolia* forma *abrupta* Trel., Contr. U.S. Nat. Herb. 26:218. 1929.

Erect herbs to 75 cm. tall, usually terrestrial, stems unbranched or few-branched with adventitious roots at the lower nodes, leafy internodes 4–25 (55) mm. long, 1.2–3 mm. thick (dry), glabrous. Leaves alternate and usually evenly spaced along the stem, petioles 6–18 (22) mm. long, 1–2.5 mm. thick, glabrous, deeply grooved and with a thin-margin adaxially, the margins continuous with the margin of the lamina and clasping the stem at the base; lamina 4–14 cm. long, 1.5–4.5 cm. broad, narrowly elliptic or narrowly obovate to lanceolate or oblanceolate, tapering to the acute or short-acuminate apex, gradually narrowed at the attenuate base, drying thin chartaceous and dark above, usually paler beneath, glabrous, venation pinnate and conspicuous on both surfaces, the 4 to 7 pairs of major secondary veins arising throughout the length of the midvein, arcuate ascending. Inflorescence terminal or leaf-opposed, solitary at a node or rarely paired at the shoot-apex, to 25 cm. long, compound of (2) 4 to 9 spikes arranged alternately on the unbranched axis, (the lower spikes rarely subtended by a leaf and apparently simple), the common peduncle (to the first spike) 2–7 cm. long, about 1.4 mm. thick, glabrous; individual spikes 3.5–10 cm. long, flowering rachis about 1 mm. thick, the flowers remaining approximate on the rachis; floral bracts 0.4–0.5 mm. long, pellucid punctate; anthers about 0.1 mm. long; fruit basally attached within a depression in the rachis, erect or ascending, body of the fruit 1–2 mm. long, 0.2–0.3 mm. thick, very narrowly cylindrical or ellipsoid, reddish pellucid verrucose and sometimes with darker longitudinal lines, stigma borne in the center of the abaxial face of the style-like beak, subapical, tissue of the beak usually translucent, about 0.3 mm. long and often recurved.

Plants of the wet forest floor between 1,000 and 2,500 m. altitude around the Meseta Central; flowering throughout the year. Ranging from Mexico to northern South America.

Recognized by the usually terrestrial habit, glabrous parts, narrow leaves drying thin, compound inflorescences, and very slender fruit. Closely related to *P. lancifolioidea;* the two species differ from all other Costa Rican peperomias in their very slender fruit. *Peperomia floribunda* (Miq.) Dahlst. is probably this species.

Peperomia lancifolioidea W. Burger, sp. nov.

Herbae erectae usque ad 30 cm. altae, caules plerumque sine ramis et cum radicibus adventiis. Foliae alternae, petiolis 4–14 mm. longis, laminis 5–18 (22) cm. longis et 1.5–5.2 cm. latis, anguste ellipticis, lanceolatis vel oblanceolatis, praeter apicem ciliolatum glabris. Inflorescentiae terminales vel foliis oppositae, usque ad 18 cm. longae, compositae 3–15 spicarum, spicae 3–8 cm. longae, alternatae vel in turmis alternatis; bractae 0.2–0.3 mm. latae, antherae 0.2–0.3 mm. longae, fructus circa 0.8 mm. longi, 0.2–0.3 mm. crassi, anguste obovoidei vel anguste cylindracei, rostro 0.1 mm. longo. HOLOTYPUS: *Austin Smith 1842*, Field Museum 996855.

Erect herbs, terrestrial or sometimes epiphytic, to 30 cm. tall, stems usually unbranched and with adventitious roots at the lower nodes, leafy internodes (2) 6–30 mm. long, 1.4–4 mm. thick (dry), glabrous. Leaves alternate and usually evenly spaced along the stem; petioles 4–14 mm. long, 1–4 mm. thick, glabrous, deeply grooved and with thin margins adaxially, the margins continuous with the edge of the lamina and slightly expanded at the clasping leaf-base; lamina 5–18 (22) cm. long, 1.5–5.2 cm. broad, narrowly elliptic to lanceolate or oblanceolate, gradually tapering to the acute apex, very gradually tapering to the attenuate base, drying thin- to stiff-chartaceous and usually dark in color on both surfaces, glabrous or minutely (0.1 mm.) ciliolate at the apex, venation pinnate but the secondary veins usually obscure, the 3 to 6 pairs of major secondaries arising throughout the length of the midvein. Inflorescence terminal or leaf-opposed, solitary at each node or occasionally 2 at the apex of the stem, to 18 cm. long, compound with the main axis simple or occasionally branched, the 3 to 15 spikes borne alternately or in alternate groups, common peduncle (to the first spike) 3–8 cm. long, 0.8–1.5 mm. thick, glabrous; individual spikes 2.5–6 cm. long, flowering rachis 0.7–1.4 mm. thick, the flowers remaining crowded on the rachis; floral bracts 0.2–0.3 mm. long, pellucid punctate; anthers 0.2–0.3 mm. long; fruit basally attached in a depression in the rachis, erect or ascending, body of the fruit about 0.8 mm. long, 0.2–0.3 mm. thick, very narrowly obovoid or cylindrical, reddish pellucid verrucose and darker apically, stigma borne near the abaxial base of the beak, the usually translucent tissue of the beak becoming only about 0.1 mm. long and slightly recurved.

Plants of everygreen moist forests from the western edge of the Meseta Central (Ciudad Quesada) to the border of Panama (San Vito de Java) between 500 and 1,500 m. altitude. Endemic to Costa Rica but probably occurring in Western Panama.

Recognized by the usually terrestrial habit, narrow and attenuate leaves, glabrous parts, compound inflorescences, and very narrow fruit with poorly developed beak. This species is very closely related to *P. lancifolia* and differs in the prominence of leaf-venation (dry), anther-size, fruit-length, and development of the beak. The two species share the same range in parts of the Meseta Central but the data is insufficient to suggest that they differ ecologically. *P. lancifolioidea* is known from the following collections: *Austin Smith F 1842, J. León 1166, Standley 47243, Quirós 127, Williams et al., 28469,* from the area in and around the Meseta Central; *Raven 20918, 21739,* and *21950,* and *Burger & Matta 4411,* from near San Vito. These collections have been made between January and August.

Peperomia lignescens C.DC., Journ. Bot. 4:137. 1866. *P. tenuifolia* C.DC., Linnaea 37:371. 1872. *P. aguacatensis* C.DC., l.c. 376. *P. carthaginensis* C.DC., Linnaea 37:377. 1872. *P. lignescens carthaginensis* (C.DC.) Trel., Contr. U.S. Nat. Herb. 26:193. 1929. *P. lignescens* var. *subcuneilimba* Trel., l.c. *P. jilotepequeana* Trel. & Standl., Fieldiana, Bot. 24, 3:254. 1952.

Terrestrial or occasionally epiphytic herbs with erect stems to 25 cm. tall, the stems usually unbranched, grayish and woody in appearance when dry and with leaf-scars 2–3 mm. broad, leafy internodes less than 1 cm. long, 3–6 mm. thick (dry), glabrous or with a few hairs near the leaf-bases. Leaves alternate in a spiral and usually borne close together at the apex of the stem; petioles 2–8 cm. long, about 1 mm. thick (dry), glabrous, grooved adaxially and broadened at the base; lamina 4–10 (14) cm. long, 2–6 cm. broad, narrowly ovate to elliptic or lanceolate, gradually tapering to the acute or acuminate apex, usually rounded at the subcordate to truncate base or sometimes obtuse, occasionally unequal and folded at the petiole, drying membranaceous to thin chartaceous and usually paler beneath, glabrous (in Costa Rica) and dark reddish punctate on both surfaces, venation pinnate and prominent beneath, the 3 or 4 pairs of secondary veins arising from the lower half of the midvein and arcuate-ascending. Inflorescences congested at the stem-apex but apparently solitary in the leaf-axils, simple, 7–22 cm. long; peduncle 5–25 mm. long, 0.5–1.5 mm. thick, glabrous, flowering rachis becoming 2–3 mm. thick, the flowers remaining approximate on the rachis; floral bracts about 0.5 mm. long, conspicuously (0.05 mm.) reddish pellucid punctate; anthers 0.1–0.2 mm. long, minutely punctate; pistil borne in a groove in the rachis; fruit subbasally attached in a depression in the rachis, ascending or becoming erect, body of the fruit 0.5–0.7 mm. long, 0.4–0.6 mm. thick, globose-ovoid or ellipsoid, conspicuously reddish pellucid punctate in the upper part, smooth and often paler in color on the lower half, stigma apparently terminal and apical on the conical beak-like apex of the fruit, the upper pellucid verrucose part of the fruit 0.1–0.3 mm. long.

Plants of evergreen montane forest formations between 1,000 and 2,000 m. altitude and as yet collected only from the Central Highlands between August and January. Ranging from Guatemala (as *P. jilotepequeana*) to Costa Rica.

A very distinctive peperomia with pinnately veined leaves at the apex of the unusual erect stem, thin laminae truncate or subcordate at the base, unusual fruit, and conspicuous dark dots on many parts. This species is closely related to *P. ciliolibractea* of Panama but the latter has puberulent leaves, ciliate floral bracts, and is found at lower altitudes. *Peperomia petrophila* and *P. pseudo-dependens* are also very closely related and may even be unusual forms of this species (q. v.).

Peperomia macrostachya (Vahl) A. Dietrich, Sp. Pl. 1:149. 1831. *Piper macrostachyon* Vahl, Enum. 1:341. 1804. *Peperomia elongata* H.B.K., Nov. Gen. Sp. 1:62, 1815. *P. naranjoana* C.DC., Linnaea 37:378. 1872, ex char. *P. glaberrima* C.DC., Anal. Inst. Fis.-Geog. Costa Rica 9:178. 1897. *P. glabricaulis* C.DC., l.c. *P. pendula* C.DC., l.c., not Willd. *P. cylindribacca* C.DC. ex Schroeder, Candollea 3:123. 1926. *P. oblongibacca* C.DC. ex Schroeder, l.c. 129. *P. tilarana* Trel., Contr. U.S. Nat. Herb. 26:211. 1929. *P. circumscissa* Trel., l.c. *P. orientalis* Trel., l.c.

Succulent herbaceous climbers, stems ascending in early stages but often becoming repent or pendulous, rooting at most nodes, leafy internodes 1–8 cm. long, 1.5–4.5 mm. thick (dry), glabrous or sparsely and minutely (0.1–0.5 mm.) puberulent near the nodes. Leaves alternate, usually well spaced along the stem; petioles 1–12 mm. long or occasionally the leaf sessile, 1.5–4 mm. thick, deeply grooved on the adaxial side, glabrous or occasionally cilliate or puberulent; lamina (3) 5–12 cm. long, 1.5–4.5 (6) cm. broad, narrowly to broadly elliptic, broadest near the middle, tapering to the obtuse, acute, or acuminate apex, tapering to the obtuse to cuneate base, succulent and drying subcoriaceous, glabrous or rarely puberulent but often minutely (0.2–0.4 mm.) ciliate along the edge in younger leaves, venation pinnate but usually obscure with 3 to 6 pairs of major secondary veins, usually arising from the lower half of the midvein. Inflorescence terminal or leaf-opposed, solitary at each node but often with several borne together on short leafless stems, simple or apparently compound, to 12 cm. long; peduncles to 35 mm. long, about 1 mm. thick, bearing a deciduous bract or undeveloped leaf near the middle, glabrous or sparsely puberulent in early stages, flowering rachis becoming 2–3 mm. thick, the flowers and fruit remaining crowded on the rachis; floral bracts 0.4–0.7 mm. broad, pellucid dotted, obscured by the fruit; anthers 0.2–0.4 mm. long, 0.2–0.3 mm. broad; pistil borne in a depression in the rachis; fruit basally attached within a depression in the rachis, erect or ascending, cylindrical, becoming about 2 mm. long and 0.7 mm. thick, the surface pellucid verrucose, yellowish to red, stigma subapical in the center of the abaxial side of the beak, translucent tissue of the apex prolonged apically to form a short (0.1–0.3 mm.) oblique beak.

Succulent epiphytes in wet forests from sea level to 1,800 m. elevation; flowering throughout the year. A common species ranging from Mexico to South America and to be expected throughout the moister areas of Costa Rica.

Peperomia macrostachya is closely related to *P. vinasiana* and more distantly to *P. hernandiifolia* with peltate leaves. These three species are thick succulent scandent or pendant plants. I cannot distinguish between *P. macrostachya, P. elongata, P. cylindribacca,* and *P. oblongibacca* as Yuncker has done. While I have not seen the original material of the two earliest described of these, I am sure that they are part of this complex. Though quite diverse, the assemblage of plants included here seems best treated as a single wide-ranging species.

Peperomia maculosa (L.) Hooker, Exot. Fl. 2. pl. 92. 1825. *Piper maculosum* L., Sp. Pl. 30. 1753. *Peperomia parmata* Trel., Contr. U.S. Nat. Herb. 26:212. 1929. *P. leridana* Trel. in Woodson & Schery, Ann. Mo. Bot. Gard. 27:303. 1940. *P. tenebraegaudens* Trel. in Woodson & Schery, l.c. 305.

Terrestrial or occasionally epiphytic herbs, erect to 45 cm. tall, stems usually unbranched, often decumbent and only the lower nodes with adventitious roots, leafy internodes 1–5 (8) cm. long, 2–7 mm. thick (dry), minutely puberulent or becoming glabrous, the hairs slender, whitish and about 0.5 mm. long. Leaves alternate and peltate, usually only 4 or 5 per stem; petioles 5–15 cm. long, 1.5–4.5 mm. thick, densely puberulent in early stages but becoming glabrous, terete, attached near the base of the lamina within 1–2 cm. of the margin; lamina 8–23 cm. long, 4.5–13 cm. broad, narrowly to broadly ovate, often tapering gradually to the short-acuminate apex, round or subtruncate at the base, succulent and drying subcoriaceous, usually dark above and paler beneath, puberulent beneath and along the margin in early stages, glabrous or very sparsely puberulent above, hairs about 0.3 mm. long; venation pinnate, the 3 to 5 pairs of major secondary veins usually obscure. Inflorescences terminal or leaf-opposed, usually solitary at each node, to 35 cm. long, simple or occasionally with 2 or 3 spikes on a common peduncle or apparently subtended by a leafless node; peduncle 2–7 cm. long, 1.2–2.5 mm. thick, glabrous or sparsely puberulent, with 1 or 2 bracts or nodes, bracts of the peduncle to 15 mm. long and deciduous, flowering rachis becoming 4 mm. thick; the flowers remaining crowded or approximate, floral bracts 0.4–0.7 mm. long, pellucid punctate; anthers about 0.2 mm. long; pistil borne on the surface of the rachis, with a style-like anterior extension forming the slender beak above the stigma; fruit basally or subbasally attached, ascending, body of the fruit about 0.8 mm. long and 0.5 mm. thick, ovoid, surface dark reddish pellucid verrucose, the beak slender and style-like to 0.5 mm. long, stigma sessile at the abaxial base of the beak.

Collected in Costa Rica between 1,200 and 2,000 m. altitude in wet evergreen forests around the Meseta Central and Caribbean

slope. Ranging from Guatemala to South America and the West Indies and apparently confined to moist evergreen forests above 800 m. elevation.

Very closely related to *P. hernandiifolia* and distinguished from that species by the short erect habit, leaf-form and petiole attachment, and broader fruit. These two species are the only succulent large-leaved peltate peperomias in Costa Rica.

Peperomia mameiana C.DC. ex Schroeder, Candollea 3:128. 1926. *P. williamsii* Trel., Contr. U.S. Nat. Herb. 26:48. 1927. *P. flavispica* Trel., l.c.

Terrestrial or epiphytic herbs to 40 cm. tall but with stems usually less than 15 cm. tall and unbranched, leafy internodes 0–45 mm. long, 3–8 mm. thick (dry), glabrous. Leaves alternate and usually crowded at the apex of the stem; petioles 2.5–11 cm. long, 2.2–4.5 mm. thick, deeply ridged and somewhat grooved adaxially on drying, glabrous and leaving a conspicuous (3–5 mm.) scar on the stem; lamina 7.5–25 cm. long, 4–11 cm. broad, elliptic or obovate, obtuse at the apex, gradually tapering to the attenuate base or occasionally obtuse in the broader leaves, drying stiffly chartaceous to subcoriaceous, glabrous, venation pinnate and usually obscure, the 4 to 6 pairs of major secondary veins arising throughout the length of the midvein, the margin revolute on drying. Inflorescence terminal or axillary, to 35 cm. long, solitary or several at the apex of the stem, compound of 4 to 15 spikes on a simple or branched rachis, quite variable (paniculate, racemose, or umbellate) in form; common peduncle 5–12 cm. long (to the first spike), peduncles of the spikes 8–30 mm. long, 1–2 mm. thick, glabrous, spikes 4–18 cm. long, flowering rachis 1–2.5 mm. thick, the flowers and fruit remaining crowded on the rachis; floral bracts 0.3–0.4 mm. long, pellucid punctate, forming bands around the spike in early stages; anthers 0.1–0.2 mm. long; pistil borne in a depression in the rachis, stigma surrounded by the translucent tissue of the style-like beak; fruit basally attached within a depression in the rachis, body of the fruit 0.6–0.8 mm. long, about 0.4 mm. thick, the surface reddish pellucid verrucose but paler at the base, the beak flattened and oblique, extending 0.3–0.4 mm. above the fruit and paler in color than the fruit, the stigma sessile at the abaxial base of the beak.

The recent collection by Peter Raven (*21683*) near Rincon de Osa, Osa Peninsula, and the collection of Alexander Skutch (*4157*) in the vicinity of El General are the only specimens of this species from Costa Rica. Apparently confined to lowland (0–800 m.) wet evergreen forest and previously known only from central Panama.

An unusual species with large thick long-petiolate leaves on short erect stems, compound inflorescences with long spikes, and beaked fruit. Apparently related to *P. syringifolia* and perhaps more closely to *P. omnicola* and *P. dotana*. Our specimens have somewhat simpler inflorescences than the Panamanian material but the inflorescence appears to be very variable.

Peperomia montecristana Trel., Contr. U.S. Nat. Herb. 26:199. 1929. *P. subdita* Trel., l.c. 194.

Epiphytes, the erect stems to 35 cm. long, flowering stems usually unbranched, leafy internodes 4–30 (50) mm. long, 1–2 mm. thick, densely puberulent with slender hairs to 1 mm. long. Leaves alternate (apparently opposite at lower nodes) not crowded at the apex of the stem; petioles 2–15 mm. long, 0.5–1 mm. thick, densely puberulent and deeply grooved adaxially; lamina 12–50 mm. long, 8–20 mm. broad, elliptic to ovate, usually widest at or below the middle, tapering to the obtuse or acute apex, tapering to the usually obtuse base, drying thin-chartaceous and opaque, slightly darker above, puberulent on both surfaces with slender hairs about 0.5 mm. long, venation palmate, the 3 major veins visible beneath and free to the base. Inflorescence terminal, axillary, or leaf-opposed, 1 to 3 at a node, simple, 4–18 cm. long; peduncle to 10 mm. long and about 0.7 mm. thick, puberulent, flowering rachis about 1 mm. thick, the flowers becoming distant on the glabrous rachis; floral bracts 0.5–0.7 mm. long, pellucid punctate, thin and often becoming bent in the middle; anthers about 0.2 mm. long; pistil borne in a depression in the rachis; fruit basally or subbasally attached, eventually exserted on a short (0.2–0.3 mm.) flattened pseudopedicel, body of the fruit 0.6–0.7 mm. long, 0.4–0.5 mm. thick, ellipsoid, pellucid verrucose or pellucid rugose, smoother at the crateriform point of attachment, a small (0.1–0.2 mm.) oblique beak of translucent tissue present at the apex of the fruit, stigma subapical on the center of the beak.

Plants of the wet evergreen forest formations between sea level and 1,400 m. elevation on the Caribbean slopes. Known only from the collections noted below.

Distinctive peperomias because of the pubescence, thin alternate leaves, large floral bracts, and distant beaked fruit that are basally attached. The collections from below 100 m. elevation have shorter (8 cm.) spikes and broader more ovate leaves: *Standley 40901* (the type) below Cairo on the Río Reventazón and *Proctor, Jones, & Facey 26997*, Cerro San Isidro, Dept. Bluefields, Nicaragua. The collections from higher altitudes have more narrowly elliptic leaves and longer spikes: *Standley 41516*, Finca Las Cóncavas, Pcia. Cartago; *Cooper 192* distributed as *5927* with U.S. National Herbarium number *796574* (type of *P. subdita*), Estrella, Pcia. Cartago. The species resembles *P. cooperi* and *P. esperanzana* and to a lesser degree the unusual *P. dodgei*. *Peperomia montecristana* and these other species are poorly represented in collections and their treatment here can only be regarded as tentative.

Peperomia obtusifolia (L.) A. Dietrich, Sp. Pl. 1:154. 1831. *Piper obtusifolium* L., Sp. Pl. 30. 1753. *Peperomia valerioi* Trel., Journ. Wash. Acad. Sci. 15:458. 1925. *P. mentiens* Trel., Contr.

U.S. Nat. Herb. 26:217. 1929. *P. mentiens* var. *lata* Trel., l.c. *P. pyrolaefolia* Trel., l.c. *P. palmae* Trel. in Standl., Field Mus. Pub. Bot. 18:320. 1937.

Epiphytic or occasionally terrestrial herbs, the stems erect or repent and rooting at the lower nodes, usually less than 20 cm. tall, leafy internodes 0–2 (4) cm. long, 2–5 mm. thick (dry), glabrous and often with the waxy cuticle peeling off. Leaves alternate, crowded at the stem apex in short-stemmed plants or well spaced along the stem; petioles 5–40 mm. long, 1.5–3 mm. thick, grooved on the adaxial side and the margins continuous with the edge of the lamina, glabrous; lamina (3) 6–16 cm. long, 2.5–7 cm. broad, usually obovate or oblanceolate but very variable in different plants (occasionally suborbicular), tapering abruptly to the rounded or obtuse apex, most often tapering gradually to an attenuate base but sometimes obtuse to rounded, very succulent and usually drying subcoriaceous, glabrous or very minutely (0.05 mm.) puberulent at the tip; venation pinnate and usually obscure in the dried leaves, the 3 to 5 pairs of major secondary veins arising throughout the length of the midvein, arcuate ascending. Inflorescence terminal, axillary, or leaf-opposed, solitary or paired at the node, to 28 cm. long, compound of 2 or 3 spikes or apparently simple on a nodose peduncle, the common peduncle (to the first spike) 3–14 cm. long, 1–4 mm. thick, with 1 or 2 nodes bracteate in early stages, peduncles of the individual spikes usually unequal, glabrous or sparsely and very minutely (0.03 mm.) puberulent, spikes 5–18 cm. long, flowering rachis becoming 3 mm. thick, the flowers usually remaining crowded on the rachis; floral bracts 0.3–0.5 mm. long, conspicuously orange pellucid punctate, sometimes forming minute bands around the spike; anthers about 0.2 mm. long; pistil borne in a depression in the rachis; fruit basally attached in a deep depression in the rachis, erect or ascending, body of the fruit 0.7–0.9 mm. long, 0.3–0.4 mm. thick, narrowly ellipsoid or cylindrical, orange pellucid verrucose, stigma sessile at the abaxial base of the beak, the beak often with darker tissue at its base and translucent tissue above, 0.3–0.5 mm. long, very slender (0.05 mm.) and usually recurved at the tip.

To be expected in moist evergreen forests between sea level and 1,200 (1,500) m. altitude throughout Costa Rica; flowering throughout the year. The species is found throughout the range of the genus in the New World.

Very distinctive plants readily identified by the very thick alternate leaves, laminae that are usually narrowly obovoid and attenuate at the base, bracteate peduncle or compound inflorescence, lowland habitat, and pleasant aromatic odor when dried. *Peperomia pseudo-alpina* is very closely related and may be a high altitude ecotype of *P. obtusifolia*. *Peperomia alpina* is also closely related and these three taxa form a group worthy of intensive study; see the discussion under *P. pseudo-alpina*. I believe that the criteria used by Yuncker to separate *P. magnoliaefolia* from *P. obtusifolia* are not biologically significant.

Peperomia oerstedii C.DC., Linnaea 37:375. 1872. *P. punctata* C.DC. ex Schroeder, Candollea 3:132. 1926. *P. oerstedii* var. *punctata* (C.DC.) Trel., Contr. U.S. Nat. Herb. 26:205. 1929.

Stoloniferous epiphytes or terrestrial, the usually unbranched and erect flowering stems to 10 cm. tall (including spikes), leafy internodes 1–4 mm. long on the erect stems, about 0.5 mm. thick, densely puberulent with curved and appressed hairs 0.1–0.5 mm. long. Leaves alternate or subopposite at the apex of the shoot, evenly spaced along the stem; petioles 0.5–1.5 mm. long, about 0.3 mm. thick, puberulent at the base, grooved adaxially; lamina 5–15 mm. long, 1.5–4 mm. broad, narrowly elliptic to obovate, usually rounded at the apex, tapering to the cuneate base or rounded, stiffly chartaceous and often folded on drying, minutely (0.1 mm.) ciliolate along the apical edges but glabrous on the surfaces, venation palmate but the 3 major veins usually obscure. Inflorescence terminal and solitary, simple, 1.5–4 cm. long; the peduncle 2–5 mm. long, 0.3–0.6 mm. thick, glabrous, flowering rachis about 0.7 mm. thick, the flowers remaining congested on the rachis; floral bracts 0.3–0.5 mm. long, conspicuously pellucid punctate; anthers 0.1–0.2 mm. long; sometimes broader than long; pistil borne in a depression in the rachis; fruit subbasally or sublaterally attached in a slight depression in the rachis and exserted on a short (0.2–0.4 mm.) flat pseudopedicel in late stages, body of the fruit 0.4–0.5 mm. long, 0.4–0.5 mm. thick, globose-ovoid, with a small (0.1 mm.) oblique beak, the stigma central and subapical on the abaxial side of the beak, surface dark reddish pellucid verrucose with a pale colored area near the point of attachment.

Plants of the wet evergreen forest formation on the Caribbean slopes; endemic to Costa Rica. I have only seen the following collections: *Oersted 977* (photo, C); *Pittier 4246*, near Tres Rios; *Holm & Iltis 35*, SE of Turrialba; *W.W. & H.E. Rowlee 354*, Talamanca Valley; *Burger & Stolze 5917*, along the Rio Puerto Viejo. These were collected from May to August.

Distinctive little plants with apparently distichous alternate leaves on short unbranched stems with solitary spikes and fruit attached on the side. Closely related to *P. tenellaeformis* which differs in the usually glabrous stems, leaves more obviously narrowed at the apex, lack of pseudopedicels, and higher altitudinal range. All the material that I have seen has been collected between sea level and about 1,200 m. altitude. However, the original description cites the type locality as "monte Irasu alt. 8,000 ped. (*Oersted*) *in herb. suo*)." It may be that this name is being used incorrectly or that the data of the type collection are incorrect.

Peperomia olivacea C.DC., Journ. Bot. 4:146. 1866. *P. barbana* C.DC., Bull. Soc. Bot. Belg. 29, pt. 2:70. 1890. *P. copeyana* C.DC. ex Schroeder, Candollea 3:123. 1926. *P. pililimba* C.DC. ex Schroeder, l.c. 131. *P. olivacea* var. *perlongispica* Trel., Contr.

U.S. Nat. Herb. 26:221. 1929. *P. substrigosa* Trel. in Standl., Field Mus. Bot. 18:327. 1937.

Epiphytic or terrestrial herbs, stems erect, to about 35 cm. tall, the flowering stems usually unbranched (but see discussion), leafy internodes 4–25 mm. long, 1–5 mm. thick, usually densely puberulent with curved hairs about 0.7 mm. long and usually ascending. Leaves opposite or whorled, 2 to 4 at a node, only rarely congested at the apex of the stem; petiole 1–6 mm. long, 0.4–1 mm. thick, densely puberulent or occasionally glabrous, grooved on the adaxial side; lamina (10) 16–36 mm. long, 4–15 mm. broad, obovate to oblanceolate or elliptic, obtuse or rounded at the apex, often emarginate at the tip, gradually tapering to the acute or attenuate base, drying stiffly chartaceous or subcoriaceous, puberulent throughout or glabrous on the surfaces and minutely (0.1–0.2 mm.) puberulent only at the apex, venation palmate but usually obscure, the 3 major veins united near the base. Inflorescence terminal or occasionally axillary, solitary or less-often several at a node, simple, 6–27 cm. long; peduncle 6–20 (30) mm. long, 0.7–1.6 mm. thick, puberulent, flowering rachis to 24 cm. long, 1–3 mm. thick, the flowers usually remaining congested on the spike; floral bracts about 0.4 mm. long, conspicuously pellucid punctate; anthers 0.1–0.2 mm. long; pistil borne in a depression in the rachis; fruit sublaterally attached in a slight depression in the rachis and strongly ascending, body of the fruit 0.5–0.6 mm. long and 0.4–0.5 mm. thick, globose-ovoid, the surface conspicuously reddish pellucid verrucose, whitish and crateriform at the point of attachment, a short (0.1–0.2 mm.) oblique beak of paler colored tissue present at the apex, stigma subapical on the abaxial side of the beak.

Plants of the moist and seasonally dry forests of higher altitudes, between (500) 1,000 and 2,000 m. elevation. Ranging from Mexico to Panama; flowering throughout the year.

Readily recognized by the usually hairy stems with opposite or whorled succulent leaves, long inflorescences (at maturity), and almost laterally attached fruit with small beak. Most of the collections have thick solitary spikes on the ends of unbranched stems and these are found between 1,400 and 2,000 m. elevation. The plants of lower elevations have thinner spikes (often several at a node) on conspicuously branched stems. The specimens from lower elevations are without fruit and I believe they are only ecotypic variants. The photograph of the type (*Hoffmann 810* in Berlin, FM negative #10820) was collected near San Jose and is representative of these plants of lower altitudes. *P. barbana* C.DC. is the earliest Costa Rican name applicable to the plants of higher elevations.

Peperomia omnicola C.DC., Bull. Herb. Boiss. 6:507. 1898. *P. substriata* C.DC. ex Schroeder, Candollea 3:134. 1926. *P. pothifolia* Trel., Contr. U.S. Nat. Herb. 26:210. 1929. *P. huitzensis* Standl. & Steyer., Fieldiana: Bot. 24, pt. 3:253. 1952.

Terrestrial or epiphytic herbs to 1 m. tall, the stems to 2 m. long and often unbranched, leafy internodes 1.2–6 cm. long, 2–7 mm. thick (dry), minutely puberulent and becoming glabrescent, the hairs slender and bent, to 0.5 mm. long. Leaves alternate and often approximate at the end of the stem; petioles (1.5) 3–8 cm. long, 1–3 mm. thick, densely puberulent in early stages but becoming glabrous, deeply grooved adaxially and clasping the stem at the base; lamina 5–22 cm. long, 3–8 (10) cm. broad, oblong-elliptic but sometimes broadest above or below the middle, acute or short-acuminate at the apex, tapering abruptly or sometimes rounded at the obtuse, equal or unequal base, drying stiffly chartaceous and usually paler in color beneath, with slender appressed hairs 0.1–0.3 mm. long on both surfaces but becoming glabrous with age, venation pinnate but somewhat obscure, the 4 to 7 pairs of major secondary veins arising from throughout the length of the midvein. Inflorescence terminal or leaf-opposed, solitary at the node, to 30 cm. long, compound of (3) 5 to 15 spikes on a branched or unbranched axis and umbellate to paniculate in arrangement, the common peduncle to 7 cm. long, 0.7–2.5 mm. thick, minutely (0.1–0.3 mm.) puberulent, individual spikes 5 to 18 cm. long, flowering rachis becoming 2 mm. thick, the flowers and fruit becoming slightly separated on the rachis; floral bracts about 0.5 mm. long, pellucid punctate; anthers 0.1–0.2 mm. long; pistil borne in a depression in the rachis, stigma central to the translucent tissue of the broadly triangular beak; fruit basally attached in a slight depression in the rachis, erect or ascending, body of the fruit 0.7–0.9 mm. long and 0.5–0.7 mm. thick, narrowly ovoid, reddish pellucid verrucose but whitish at the base, the beak short (0.2–0.3 mm.) and recurved, the round (0.1 mm.) stigma sessile near the abaxial base of the beak.

Plants of wet forests from sea level to 2,000 m. altitude and thus far collected only on the Caribbean drainage in Costa Rica. Ranging from Guatemala (type of *P. huitzensis, Steyermark 48613*) to Ecuador and Venezuela.

Distinguished by the long-petiolate leaves with slender hairs and the usually terminal compound inflorescence with wide-spreading spikes and beaked fruit. Our material appears to be conspecific with South American material identified as *P. omnicola* by Yuncker. This species is quite variable and closely allied to *P. dotana*. Together with *P. mameiana* and *P. dotana*, these species form a natural group quite difficult to separate. The variation in inflorescence and leaf morphology has given rise to far too many names; more collecting may prove that some of the species accepted here are only variants of another.

Peperomia palmana C.DC., Bull. Soc. Bot. Belg. 29, pt. 2:71. 1890; 30:233. 1891. *P. oxystachya* C.DC., Anal. Inst. Fis.-Geog. Costa Rica 9:180. 1897, fide Trel. *P. palmana* var. *pseudo-oxystachya* Trel., Contr. U. S. Nat. Herb. 26:221. 1929. *P. manueli* Trel. in Standl., Field Mus. Pub. Bot. 18:1544. 1938. *P. nudinodis* Trel. in

Standl., l.c. 18:1545. 1938. *P. quotifolia* Trel. in Standl., l.c. 18:1545. *P. laesa* Trel. in Woodson & Schery, Ann. Mo. Bot. Gard. 27:402. 1940.

Epiphytic or terrestrial herbs, erect to 40 cm. tall with stems of very different form often on the same rootstock, unbranched or with widely separated open branching, leafy internodes 1–5 cm. long, 0.5–2.7 mm. thick (dry), apparently glabrous or very minutely (0.03–0.1mm.) puberulent. Leaves opposite or whorled, 2 to 4 at a node, usually well spaced along the stem; petioles 1.2–6 mm. long, 0.2–0.8 mm. thick, grooved on the adaxial side, glabrous or minutely puberulent; lamina 1–4 cm. long, 0.6–2 cm. broad, elliptic or narrowly ovate to lanceolate, quite variable (often on the same plant), occasionally rounded at the apex but more often tapering to an obtuse to long-acuminate apex, obtuse to acute at the base, drying membranaceous to thin chartaceous, minutely puberulent on the margin at the apex and usually glabrous on the surfaces, venation palmate with the 3 major veins often visible on both sides, punctate on both surfaces. Inflorescences axillary or terminal, 1 to 8 at a node but most often as many as the leaves, simple, 2–10 cm. long; peduncles 5–20 mm. long, 0.2–0.8 mm. thick, glabrous or very sparsely and minutely puberulent, flowering rachis becoming 8 cm. long, 0.4–1.6 mm. thick, glabrous, the flowers becoming somewhat separate on the rachis; floral bracts 0.3–0.5 mm. long, distinctly orange or dark pellucid punctate; anthers with very short (0.1–0.2 mm.) filaments, thecae 0.2–0.3 mm. long and often broader than long, occasionally pellucid punctate; pistil borne in a slight depression in the rachis; fruit subbasally attached and ascending but becoming elevated on a short (0.3–0.5 mm.) flat pseudopedicel in late stages, body of the fruit usually ovoid, about 0.6 mm. long and 0.5 mm. thick, narrowed at the apex to form a very short (0.1 mm.) somewhat oblique beaklike structure, the stigma subapical, surface of the fruit dark reddish pellucid tuberculate, narrowed and whitish at the base.

A common species between 1,000 and 2,800 m. altitudes in wet evergreen forest formations. Flowering throughout the year and to be expected throughout Costa Rica in the highlands. The species, as presently known, ranges from the Sierra de Tilaran (Monteverde) to the province of Chiriqui, Panama.

A variable species characterized by the open-branched habit or whorls of spikes on unbranched stems (often on the same plant), the minute puberulence, slender spikes, and unusual fruit (rare in collections). Quite distinct among Costa Rican peperomias but probably related to *P. galioides*.

Peperomia panamensis C.DC. ex Schroeder, Candollea 3:130. 1926. *P. cryptolepida* Trel., Contr. U. S. Nat. Herb. 26:206. 1929. *P. delecta* Trel., l.c. *P. megalanthera* Trel., l.c. *P. calyculata* Trel., l.c. 207. *P. congestifolia* Trel., l.c. *P. saltivagans* Trel. in Standl., Field Mus. Bot. 18:324. 1937. *P. san-pedroana* Trel. in Standl., l.c. 325.

Repent or climbing epiphytes, the stems with adventitous roots at most nodes, erect flowering shoots less than 5 cm. tall, leafy internodes 1–28 mm. long, about 0.5 mm. thick, glabrous or very minutely (0.1 mm.) puberulent. Leaves alternate or subopposite at the shoot apex, sometimes congested near the ends of shoots; petioles 1–8 (12) mm. long, 0.3–0.5 mm. thick, glabrous or sparsely puberulent, grooved adaxially and decurrent on the stem; lamina 5–15 (25) mm. long, 4–12 (20) mm. broad, ovate to orbicular or elliptic, usually tapering to the rounded or obtuse apex, obtuse or rounded at the base, usually glabrous on the surfaces but with minute (0.1 mm.) hairs near the edge of the apex, drying chartaceous and opaque, venation palmate, the 3 or 5 major veins usually obscure and free to the base. Inflorescence terminal or axillary, 1 or 2 at a node, simple, to 25 mm. long; peduncle 4–12 (18) mm. long, about 0.5 mm. thick, glabrous, flowering rachis 5–15 mm. long and 1–2 mm. thick, flowers remaining crowded or somewhat separate after the anthers are shed; floral bracts 0.3–0.5 mm. long, pellucid punctate and often with a thin peripheral margin free of dots; anthers 0.2–0.4 (0.5) mm. long, longer than broad; pistil deeply immersed in the rachis, stigma usually surrounded by a ring of translucent tissue; fruit basally attached within a deep depression in the rachis and becoming elevated on a very short pseudopedicel only in late stages, body of the fruit 0.7–1 mm. long, turbinate or cylindrical but apparently globose or ovoid when the lower portion is immersed within the rachis, smooth and paler colored beneath, the upper surface distinctly pellucid punctate or pellucid verrucose, stigma apparently apical and sessile.

Plants of evergreen wet forests formations between sea level and 1,800 m. altitude. Collected only on the Caribbean watershed and around the Meseta Central between November and May. The species ranges from Costa Rica to Colombia and Trinidad.

Peperomia panamensis is very closely related to *P. rotundifolia* but differs in the larger anthers and floral bracts, development of the fruit within the rachis to produce a turbinate form, and the more glabrous thicker (dried) leaves that can grow to a larger size. These small alternate leaved creeping peperomias are often poorly preserved and further study of the living populations will have to confirm the validity of what here are described as species.

Peperomia pellucida (L.) H.B.K., Nov. Gen. & Sp. 1:64. 1815. *Piper pellucidum* L. Sp. Pl. 30. 1753. *Peperomia translucens* Trel. in Standl., Field Mus. Bot. 18:328. 1937.

Terrestrial or rarely epiphytic herbs to 35 cm. tall, often with a single main stem and divergent lateral branches, succulent and often drying translucent, leafy internodes 1–5 cm. long, 1–3 mm. thick, sometimes with longitudinal ridges continuous with the leaf-base, glabrous. Leaves alternate throughout but congested and subopposite near the shoot apices; petioles 3–15 mm. long, 0.3–1 mm. thick, glabrous, grooved on the adaxial side and decurrent on the stem; lamina 8–30 mm. long, 8–22 mm. broad, broadly ovate, obtuse or bluntly acute at the apex, rounded and truncate or subcordate at the base, drying membranaceous and usually trans-

lucent, often slightly darker above, glabrous throughout, venation palmate and visible on both surfaces, with usually 5 major veins separate to the base, the midvein with a pair of secondary veins near the middle of the lamina. Inflorescences leaf-opposed or terminal, less often axillary, 1 or 2 at a node or several at the shoot-apex, simple, 2–8 cm. long; peduncle 2–8 mm. long, 0.3–0.8 mm. thick, glabrous and translucent (dry), flowering rachis 0.3–0.8 mm. thick and often becoming ridged on drying, the flowers becoming distant on the glabrous rachis; floral bracts about 0.4 mm. long, obscurely pellucid punctate, thin and translucent, often bent in the center with the proximal half appressed to the rachis; anthers 0.1–0.2 mm. long; pistil borne on the rachis or in a slight depression; fruit basally attached from within a slight depression on the rachis and usually ascending, body of the fruit 0.5–0.6 mm. long, 0.4–0.5 mm. thick, globose ovoid, the surface with minute white dots and developing longitudinal ridges in later stages, the prominent longitudinal ridges often interconnected by minute horizontal ribbing, the stigma terminal on a short (0.1–0.2 mm.) style of paler colored tissue.

Plants of wet or moist situations on both the Caribbean and Pacific watersheds between sea level and 1,500 m. elevation; flowering throughout the year. This is a weedy species common to areas of cultivation and disturbance; usually under shade. *Peperomia pellucida* is widespread in tropical North and South America, the West Indies, and is also found in the tropics of the Old World.

Distinct by the nature of their unusual fruit, glabrous parts drying very thin, and apparently short-lived weedy habit. The species is very similar in general vegetative morphology and inflorescence to *P. hispidula* but it differs in the lack of hairs, very different fruit, and lowland habitat.

Peperomia peltilimba C.DC. ex Trel., Bot. Gaz. 73:145. 1922. *P. otoni* Trel. in Standl., Field Mus. Bot. 18:319. 1937. *P. clavigera* Standl. & Steyerm., Fieldiana: Bot. 24, pt. 3:240. 1952.

Scandent or climbing epiphytes, stems rooting at most nodes, leafy internodes 8–60 mm. long, 1.2–2 mm. thick, glabrous or sparsely and minutely (0.1–0.2 mm.) puberulent. Leaves alternate and peltate, usually evenly spaced along the stem; petiole 2.5–6.5 cm. long, 1–1.5 mm. thick, usually glabrous, attached 3–10 mm. from the base of the blade; lamina 3–7 cm. long, 2–4 cm. broad, ovate and gradually tapering to the acuminate apex, rounded at the base, drying thin to stiffly chartaceous, glabrous or sparsely and minutely (0.1–0.2 mm.) puberulent especially along the edge, venation palmate and obscure on both sides, the 5 to 9 major veins separate or united only near the base. Inflorescence axillary, terminal, or leaf-opposed, 1 or 2 per node, simple or compound and then usually of 2 spikes on a common peduncle, the common peduncle 6–18 mm. long and about 0.8 mm. thick, minutely (0.1 mm.) puberulent, with a node or bract near the middle or subtending the lower spike when 2 or more spikes are present, flowering rachis 10–24 mm. long and about 2 mm. thick at anthesis, the flowers remaining congested on the rachis; floral bracts 0.3–0.4 mm. long, orange-pellucid punctate; anthers 0.2–0.4 mm. long, forming bands around the spike in early stages; pistil

borne on the surface of the spike, erect or ascending; fruit borne in a slight depression on the surface of the rachis, body of the fruit about 0.8 mm. long and 0.4 mm. thick, narrowly ellipsoid or narrowly ovoid, reddish pellucid verrucose, stigma borne at the abaxial base of the translucent beak, the beak 0.3–0.5 mm. long, slender and readily breaking off when dry.

Plants of wet evergreen forests between 1,000 and 2,200 m. altitude usually growing on tree trunks and rocks. Thus far only collected around the Meseta Central but ranging to Guatemala.

This species is very closely related to *P. hernandiifolia* and may in fact be nothing more than a depauperate form of that species. It differs from *P. hernandiifolia* in the generally smaller parts, thinner leaves, and stems less than 25 cm. long.

Peperomia pereskiaefolia (Jacq.) H.B.K., Nov. Gen. & Sp. 1:68. 1815. *Piper pereskiaefolium* Jacq., Collect. 4:126. 1790. *Peperomia glutinosa* Millsp., Field Mus. Pub. Bot. 1:293, pl. 12. 1896. *P. crassiuscula* Millsp., l.c. 2:33. 1900. *P. viridispica* Trel., Contr. U.S. Nat. Herb. 26:44. 1927. *P. lundellii* Trel. in Standl., Field Mus. Pub. Bot. 12:406. 1936. *P. wagneri* Trel. in Yuncker, l.c. 9:276. 1940.

Epiphytic or epilithic herbs, usually marked with red or purple, the stems succulent and often pendant, with few branches, leafy internodes 1–7 cm. long, 1.5–4.5 mm. thick and deeply sulcate on drying, glabrous. Leaves opposite or whorled, 2, 3 or 4 at a node, usually evenly spaced along the stem; petioles 4–10 mm. long, 0.6–1.8 mm. thick, glabrous and with the cuticle flaking off, grooved on the adaxial side, lamina 2–6 cm. long, 1.2–3 cm. broad, elliptic or obovate, obtuse to acute or short-acuminate at the apex, often rounded at the very tip, gradually tapering to the attenuate or obtuse base, drying chartaceous or more often subcoriaceous and grayish, usually opaque, glabrous, usually punctate on both surfaces, the epidermal cells quite large (0.03 mm.), venation palmate but obscure in the older leaves, major veins 3 to 5 with only the central 3 reaching the center of the blade. Inflorescence terminal and solitary, simple, to 15 cm. long; peduncle 15–40 mm. long, 0.8–2.5 mm. thick, glabrous, flowering rachis 1–3 mm. thick, the flowers becoming separate on the glabrous rachis; floral bracts 0.6–1.1 mm. long, distinctly longer than broad, reddish pellucid punctate; anthers 0.4–0.5 mm. long; pistil borne within a depression in the rachis; fruit subbasally or laterally attached within a depression in the rachis, usually ascending, body of the fruit about 0.7 mm. long and 0.5 mm. thick, globose ovoid, a short (0.1–0.3 mm.) style present at the abruptly narrowed apex, stigma apical on the style, surface of the fruit reddish pellucid and usually drying smooth, pseudocupule obscure, pseudopedicels not seen.

I have seen no material of this species from Costa Rica but collections from Nicaragua (*Williams & Molina 20190, 20202; Williams & Williams 24049*) and Panama (*Standley 3783*) suggest that this species should be found on the seasonally dry Pacific slope between sea level and 1,200 m. altitude.

Readily distinguished from all other opposite larger leaved peperomias in our area by the unusually large floral bracts and anthers, separate flowers, terminal stigmas, glabrous parts, and deciduous-forest habitat. I have used an early name even though the assignment of the Central American plants to this name is very tentative. The taxonomy of this group of peperomias (*P. trifolia* (L.) A. Dietr., *P. victoriana* C.DC., et al.) is in very poor order. Contributing factors to this state of affairs are the relative scarcity of collections and the very succulent nature of these plants which produces great variations in the dried specimens. This species, whatever its name and final disposition, is closely related to *P. emiliana* (q. v.).

Peperomia pernambucensis Miq. in Hook., Lond. Journ. Bot. 4:420. 1845. *P. atirroana* Trel., Contr. U.S. Nat. Herb. 26:208. 1929. *P. brevicaulis* Trel., l.c. 208. *P. breviscapa* Trel., l.c. 209. *P. subacaulis* Trel., l.c. 209.

Erect herbs, usually epiphytic, stems to 10 cm. tall, leafy internodes to 18 mm long and 8 mm. thick (dry), glabrous or minutely (0.1 mm.) puberulent. Leaves alternate and usually crowded at the end of the short stem; petioles 2–7 cm. long, about 5 mm. broad, glabrous or minutely puberulent, deeply grooved on the adaxial side with thin margins continuous with the margin of the lamina and clasping the stem at the base; lamina (10) 15–30 cm. long, (3.2) 4.5–11 cm. broad, narrowly elliptic to obovate or oblanceolate, tapering to the acute or short-acuminate apex (rarely blunt or obtuse), gradually tapering to the attenuate or acute base, succulent but drying stiffly chartaceous, glabrous, venation pinnate but usually obscure, the 3 to 6 pairs of major secondary veins arising throughout the length of the midvein. Inflorescence terminal, axillary, or leaf-opposed, solitary at a node, (5) 10–24 cm. long, compound or as many as 25 spikes alternate or in whorls on the unbranched rachis, common peduncle 4–10 cm. long, 0.8–2.5 mm. thick, densely and very minutely (0.05 mm.) puberulent or apparently glabrous, with 1 to 3 leafless nodes, peduncles of the spikes 2–4 mm. long, the flowering rachis 8–25 mm. long, about 0.7–1.7 mm. thick, the flowers and fruit remaining crowded on the rachis; floral bracts 0.2–0.3 mm. long, pellucid punctate; anthers about 0.3 mm. long; fruit basally attached in a slight depression in the rachis, erect, body of the fruit 0.8–1 mm. long, 0.4–0.5 mm. thick, cylindrical or slightly obovoid, surface reddish pellucid verrucose and somewhat paler at the very base, abruptly flattened and slightly oblique at the apex, the stigma sessile and apical, with the adjacent tissue often translucent and becoming raised only 0.1 mm. above the fruit, a definite beak not developed.

Plants of wet evergreen forests between sea level and 1,600 m. elevation in the Caribbean watershed; probably flowering throughout the year. Ranging from southern Nicaragua to Colombia and the Guianas. Usually found as isolated individual plants.

Distinguished from all other Costa Rican peperomias by the racemiform panicle of short spikes and the large attenuate leaves on short stems. Apparently related to *P. poasana* among Costa Rican species which shares the short spikes and form of the fruit.

Peperomia petrophila C.DC., Linnaea 37:369. 1872.

Terrestrial herbs to 25 cm. tall, erect stems unbranched and rooting at the decumbent base, somewhat woody in appearance when dry, with a bark-like surface and leaf-scars about 2 mm. broad, leafy internodes to 1 cm. long, 1–3 mm. thick, glabrous. Leaves alternate in a spiral and usually borne close together at the apex of the stem; petioles 8–20 (35) mm. long, 0.5–1 mm. thick, glabrous, grooved adaxially and expanded at the base, decurrent on the stem; lamina 5–11 cm. long, 1.2–2 (3) cm. broad, very narrowly elliptic or lanceolate, gradually tapering to the narrowly acute or acuminate apex, acute at the base, drying membranaceous to thin-chartaceous, glabrous but with very minute (0.03 mm.) hairs at the edge of the tip, with dark reddish dots on both surfaces, venation pinnate and visible on both surfaces, prominent beneath, with 1 or 2 pairs of major secondary veins arising from the lower third of the midvein and arcuate ascending. Inflorescence apparently solitary and axillary but usually only a single inflorescence present at or near the stem-apex, simple, 5–12 cm. long; peduncle 10–25 mm. long, 0.5–1.2 mm. thick, glabrous, flowering rachis 1.5–3 mm. thick, the flowers remaining crowded on the rachis; floral bracts about 0.5 mm. long, conspicuously reddish pellucid punctate with a clear margin around the edge; anthers 0.1–0.2 mm. long, occasionally minutely punctate; pistil borne in a depression in the rachis; fruit subbasally attached in a depression in the rachis, erect or ascending, body of the fruit 0.6–0.8 mm. long, 0.6–0.7 mm. thick, becoming globose-ovoid, the lower surface smooth and grayish in color, the upper part conspicuously reddish pellucid punctate and terminating in a conical or oblique apex, the stigma apical or subapical on the very short (0.1–0.2 mm.) beak-like punctate apex.

Plants of evergreen forest formations or in moist protected situations between 1,000 and 2,000 m. altitude. The species is known from Mexico, Guatemala, Honduras, and Colombia but has not been reported from Costa Rica or adjacent countries.

Short single-stemmed plants with a single terminal (or pseudoterminal) spike, very narrow leaves, and conspicuous reddish dots on many parts. The unusual fruit with pellucid dots on the upper part and beaklike apex suggest a close relationship with *P. lignescens* but the latter has very different leaves, more spikes, and less crowded flowers.

Peperomia pittieri C.DC., Bull. Soc. Bot. Belg. 30:235. 1891. *P. muscotecta* Trel. in Standl., Field Mus. Pub. Bot. 18:1545. 1938.

Epiphytic herbs, flowering stems erect and few-branched, to about 10 cm. tall, leafy internodes 3–16 mm. long, 0.2–0.8 mm. thick and strongly ribbed when dry, glabrous or with a few minute (0.5 mm.) whitish hairs at the nodes. Leaves whorled

or sometimes opposite at the lower nodes, not conspicuously congested at the stem apex; 2 to 10 leaves per node (the internodes apparently contracted and the whorls superposed at nodes with more than 4 leaves); petioles 0.5–1.5 mm. long, about 0.2 mm. thick, glabrous; laminae often heteromorphic with those near the base of the stem ovate to orbicular, about 3×3 mm., the upper and more numerous laminae very narrowly oblong, 3–9 mm. long and 0.5–2.5 mm. broad, all the laminae rounded and emarginate at the apex, obtuse at the base, drying membranaceous to thin-chartaceous and often translucent with very minute (0.05 mm.) hairs at the distal edge, venation pinnate. Inflorescence usually terminal, solitary or 2 or 3 at a node, simple, 10–35 mm. long, peduncle 3–16 mm. long, 0.2–0.5 mm. thick, glabrous, flowering rachis 0.5–1 mm. thick, the flowers becoming separate on the glabrous rachis; floral bracts 0.3–0.5 mm. long, longer than broad and often bent away from the rachis apically, inconspicuously pellucid punctate; anthers about 0.1 mm. long, filaments 0.1–0.2 mm. long; pistil borne in a depression in the rachis, stylose from early stages, with a fimbriate stigma; fruit distinctly pedicellate, the pedicel to 1 mm. long and about 0.7 mm. thick, body of the fruit 0.7–1.1 mm. long, 0.3–0.4 mm. thick, narrowly obovoid, surface orange pellucid and slightly verrucose, stigma terminal on a short (0.1 mm.) conical style of lighter colored tissue.

A very distinctive species usually found on moss-covered tree-trunks between 1,200 and 2,200 m. elevation. Known only from the evergreen wet montane forests of Costa Rica, around the Meseta Central and the western Cordillera de Talamanca. Flowering collections have been made between September and March.

The small, almost linear, whorled leaves on short stems, inflorescence with separate flowers and saddle-shaped bracts, and long-pedicellate fruit distinguish this species. Rather similar in appearance to very young specimens of *P. galioides*, but these are minutely puberulent. On the basis of inflorescence and fruit, this species appears to be related to *P. tenella* and *P. pedicellata* Dahlst.

Peperomia poasana C.DC., Bull. Soc. Bot. Belg. 30:224. 1891. *P. poasana* var. *herediana* Trel., Contr. U.S. Nat. Herb. 26:208. 1929.

Erect herbs to 0.7 m. tall, terrestrial or epiphytic, leafy internodes 15–85 mm. long, 1.5–4 mm. thick (dry), glabrous. Leaves alternate and well spaced along the stem; petioles 6–45 mm. long, about 1.5 mm. thick, deeply grooved and with thin margins on the adaxial side, the margins continuous with the margin of the lamina and clasping the stem at the base, glabrous; lamina 5–15 cm. long, 2.4–5 cm. broad, elliptic, gradually tapering to the acuminate apex, gradually tapering to the attenuate base, drying chartaceous and distinctly paler beneath than above, glabrous, venation pinnate and usually visible on both surfaces, prominent beneath and sometimes impressed above, the 3 or 4 pairs of major secondary veins arising from the lower two-thirds of the midvein and arcuate ascending. Inflorescence terminal, leaf-opposed, or axillary, 6–15 cm. long, solitary or occasionally 2 at a

node, compound with the main axis usually branched, the 15 to 40 spikes borne in whorls or groups on the main axis or on the alternating secondary branches, common peduncle (to the first spike) 4–9 cm. long, about 1.2 mm. thick (dry), glabrous; spikes 4–18 mm. long, flowering rachis 3–10 mm. long, about 0.8 mm. thick, the flowers remaining crowded on the rachis; floral bracts about 0.3 mm. long, pellucid punctate; anthers about 0.3 mm. long; fruit basally attached in a depression in the rachis, erect, body of the fruit 0.6–0.8 mm. long, 0.3–0.4 mm. thick, obovoid to cylindrical, stigma sessile and apical, a beak not developed, surface of the fruit orange pellucid verrucose.

Plants of the wet evergreen forest floor between 1,500 and 2,500 m. altitude. Collected on the Caribbean slopes of the Meseta Central and in the Cordillera de Talamanca. Apparently endemic to Costa Rica and collected only between December and May.

Distinguished from all other Costa Rican peperomias by the compound paniculate inflorescence with very short spikes. Apparently related to *P. pernambucensis*, among Costa Rican species, which shares the characters of the compound inflorescence with short spikes and the form of the fruit. A very closely related and apparently undescribed species has recently been found on the ridge-top mist forest of Cerro Jefe in central Panama on the Pacific slope.

Peperomia pseudo-alpina Trel., Contr. U.S. Nat. Herb. 26:217. 1929. *P. palmensis* Trel. in Standl., Field Mus. Bot. 18:320. 1937. *P. solisii* Trel. in Standl., l.c. 326.

Epiphytic or terrestrial herbs, the stems erect and usually 10–30 cm. tall, branched or unbranched, leafy internodes 1–5 cm. long, 1–4 mm. thick (dry), glabrous. Leaves alternate, usually evenly spaced along the stem; petioles 3–14 (20) mm. long, 0.7–2 mm. thick, grooved on the adaxial side with the margins continuous with the edge of the lamina; glabrous; lamina 2–7 cm. long, 1.5–5 cm. broad, usually broadly elliptic or broadly obovate, tapering abruptly to the rounded or obtuse apex, tapering more gradually to the usually obtuse base, very succulent and drying subcoriaceous, glabrous or very minutely (0.05 mm.) puberulent at the apex, venation pinnate with the 2 to 4 pairs of major secondary veins usually arising from the lower half of the midvein, arcuate ascending, often slightly raised on drying or occasionally obscure. Inflorescence terminal, leaf-opposed, or axillary, usually compound of 2 or 3 spikes or less often of a single spike on a nodose peduncle, to 15 cm. long, the common peduncle (to the first spike) 5–50 mm. long, 0.5–2 mm. thick with 1 or 2 nodes bracteate in early stages; peduncles of the individual spikes subequal, glabrous, individual spikes 2–8.5 cm. long, flowering rachis 1.5–6 cm. long, 0.8–2.5 mm. thick, the flowers remaining crowded on the rachis; floral bracts 0.3–0.7 mm. long, range pellucid punctate; anthers 0.2–0.4 mm. long; pistil borne in a depression in the rachis; fruit basally attached in a deep depression in the rachis, erect or ascending, body of the fruit 0.7–1 mm. long, 0.4–0.6 mm. long, narrowly ellipsoid or cylindrical, orange pellucid verrucose, the beak 0.3–

0.7 mm. long and usually recurved at the tip, very slender (0.05 mm.) and translucent in the upper part but with thicker tissue at the base, stigma sessile at the abaxial base of the beak.

Plants of the wet evergreen montane forests between 1,000 and 2,300 m. altitude; collected only around the central highlands but to be expected throughout Costa Rica at the middle altitudes; flowering throughout the year. Ranging from Guatemala to Costa Rica and probably into South America (see the discussion below).

This species is readily recognized by the thick alternate leaves, laminae with blunt apices and almost as broad as long, usually compound spike, and montane habitat. At first, I placed the material referred here under *P. obtusifolia* and this taxon may in fact be a high altitude ecotype of that species. In addition, *P. pseudo-alpina* appears to be intermediate between *P. obtusifolia* and *P. alpina* in many respects. I believe it is best to file our collections under the three separate "species" until these taxa can be studied over a broad geographical range. Transplant studies and growing seeds of a single plant at various altitudes are also necessary before definite conclusions can be reached.

Peperomia pseudo-dependens C.DC., Journ. Bot. 4:137. 1866. *P. rio-poasensis* Trel. in Standl., Field Mus. Bot. 18:324. 1937. *P. rio-poasensis* var. *subacaulescens* Trel. in Standl., l.c. *P. quirosi* Trel. in Standl., l.c. 1545. 1938.

Weak-stemmed herbs, apparently terrestrial, stems decumbent and not more than 10 cm. tall, few-branched with adventitious roots at most of the lower nodes, leafy internodes to 15 mm. long, 0.8–2 (4) mm. thick, glabrous. Leaves alternate in a spiral, crowded on short stems or distant; petioles 3–12 cm. long, 0.5–1.5 mm. thick, glabrous, grooved adaxially, expanded at the base and clasping the stem; lamina 3–7 (11) cm. long, 2.5–6 cm. broad, broadly ovate to orbicular, tapering abruptly to the obtuse or rounded apex, truncate to subcordate at the base, usually folded at the attachment of the petiole when pressed, drying membranaceous to thin-chartaceous, opaque or translucent and often paler beneath, glabrous above and below but very minutely (0.03 mm.) and sparsely puberulent along the edge, bright pellucid dots often present on both surfaces, venation palmate and visible on both surfaces, major veins 7 to 11, the 3 central veins united up to 1 cm. above the base. Inflorescences axillary or pseudo-terminal, 1 to 3 at a node, simple, 4–10 (15) cm. long; peduncle 5–15 mm. long, about 1 mm. thick, glabrous, flowering rachis 1.5–3 mm. thick, the flowers remaining approximate or becoming distant on the rachis but usually remaining in whorls or spirals, the rachis smooth and glabrous; floral bracts 0.3–0.5 mm. long, pellucid punctate and often bright orange in color; anthers 0.1–0.2 mm. long; pistil borne in a depression in the rachis; fruit basally or subbasally attached in a depression in the rachis, ascending, body of the fruit becoming 0.8 mm. long and 0.6 mm. thick, globose-ovoid, with a conspicuous groove on the adaxial side continuous with the

crateriform point of attachment, the lower portion pale-colored and smooth, the upper part pellucid punctate or verrucose, slightly narrowed at the apex to form a very short (0.1 mm.) beak-like projection, stigma apparently apical on the pellucid apical tissue.

Rare plants of moist situations between sea level and 1,500 m. elevation. Known in Costa Rica from only the following collections, all from Carrillos de Poas (Alajuela): *Quiros 7; Brenes 17246, 17247,* and *19369;* flowering from September to November.

Distinctive weak-stemmed plants with thin rounded leaves, and spikes with the flowering parts in a distinct spiral or in bands. *Peperomia pseudo-dependens* sensu Yuncker (Trelease & Yuncker 1950, 475–476) is closely related and perhaps conspecific with Guatemalan specimens placed under *P. bernoullii* C.DC. by Standley (Fieldiana, Bot. 24; 3:238). *Peperomia killipi* Trel. of Panama is quite similar in appearance but differs in the narrower leaves, papillate flowering rachis, and fruit with a definite beak. *Peperomia pseudo-dependens* is very closely related to *P. lignescens* and may prove to be no more than a variety of that species.

Peperomia quadrifolia (L.) H.B.K., Nov. Gen. & Sp. 1:69. 1815. *Piper quadrifolium* L., Sp. Pl., ed. 2. 43. 1762. *Peperomia subquadrifolia* Trel., Contr. U.S. Nat. Herb. 26:43. 1927. *P. pseudo-tetraphylla* Trel., l.c. 224. 1929. *P. pseudo-tetraphylla* var. *juvenalis* Trel. l.c. *P. rio-albae* Trel. in Standl., Field Mus. Bot. 18:324. 1937.

Erect or repent epiphytic herbs, leafy stems erect and often branched, to 20 cm. tall, leafy internodes 3–28 mm. long, 0.7–2 mm. thick, glabrous and strongly ridged on drying. Leaves whorled or opposite, usually 4 at a node, evenly spaced or somewhat crowded at the apex; petioles 1–2.5 mm. long, 0.2–0.8 mm. thick, grooved on the adaxial side, glabrous but often with the cuticle flaking off; lamina 5–15 mm. long, 2.5–10 mm. broad, obovate, obtuse to rounded and retuse at the apex with a notch (0.5 mm.) at the tip, acute to attenuate at the base, drying subcoriaceous and opaque, glabrous or with a few minute (0.1 mm.) hairs at the apex, venation palmate but the 3 major veins usually obscure. Inflorescences terminal and solitary, simple, 2–6 cm. long, peduncle to 18 mm. long, 0.3–0.8 mm. thick, glabrous and becoming ridged on drying, flowering rachis 1.5–4 cm. long, about 1.2 mm. thick; flowers remaining congested or becoming slightly separated on the glabrous rachis; floral bracts 0.3–0.5 mm. long, pellucid punctate; anthers 0.1–0.2 mm. long, often equally broad; pistil borne within a depression in the rachis; fruit basally attached within a depression in the rachis, erect or ascending, becoming elevated on a conspicuous (0.3 mm.) pseudopedicel in late stages, body of the fruit 0.5–0.7 mm. long, about 0.4 mm. thick, ovoid and broadest at the base or occasionally cylindrical, somewhat asymmetric at the base, acutely narrowed to the terminal stigma, the style-like portion about 0.2 mm. long and drying yellowish-translucent, reddish pellucid verrucose beneath the style, the somewhat thicker lower portion of the fruit with a smooth surface (the "pseudocupule").

Plants of moist evergreen forests between 1,000 and 3,000 m. elevations on both the Caribbean and Pacific slopes of Costa Rica. Ranging from Mexico to northern South America and the West Indies.

Distinguished among the other small peperomias with whorled leaves by the glabrous rachis, form of the fruit, and smaller obovate leaves usually retuse at the apex.

Peperomia reptabunda Trel., Contr. U.S. Nat. Herb. 26:206. 1929. *P. stenophylla* var. *paradendrophila* Trel., l.c. 201. *P. defracta* Trel. in Standl., Field Mus. Bot. 18:312. 1937. *P. defrenata* Trel. in Standl., l.c. 1544. 1938. *P. diruptorum* Trel. in Woodson & Schery, Ann. Mo. Bot. Gard. 27:302. 1940. Figure 1.

Stoloniferous or occasionally repent, epiphytes or terrestrial, erect flowering stems to 15 (25) cm. tall and usually unbranched, leafy internodes 1–10 mm. long on erect flowering shoots, 0.5–1.2 mm. thick, glabrous. Leaves alternate in a spiral, often somewhat crowded at the ends of shoots; petioles 2–8 mm. long, about 0.4 mm. thick, grooved and somewhat winged adaxially, usually decurrent on the stem, glabrous; lamina 1–5 cm. long, 4–15 (20) mm. broad, narrowly elliptic to oblanceolate (or rarely broadly obovate or suborbicular in repent plants), obtuse or acute or sometimes rounded at the apex, attenuate or acute (rarely obtuse) at the base, drying chartaceous and much darker above than below, glabrous on the surfaces but minutely (0.1 mm.) ciliolate along the edge at the tip, venation subpalmate or pinnate, the 2 major lateral veins free or united with the midvein up to 8 mm. from the base, arcuate-ascending, the 3 major veins readily visible beneath. Inflorescence terminal and solitary or rarely axillary or more than 1 per node, simple, 2.5–8 cm. long; peduncle 8–25 mm. long, about 0.5 mm. thick, glabrous, flowering rachis about 1 mm. thick, the flowers remaining crowded on the rachis; floral bracts about 0.5 mm. long, pellucid punctate; anthers 0.1–0.2 mm. long, occasionally punctate and often broader than long; pistil borne in a depression in the rachis; fruit subbasally or sublaterally attached in a depression in the rachis and ascending, often with a groove from the point of attachment partly up the abaxial side, body of the fruit 0.5–0.6 mm. long, about 0.5 mm. thick, globose-ovoid, reddish pellucid verrucose but whitish near the point of attachment, a distinct beak of translucent oblique tissue 0.1–0.2 mm. long present at the apex of the fruit, stigma subapical on the abaxial side of the beak.

Plants of wet evergreen forest formations between sea level and 1,600 m. elevation. The species is endemic to Costa Rica but it is poorly defined and part of a very difficult group (see below); collected in flower from June to January.

In its typical form, a small, erect and unbranched plant with single spikes and narrow leaves with conspicuous venation beneath. Atypical specimens are repent with short obovoid leaves rounded at the apex; the type of *P. reptabunda* (*Tonduz 12791*) is an example of

this form. The relatively long, slender peduncle and small, round fruit attached almost on the side with distinct beak are important characters. *Peperomia diruptorum* Trel. of Panama is very closely related. These belong to a complex of species that are distinguished by the alternate leaves, simple inflorescences, and small beaked fruit attached almost laterally (with respect to the beak). This group includes *P. angularis, P. alata,* and others; immature or atypical material of this complex may be impossible to identify in the dried condition.

Peperomia rhombea Ruiz & Pavon, Fl. Peruv. & Chil. 1:31. 1798. *P. aguacalientis* Trel., Contr. U.S. Nat. Herb. 26:222. 1929. *P. setosispica* Trel. in Standl., Field Mus. Pub. Bot. 18:1546. 1938.

Epiphytic herbs with erect or spreading few-branched stems to 25 cm. tall, leafy internodes 12–40 mm. long, 0.6–1.7 mm. thick, glabrous or very minutely (0.03 mm.) puberulent. Leaves usually in whorls of 4, less often opposite, evenly spaced along the stem; petioles 0.5–2.5 mm. long, about 0.5 mm. thick, the cuticle often peeling off when dried, grooved adaxially; lamina (10) 15–35 mm. long, 4–10 mm. broad, ellipsoid or narrowly rhomboid, tapering to both ends, acute or short-acuminate at the apex but with a blunt and rounded tip, obtuse to acute at the base, drying stiffly chartaceous or subcoriaceous, essentially glabrous, pellucid punctate and often with the cuticle peeling off, venation palmate but obscure. Inflorescence axillary or terminal, 1 to 4 per node, simple, 2.5–6 (12) cm. long; peduncle 8–18 (40) mm. long, 0.4–0.8 mm. thick, glabrous or sparsely and very minutely (0.03 mm.) puberulent, flowering rachis about 1.4 mm. thick, glabrous, the flowers remaining crowded on the rachis; floral bracts 0.3–0.4 mm. long, with conspicuous reddish pellucid dots; anthers 0.2–0.3 mm. long, in diagonally opposed groupings of 4 in early stages; pistil apparently maturing much later than the stamens, deeply imbedded within a depression in the rachis; fruit basally attached in a depression in the rachis and finally elevated on a distinct pseudopedicel 0.3–0.6 mm. long and 0.1–0.2 mm. thick, (the pseudopedicel apparently absent in some plants), body of the fruit 0.6–0.8 mm. long, 0.4–0.5 mm. thick, ovoid, gradually narrowed to the sessile terminal stigma, surface reddish pellucid verrucose in the upper half, the lower half pale in color and smoother in texture (the pseudocupule), a beak not developed but the stigma sometimes subtended by thickened tissue.

Plants of the evergreen wet forest formations of the Caribbean slopes between sea level and 1,500 m. elevation. Known only from central Costa Rica but ranging from Mexico to Brazil and the West Indies (fide Dahlstedt). Rare in collections; I have seen only the following: *Dodge s.n. (23 V 1930), Leon 777, Maxon 711, Pittier 2555 & 3657, Quiros 1199, J.D. Smith 4928,* and *Standley 35909;* flowering between February and June.

The thick usually whorled leaves resemble larger specimens of *P. quadrifolia* and *P. reflexa* but the usually rhombic lamina-shape and

unusual fruit eventually exerted on a pseudopedicel clearly distinguish this species. The absence of adventitious roots at most nodes distinguish it from *P. emiliana*.

Peperomia rotundifolia (L.) H.B.K., Nov. Gen. & Sp. 1:65. 1815. *Piper rotundifolium* L., Sp. Pl. 30. 1753. *Peperomia tenuicaulis* C.DC., Anal. Inst. Fis.-Geog. Costa Rica 9:177. 1897. *P. punctataefolia* Trel., Contr. U.S. Nat. Herb. 26:204. 1929. *P. punctataefolia* var. *munyecoana* Trel., l.c. *P. incisa* Trel., l.c. 205. *P. rejecta* Trel., l.c. 205. *P. delicatissima* var. *venusta* Trel. in Standl., Field Mus. Bot. 18:1544. 1938. *P. cruentata* Trel. in Woodson & Schery, Ann. Mo. Bot. Gard. 27:302. 1940.

Repent or climbing epiphytes with creeping stems rooting at most nodes and short (1–8 cm.) erect flowering shoots, leafy internodes 3–20 mm. long, 0.2–0.7 mm. thick (dry), glabrous or puberulent with thin hairs 0.05–0.6 mm. long. Leaves alternate or subopposite beneath the inflorescence, usually evenly spaced along the stem; petioles 1–4 (7) mm. long, 0.2–0.5 mm. thick, glabrous or puberulent, grooved adaxially and slightly decurrent on the stem; lamina 5–15 (22) mm. long, 3–12 mm. broad, orbicular to elliptic, ovate or obovate, occasionally becoming quite narrow (3:1), rounded or sometimes obtuse at the apex, rounded or tapering to the obtuse base, drying membranaceous to thin-chartaceous, translucent or opaque, puberulent or sometimes glabrous, the surfaces occasionally conspicuously punctate, venation palmate but usually obscure, the 3 major veins separate to the base. Inflorescences usually terminal and solitary on the flowering shoot, simple, 1–4 (7) cm. long; peduncle 1–10 mm. long, 0.2–0.5 mm. thick, glabrous or with thin hairs up to 0.6 mm. long, the hairs sometimes present on the lower part of the rachis, flowering rachis 0.3–1 mm. thick, the flowers becoming slightly separated; floral bracts 0.3–0.7 mm. long, often conspicuously pellucid punctate; anthers 0.1–0.3 mm. long; pistil borne in a depression in the rachis; fruit basally or subbasally attached in a slight depression in the rachis and ascending, becoming exserted on a pseudopedicel (in some) in late stages, body of the fruit 0.5–0.7 mm. long, about 0.5 mm. thick, globose-ovoid, surface reddish pellucid verrucose, stigma apical or subapical on a short (0.1 mm.) and slightly oblique beak-like development on the apex of the fruit.

Small slender plants usually found on slender stems or on tree trunks in wet evergreen forest formations from sea level to 2,200 m. elevation. The species ranges throughout the tropics of this hemisphere; it flowers throughout the year in Costa Rica.

Peperomia rotundifolia is characterized by the very small round to elliptic alternate leaves on slender creeping stems with roots at most nodes. Collections rarely possess mature fruit and it may be that I have placed specimens of biologically distinct taxa under this name. The closely related *P. ebingeri* and *P. panamensis* are like-

wise poorly understood. My circumscription of these species must be considered no more than tentative.

Peperomia saligna H.B.K., Nov. Gen. & Sp. 1:62. 1815. *P. allagotacta* C.DC. ex Schroeder, Candollea 3:121. 1926. *P. bistortaefolia* Trel., Contr. U.S. Nat. Herb. 26:195. 1929.

Epiphytic or terrestrial herbs to 30 cm. tall, the main stem erect or decumbent, about 3–5 mm. thick when dry and woody in appearance with prominent leaf scars, axillary branches slender (1–1.5 mm. thick) and smooth, leafy internodes of the main-stem 2–8 mm. long, 1.2–3 mm. thick, glabrous and with the epidermal layer often exfoliating, internodes to 4 cm. long on the axillary branches. Leaves often dimorphic, alternate in a spiral on the main-stem but usually opposite or subopposite on the lateral (axillary) branches, often crowded near the shoot apex; petiole 0–4 mm. long, about 0.8 mm. thick, glabrous, with a shallow groove and often winged adaxially, broadened at the base and decurrent on the stem; laminae of the main-stem 3–8 cm. long and 8–15 mm. broad, very narrowly elliptic to oblanceolate, tapering to the acute apex, attenuate at the base, laminae of the lateral branches usually shorter (1.5–3 cm.) and more ovate, drying stiffly chartaceous and much paler in color beneath, very minutely (0.1 mm.) puberulent at the edge of the apex and on the midvein above, venation pinnate and readily visible beneath, the 2 or 3 pairs of secondary veins strongly ascending. Inflorescences borne only on the lateral (axillary) branches, terminal or axillary, 1 to 4 at a node, simple, 3–7 cm. long; peduncle 1–3 cm. long, 0.5–1 mm. thick, glabrous, flowering rachis becoming 1.5 mm. thick, the flowers becoming distant on the rachis; floral bracts 0.6–0.7 mm. long, inconspicuously pellucid punctate; anthers 0.2–0.4 mm. long; pistil borne in a slight depression in the rachis; fruit subbasally attached in a depression in the rachis and ascending, body of the fruit 0.7–1 mm. long, 0.5–0.7 mm. thick, obovoid and somewhat flattened on one side, the surface pellucid but very slightly verruculose on drying, stigma subapical in the center of the oblique translucent tissue of the very short (0.1–0.2 mm.) beak, a flat pseudopedicel usually produced in late stages and becoming 0.7 mm. long.

Plants of high montane forest formations and subalpine communities above 2600 m. elevation. Costa Rica is the northernmost extension of this species in North America; it extends southward to Colombia and Ecuador and has been found on Volcan Chiriqui (type of *P. allagotacta*). Only the following collections from Costa Rica are known to me: *Standley & Valerio 44008* (type of *P. bistortaefolia*), *Standley 43693, Carlson 3556, Holm & Iltis 495, Brenes s.n., Jan. 21, 1906;* flowering from November to March.

This species is readily distinguished by its high-altitude habitat, unusual branching pattern, leaf-dimorphism, and obovoid fruit (fully mature). No close relationship appears to exist between this species and other Costa Rican peperomias though *P. lignescens* and *P. petrophylla* share some of the floral and vegetative peculiarities.

Peperomia seemanniana Miq. in Seem., Bot. Voy. Herald, 198, pl. 37. 1854. *P. jarisiana* C.DC., Linnaea 37:382. 1872. *P. nemoralis* C.DC., Anal. Inst. Fis.-Geog. Costa Rica 9:179. 1897. *P. guanacastana* Trel., Contr. U.S. Nat. Herb. 26:220. 1929.

Epiphytic herbs, the stems often pendant, few-branched and the nodes often with adventitous roots, leafy internodes 2–8 cm. long, 1.5–4 mm. thick and often deeply furrowed on drying, glabrous. Leaves opposite or whorled, 2 to 4 at a node, usually well spaced along the stems; petiole 2–15 mm. long or the lamina subsessile, 1–2.5 mm. thick, deeply grooved and slightly wing-margined at the apex, glabrous; lamina 5–12 cm. long, 2–4.5 cm. broad, usually elliptic in outline, acute to acuminate at the apex, gradually tapering to the attenuate base, drying chartaceous to subcoriaceous and often pale gray in color, glabrous throughout, venation subpalmate with the 5 major veins closely approximate to 10 mm. above the petiole, the 3 central veins visible or obscure. Inflorescence terminal or axillary, 1 or 2 at a node, simple, 5–15 cm. long; peduncle 1.2–6 cm. long, 0.8–2 mm. thick glabrous, flowering rachis 1.5–2.5 mm. thick and strongly ridged on drying, the flowers remaining crowded on the rachis; floral bracts 0.3–0.5 mm. long, pellucid punctate and with a translucent margin; anthers 0.2–0.3 mm. long; pistil borne in a depression within the rachis; fruit subbasally attached within a depression in the rachis, erect or ascending (pseudopedicels apparently not developed), body of the fruit 0.5–0.6 mm. long and 0.4–0.5 mm. thick, globose-ovoid, narrowed apically to form a short (0.1 mm.) oblique beak, stigma subapical or apparently apical on the beak, surface of the fruit reddish pellucid verrucose.

Plants of wet evergreen forest formations between sea level and 1,500 m. altitude. Collected in Costa Rica between December and April on the Caribbean watershed below 1,000 m., and in the Central Highlands from Guanacaste to San Vito de Java (Puntarenas). The species ranges from Guatemala to western Panama.

The pendant stems, with succulent elliptic opposite or whorled leaves, glabrous parts, solitary or paired spikes to 15 cm. long, and congested fruit characterize this species. Herbarium material closely resembles some specimens of *P. pereskiaefolia* but the two species differ in habitat, size of the floral parts, and spacing and form of the fruit.

Peperomia serpens (Sw.) Loud., Hort. Brit. 13. 1830. *Piper serpens* Sw., Prodr. Veg. Ind. Occ. 16. 1788. *Peperomia pseudocasaretti* C.DC., Anal. Inst. Fis.-Geog. Costa Rica 9:179. 1897. *P. donnell-smithii* C.DC., l.c. *P. aguacatensis* var. *orosiana* Trel., Contr. U.S. Nat. Herb. 26:194. 1929. *P. aguacatensis* var. *picta* Trel., l.c. *P. cataratasensis* Trel. in Standl., Field Mus. Bot. 18:310. 1937. *P. osana* Trel. in Standl., l.c. 319. *P. praecox* Trel. in Standl. l.c. 1545. 1938.

Repent or climbing epiphytes, stems with adventitious roots at most nodes, leafy internodes 0.5–6 cm. long, 0.5–1.6 mm. thick (dry), minutely (0.5 mm.) crisp-puberulent, leaves alternate throughout, evenly spaced along the stem; petioles 4–35 mm. long, 0.3–0.8 mm. thick, grooved on the adaxial face, puberulent; lamina 8–55 mm. long, 6–40 mm. broad, usually ovate but the smaller sometimes orbicular to reniform and broader than long, tapering to the obtuse, acute, or short-acuminate apex or rounded in smaller laminae, rounded and truncate to subcordate (rarely obtuse) at the base, drying membranaceous to stiffly chartaceous and often much darker above than below, puberulent on both surfaces and the edge or occasionally glabrous, the hairs thin and 0.2–0.6 mm. long, venation palmate and usually visible beneath, obscure above, with 3 to 7 major veins, the 3 central veins free or united for up to 5 mm. above the base. Inflorescence axillary or terminal, usually solitary at a node, simple but with a bract or undeveloped leaf on the peduncle, 2–6 cm. long; peduncle 6–35 mm. long (sometimes longer than the flowering portion), 0.3–1.2 mm. thick, glabrous or minutely puberulent, 1 or 2 alternate small (3 mm.) bract-like structures present on the peduncle, flowering rachis about 1–1.5 mm. thick, the flowers remaining congested on the rachis; floral bracts about 0.3 mm. long, pellucid punctate; anthers about 0.3 mm. long, often forming bands around the spike at anthesis; pistil borne in a depression in the rachis; fruit basally attached within a depression in the rachis about 1 mm. long and erect, body of the fruit 0.5–0.6 mm. long and 0.2–0.3 mm. thick, narrowly ellipsoid, the surface orange pellucid verrucose, the apical translucent tissue forming a distinct beak 0.3–0.5 mm. long and about 0.1 mm. thick, the stigma subapical at the abaxial base of the style-like beak.

Plants of lowland (0–1,600 m.) wet evergreen forest formations, rarely collected above 1,200 m. altitude. Apparently common on the Caribbean side of Costa Rica but only collected on the Osa Peninsula and near San Ramon on the Pacific side. The species ranges from Nicaragua southward to Brazil and Peru and to the West Indies.

The creeping habit, smaller often long petioled leaves, bracteate peduncle, and ellipsoid fruit with conspicuous beak serve to distinguish this species. At first, I attempted to separate the smaller (—20 mm.) leaved specimens from the larger but as more material became available this distinction proved artificial. The form of the fruit and developed beak clearly ally this species to *P. distachya*, *P. macrostachya*, and *P. hernandiifolia* (Subg. *Rhyncophorum*, Dahlstedt 1900) among Costa Rican species. The bracteate peduncle is a very important characteristic and very useful in the absence of fruit.

Peperomia syringifolia C.DC., Bull. Herb. Boiss. 6:514. 1898. *P. platyphylla* C.DC. ex Schroeder, Candollea 3:132. 1926.

Erect herbs to 0.5 m. tall, the stems usually unbranched, leafy internodes 8–75 mm. long, 2.5–8 mm. thick (dry), glabrous. Leaves alternate, usually well spaced along the stem; petioles 5–17 cm. long, 1–5 mm. thick, glabrous, grooved

on the adaxial side; lamina 10–18 cm. long, 8–13 cm. broad, broadly ovate, tapering to the short-acuminate or abruptly acute apex, rounded and subcordate or truncate (rarely obtuse in ours) at the base, drying stiffly chartaceous, glabrous, venation pinnate and apparent on both surfaces, prominent beneath, the 3 or 4 pairs of major secondary veins arising from the lower half of the midvein and arcuate ascending. Inflorescences terminal axillary, or leaf-opposed, solitary to several at a node, to 25 cm. long, usually compound of 2 spikes; common peduncle to 14 cm. long, with caducous lanceolate bracts subtending the spikes in early stages, peduncles of the spikes unequal with the shorter 0–9 mm. long and the longer 5–15 mm. long (in ours), glabrous or sparsely and very minutely (0.05 mm.) puberulent, flowering rachis to 15 cm. long, 1.2–3 mm. thick, the flowers and fruit remaining approximate on the rachis; floral bracts 0.3–0.5 mm. long, pellucid punctate; anthers 0.3–0.4 mm. long; pistil borne in a slight depression in the rachis; fruit basally attached and erect or ascending, body of the fruit ellipsoid or narrowly ovoid, 0.6–0.8 mm. long, 0.3–0.4 mm. tnick, narrowed at the apex with the translucent tissue around the stigma forming a style-like beak 0.3–0.5 mm. long and usually bent, stigma sessile at the abaxial base of the beak, surface of the fruit reddish pellucid verrucose.

Growing epiphytically or among wet rocks along water courses in wet forests. Known from only three collections in Costa Rica: *Cook & Doyle 269* from Juan Viñas, Rio Reventazon at 1,000 m., *Standley 37898* at La Hondura between 1,300 and 1,700 m., and *Burger & Matta 4444* from San Vito de Java at 1,200 m. elevation. The species ranges southward to Ecuador.

This species is distinguished by its large ovate leaves with arcuate ascending secondary venation, compound inflorescence of paired spikes, and beaked fruit. Rather similar and undoubtedly closely related to *P. omnicola* but that species has more spikes per inflorescence and the leaves are pinnately veined above the middle.

Peperomia tenella (Sw.) A. Dietrich, Sp. Pl. 1:153. 1831. *Piper tenellum* Swartz, Prodr. 16. 1788. *Peperomia tenuipes* Trel., Contr. U.S. Nat. Herb. 26:192. 1929. *P. coliblancoana* Trel. in Standl., Field Mus. Bot. 18:311. 1937. *P. sphagnicola* Trel. in Standl., l.c. 326.

Epiphytic herbs to 20 (30) cm. tall, flowering stems usually erect and unbranched, leafy internodes 3–7 (15) mm. long, about 1 mm. thick, glabrous and often drying yellowish. Leaves alternate throughout and distichous, evenly spaced on the stem; petioles 1–4 mm. long, 0.4–0.8 mm. thick, glabrous, deeply grooved adaxially and decurrent on the stem; lamina 8–25 (35) mm. long, 5–12 (18) mm. broad, ovate to elliptic, narrowed to the usually emarginate apex, obtuse or acute or sometimes rounded at the base, drying stiffly chartaceous, usually much paler in color beneath than above, glabrous on both surfaces but usually very minutely (0.1 mm.) puberulent in the notch at the tip, venation palmate or pinnate and visible on both surfaces, the 3 major veins free or united near the base,

a gland-like structure sometimes present beneath the apical notch. Inflorescences terminal and solitary, simple, 3–12 cm. long; peduncle 3–12 mm. long, 0.5–1.5 mm. thick, glabrous, flowering rachis 0.8–1.5 mm. thick, the flowers becoming separated on the glabrous rachis; floral bracts 0.5–0.8 mm. long, pellucid punctate; often longer than broad; anthers about 0.2 mm. long; pistil at first borne within a depression in the rachis; fruit basally attached on a distinct pedicel, the pedicel becoming 2 mm. long and 0.1–0.2 mm. thick, body of the fruit 1–1.5 mm. long and 0.5–0.7 mm. thick, ellipsoid or narrowly obovoid, the surface reddish pellucid but quite smooth, the apex of the fruit with a concave oblique disc-like stylar portion of paler colored tissue, stigma apical on the short (0.1–0.3 mm.) scutelliform style.

A species of evergreen forest formations (especially cloud forests) between 1,000 and 2,500 m. altitude; flowering throughout the year. Ranging from Honduras to northern South America and the West Indies.

The pedicellate fruit, small alternate leaves with notched apex, and small habit distinguish this species. Specimens without mature fruit are very similar to *P. tenellaeformis* but differ in the larger floral bracts and consistently alternate leaves. The size of leaves seems quite variable and not worthy of specific rank (as in *P. tyleri* Trel. in Trel. & Yuncker 1950). The fruit is most unusual and indicates a relationship with *P. pittieri*.

Peperomia tenellaeformis Trel., Contr. U.S. Nat. Herb. 26:203. 1929.

Epiphytes or occasionally terrestrial, repent or stoloniferous with erect flowering shoots to 10 cm. tall, usually unbranched, leafy internodes 1.5–8 mm. long on the erect shoots, to 2 cm. long on the repent stems, 0.3–1 mm. thick, glabrous or with scattered short (0.3 mm.) hairs. Leaves alternate along the stem but usually opposite beneath the inflorescence, apparently distichous and usually evenly spaced along the stem, leaves of the repent stems often distant and orbicular; petiole 1–3 mm. long, 0.2–0.5 mm. thick, glabrous, grooved adaxially and decurrent on the stem; lamina of the flowering stems 4–20 mm. long, 2–7 mm. broad, narrowly ovate or lance-ovate to elliptic, tapering to the acute apex but rounded or emarginate at the tip, obtuse to acute at the base, drying thin-chartaceous and often pale in color, usually opaque, generally glabrous on the surfaces but minutely (0.1–0.4 mm.) ciliolate along the edge and at the apex, venation palmate but the midvein with secondaries, the 3 major veins usually obscure, often pellucid punctate on the lower surface. Inflorescence terminal, solitary or rarely 2, simple, 2–4 cm. long; peduncle 2–5 mm. long, about 0.5 mm. thick, glabrous, flowering rachis 0.6–1.2 mm. thick, the flowers congested or becoming slightly separated on the glabrous rachis; floral bracts 0.3–0.5 mm. long, often conspicuously punctate; anthers 0.1–0.2 mm. long and often broader than long; pistil borne in a depression in the rachis; fruit subbasally or sublaterally attached in a slight depression in the rachis and ascending, body of the fruit about 0.5 mm. long and 0.5 mm. thick, globose-ovoid, the surface orange pellucid verrucose, the apex of the fruit with a

short (0.1 mm.) oblique beak of translucent tissue, stigma subapical on the abaxial surface of the beak.

Small plants of wet evergreen forest formations found primarily between 1,000 and 1,800 m. altitude and rarely at lower elevations. Endemic to Costa Rica; flowering from July to December.

Distinct little plants with short erect unbranched flowering stems, distichous leaves, usually solitary spikes, and small beaked fruit attached toward the side (with respect to the beak). Vegetatively quite similar to *P. tenella* with pedicellate fruit. The leaves of repent stems are often very different in form from leaves of erect stems and immature specimens may resemble *P. rotundifolia*. *Peperomia tenellaeformis* resembles *P. jamesoniana* C.DC. of northern South America and *P. chiriquiensis* Yuncker of Panama and I believe that these three are closely related. Among Costa Rican species, *P. oerstedii* is the most closely related (q. v.).

Peperomia tetraphylla (G. Forst.) Hook. & Arn., Bot. Beech. Voy. 97. 1841. *Piper reflexum* L.f., Suppl. Pl. 91. 1781. *Piper tetraphyllum* G. Forst., Insul. Austr. Prodr. 5. 1786. *Peperomia reflexa* (L.f.) A. Dietr., Sp. Pl. ed. 6, 1:180. 1831, not *P. reflexa* H.B.K., 1815. *P. reflexa* var. *angustifolia* C.DC., Anal. Inst. Fis.-Geog. Costa Rica 9:180. 1897. *P. cartagoana* Trel., Contr. U.S.Nat. Herb. 26:222. 1929. *P. reflexaefolia* Trel., l.c. 223.

Epiphytic herbs, repent with erect flowering stems to about 15 cm. tall, leafy internodes 5–25 (40) mm. long, 0.4–2 mm. thick, sparsely puberulent between the nodes but often densely puberulent at the node, the hairs about 0.1 mm. long, conspicuously ridged when dry. Leaves opposite or whorled, usually 4 at a node, evenly spaced or somewhat crowded near the apex; petioles 0.5–2.2 mm. long, 0.4–0.8 mm. thick, minutely (0.05–0.1 mm.) and often densely puberulent, grooved on the adaxial side; lamina 8–22 mm. long, 5–14 mm. broad, usually elliptic or rhombic and tapering to both base and apex, obtuse or occasionally rounded at the apex, often emarginate at the tip, usually obtuse at the base, drying stiffly chartaceous or subcoriaceous and yellowish or grayish with the edges revolute on drying, minutely (0.1 mm.) puberulent around the apex and base, glabrous or very sparsely puberulent on the upper and lower surfaces, pellucid dots in crateriform depressions often present on the surfaces, venation palmate with the 3 principal veins usually obscure, the epidermal cells large (0.03 mm.) and often visible (×20) on older leaves. Inflorescences terminal and solitary, simple, 2–5 (7) cm. long; peduncle 1–2.5 (3.8) cm. long, sparsely to densely puberulent (especially beneath the flowering rachis), the hairs about 0.1 mm. long, flowering rachis 1–2.5 mm. thick, densely puberulent with erect broad-based hairs 0.05–0.2 mm. long; the flowers remaining crowded on the rachis; floral bracts 0.3–0.5 mm. long, pellucid punctate (reddish in early stages); anthers 0.1–0.2 mm. long, borne on short (0.1–0.2 mm.) filaments; pistil borne within a deep depression within the rachis; fruit

basally attached within the depression in the rachis, erect, body of the fruit 0.7–0.8 mm. long, 0.3–0.4 mm. thick, narrowly ovoid or cylindrical, the yellowish translucent tissue at the apex of the fruit conical and style-like, 0.1–0.2 mm. long and not usually abruptly narrowed, stigma apical, surface reddish pellucid but not conspicuously verrucose, sometimes thickened and paler colored basally (the pseudocupule).

In wet evergreen forest regions between 1,200 and 2,800 m. elevation; thus far collected only around the Meseta Central and western Cordillera de Talamanca in Costa Rica. A pantropical species ranging from Mexico to South America and the West Indies in the New World. The plants are most often found as epiphytes on tree trunks and thick branches. Common names are: *Garrapatilla*, *Hilotillo*, and *Corredera*.

This species differs from the closely related *P. deppeana* in the larger parts, more conspicuous hairs, fruit with less prominent style, and higher altitude habitat. These two species are easily recognized because of their puberulent flowering rachis and succulent little leaves in whorls. I have followed Yuncker's nomenclatural judgments as regards the early names of this species (in Brittonia 14:188. 1962).

Peperomia tsakiana C.DC., Anal. Inst. Fis.-Geog. Costa Rica 9:178. 1897. *P. compotrix* Trel., Contr. U.S. Nat. Herb. 26:213. 1929.

Apparently epiphytic, stems erect or climbing with roots at most nodes, leafy stems unbranched or few branched, to 20 cm. long, leafy internodes 7–30 mm. long, 1.7–4 mm. thick, densely crisp-hairy (in early stages), the hairs 0.5–1 mm. long. Leaves alternate and evenly spaced along the stem, petioles 1.5–5 cm. long, 2–3 mm. thick, densely crisp-hairy; lamina 8–18 cm. long, 3–6 (7.5) cm. broad, narrowly elliptic to oblanceolate, tapering to the acute or short-acuminate apex, gradually tapering to the attenuate or acute base, drying chartaceous and usually dark in color, glabrous on the upper surfaces and sparsely puberulent on the veins beneath with thickened hairs 0.5–1 mm. long, venation pinnate with 4 to 7 pairs of major secondary veins arising throughout the length of the midvein, prominent beneath and often impressed above. Inflorescence axillary, terminal, or leaf-opposed, solitary at the node, 8–25 cm. long, compound of 7 to 15 spikes in a paniculate or racemose arrangement, common peduncle 2–10 cm. long, 1–2 mm. thick, densely to sparsely puberulent, individual spikes 3–6 cm. long; peduncles of the spikes, 2–14 mm. long and often subtended by a bract about 5 mm. long, flowering rachis about 0.8 mm. thick, the flowers remaining crowded on the rachis; floral bracts 0.3–0.4 mm. long, pellucid punctate; anthers 0.2–0.4 mm. long; pistil borne in a depression in the rachis; fruit basally attached in a depression in the rachis and erect, body of the fruit 0.7–0.8 mm. long, 0.2–0.3 mm. thick, narrowly cylindrical, orange pellucid verrucose and somewhat darker at the apex, an elongate style-like beak present at the apex of the fruit and 0.2 0.4 mm. long, stigma subapical at the abaxial base of the beak.

Plants of the lowland (0–800 m. alt.) wet evergreen forest formations of the Caribbean slope. Endemic to Costa Rica and flowering between February and April. I have seen only the following collections: *Tonduz 9540,* Forets de Tsaki, Talamanca; *Standley 37542,* vicinity of Guápiles; *Lankester s.n.* Feb. 1926, Chitarriá, Pcia Cartago.

Unusual peperomias distinguished by the compound inflorescences, pubescence, attenuate leaf-base, beaked fruit, and lowland habitat. Apparently closely related to *P. lancifolioides* and *P. lancifolia* with glabrous parts and very slender fruit. Very similar in appearance to *P. guapilesiana* and especially *P. austin-smithii* but these species have obovoid fruit without a developed beak. I believe that these species are a related group but they are poorly represented in herbaria.

Peperomia tuisana C.DC., Anal. Inst. Fis.-Geog. Costa Rica 9:176. 1897.

Apparently epiphytes, erect stems to 35 cm. tall and few-branched, leafy internodes 6–40 mm. long, 1–3 mm. thick, densely puberulent with yellowish hairs to 1 mm. long. Leaves alternate or subopposite, usually opposite or whorled at the flowering nodes, evenly spaced along the stem; petioles 4–10 mm. long, 0.7–2 mm. thick, densely puberulent with slender hairs 0.5–1 mm. long; lamina 2–5 cm. long, 1–2.5 cm. broad, elliptic to ovate or rhombic, tapering to the usually obtuse apex, the tip often blunt or rounded, tapering to the obtuse or acute base, drying chartaceous and dark in color, opaque, sparsely to densely puberulent, the short (0.5–1.5 mm.) slender hairs yellowish to brownish, venation palmate with the 3 major veins usually obscure, the veins free to the base. Inflorescences terminal or axillary, solitary at the node, simple, 6–16 cm. long; peduncle 2–4.5 cm. long, 0.7–1.8 mm. thick, densely puberulent, flowering rachis 0.5–2.5 mm. thick, the flowers and fruit usually remaining congested on the glabrous rachis; floral bracts 0.4–0.6 mm. long, pellucid punctate, the margin entire; anthers 0.1–0.2 mm. long; pistil borne in a depression in the rachis; fruit subbasally attached in a depression in the rachis and ascending, body of the fruit 0.6–0.8 mm. long, about 0.5 mm. thick, globose ovoid, dark reddish pellucid verrucose but smoother and paler in color near the point of attachment, tapering to the short (0.1 mm.) oblique beak of slightly translucent tissue, stigma subapical in the center of the abaxial side of the beak.

Plants of the wet evergreen forest formations on the Caribbean slopes and around the Meseta Central between 500 and 1,200 m. altitude. Ranging from Costa Rica northward, probably to Guatemala.

Distinguished by the dense puberulence (at least on younger parts), solitary spikes on usually unbranched stems with alternate leaves, and glabrous flowering rachis and floral bracts. Very closely related to *P. costaricensis* and differing only in the glabrous rachis and

bracts and slightly different fruit. The more laterally attached fruit smooth and pale colored only near the point of attachment may not be significant as only one fruiting collection of *P. tuisana* has been seen: *Maxon 109,* Santiago E. of Cartago. The only other Costa Rican collection I have seen is *Tonduz 11533* from the type locality, Foret de Tuis.

Peperomia vinasiana C.DC., Bull. Soc. Bot. Belg. 30:231. 1891.

Herbaceous climbing epiphytes with long pendant stems, leafy internodes to 10 cm. long and 3 mm. thick (dry), glabrous. Leaves alternate and well spaced along the stem; petioles 15–22 mm. long, 1–2.5 mm. thick, glabrous, obscurely grooved on the adaxial side; lamina 8–13 cm. long, 4.5–7.5 cm. broad, usually ovate, tapering to the obtuse, acute, or short-acuminate apex, rounded and truncate or subcordate at the base, the tissue of the margin occasionally continuous across the petiole and the lamina subpeltate, succulent and drying stiffly chartaceous or subcoriaceous and usually brittle, glabrous, venation pinnate to subpalmate and usually obscure, the 3 or 4 pairs of major secondary veins arising from the lower half of the midvein with the upper secondaries arising near the middle of the blade. Inflorescences terminal or leaf-opposed, 1 or 2 at a node, to 30 cm. long, simple or compound with 2 or 3 spikes borne together on a common bracteate peduncle, common peduncle or peduncle of the single spikes usually with a deciduous lanceolate bract to 2 cm. long, peduncles of the spikes 8–35 mm. long, 0.8–2 mm. thick, glabrous, flowering rachis becoming 3.5 mm. thick, the flowers and fruit remaining crowded or approximate on the rachis; floral bracts 0.3–0.4 mm. long, inconspicuously punctate; anthers 0.1–0.2 mm. long and often broader than long; pistil borne in a depression in the rachis, stigma surrounded by a margin of translucent tissue; fruit basally attached within a depression in the rachis, erect or ascending, body of the fruit about 1.4 mm. long and 0.5 mm. thick, ovoid, the surface reddish pellucid verrucose, stigma apical or subapical by the anterior extension of translucent tissue forming a short (0.1 mm.) oblique beak, the stigma central on the flattened beak, the fruit often bearing anthers near the apex.

In wet forests between 500 and 1,000 m. elevation but to be expected at both higher and lower areas. I have not seen the type but an excellent photograph from the Delessert Herbarium leaves no doubt as to the applicability of the name based on Pittier's collection (*2199*) from Juan Vinas. Only two other collections have been seen: *Williams et al. 28458* at Rio Hermosa, Finca El Quizarrá, and *Burger & Matta 4823* near the Rio Penas Blancas in the General Valley; both collected in January.

An unusually large pendant species resembling *Sarcorhachis naranjoana* and closely related to *P. macrostachya.* The thick glabrous leaves, rounded and subcordate at the base, and ovoid fruit with poorly developed beak, characterize this apparently

endemic species. *Peperomia macrostachya* with its narrow fruit, *P. hernandiifolia* with peltate leaves, and this species are all large climbing or repent plants with thick alternate leaves.

Names Not Treated In This Flora

The following are names in *Peperomia* based on collections from Costa Rica that have not been seen and are not treated in this Flora. Since this work treats only a small area and many problems require a monographic study over the entire neotropical area, loans from European herbaria were not requested.

P. analectae Trel. in Standl., Field Mus. Bot. 18:307. 1937.

P. arifolia var. *acutifolia* C.DC., Bot. Gaz. 73: 142. 1922.

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P. reflexa var. *subemarginulata* C.DC. in DC., Prodr. 16, pt. 1:452. 1869.

P. sanramonensis C.DC. ex Schroeder, Candollea 3:133. 1926.

P. sepicola Trel., Contr. U.S. Nat. Herb. 26:225. 1929.

P. silvivaga C.DC., Anal. Inst. Fis.-Geog. Costa Rica 9:177. 1897.

P. stenophylla C.DC., Bull. Soc. Bot. Belg. 30, pt. 1:228. 1891.

P. subemarginulata (C.DC.) Trel., Contr. U.S. Nat. Herb. 26:223. 1929.

P. vinasiana var. *macrocarpa* (C.DC.) Trel., Contr. U.S. Nat. Herb. 26:195. 1929.

I consider the following names to be without effective descriptions, having been published as part of a key.

P. calvifolia C.DC., Candollea 1:290, 381. 1923.

P. muscicola C.DC., l.c. 298, not Ridl.

P. muscisedens C.DC., l.c. 398, as *muscicola.*

P. naranjoana var. *brevipetiola* C.DC., l.c. 399.

P. sessilifolia C.DC., l.c. 290, not HBK.

P. sessilifolioidea C.DC., l.c. 409, as *sessilifolia.*

PIPER Linnaeus

Herbs, shrubs, small trees, or rarely climbers, terrestrial or very rarely epiphytic, stems with thickened nodes; a single lateral prophyll usually present at flowering nodes, the prophyll often modified to form a cap-like structure enclosing the shoot-apex. Leaves alternate and petiolate, leaf-base usually sheathing the stem at sterile nodes, sheathing the stem or with a stipular or ligule-like structure or a stipular development absent at flowering nodes; lamina entire and unlobed or lobed only at the base (in Costa Rican species), hairs present or absent, simple and multicellular, minute pellucid dots often present in the lower epidermis. Inflorescence a solitary leaf-opposed spike (excluding *Pothomorphe* and *Sarcorhachis*), morphologically terminal, peduncle usually shorter than the flowering part; flowers loosely to densely crowded on the rachis, sessile or rarely (*P. yucatanensis*) pedicellate, each flower subtended by a floral bract, the bracts quite variable in shape with a broad apex on a usually flattened stalk, often subpeltate and triangular or U- V- or Y-shaped viewed from above; stamens usually 4, rarely 2 or 6, and variously attached to the base of the pistil, filaments usually short with the anthers borne at the level of the stigmas and 2-thecous; pistil usually sessile, ovary unilocular with a single basal ovule, a style present or absent, style-branches or stigmas 2, 3, or 4 or occasionally poorly differentiated; fruit drupaceous, fleshy or dry, usually crowded and often angular by compression, surfaces smooth and glabrous or sometimes pellucid-muricate or puberulent above.

Plants of varied habitats, best represented in Costa Rica in the wet forest formations below 1,500 m. elevation. The genus is absent above 3,000 m. and only a few species are found in the seasonally dry deciduous (tropical dry) forest formations of Guanacaste and northern Puntarenas. The genus is easily recognized by the alternate entire leaves and solitary leaf-opposed densely flowered spike.

The vegetative parts often have a spicy-aromatic odor when crushed.

The taxonomy of the neotropical species of *Piper* is in a state of chaos. Hundreds of species have been described without reference to their position within the genus or to related species. There is no natural classification of the genus; there are no effective subgenera or sections. To my knowledge, no other large genus of angiosperms suffers a comparable lack. This is in part due to the morphological uniformity of the species and to the greatly reduced flowering parts. This difficulty has been compounded by the description of many species based on collections lacking mature flowers and fruit. An analysis of the shoot-apex at flowering nodes has provided vegetative characters capable of relating species in the absence of mature flowering parts. The prophyll and leaf-base at flowering nodes must be understood in order to use the keys to species.

The prophyll is a small bract-like structure found at the base of axillary shoots in some angiosperms. Dicotyledonous plants generally have two but *Piper* (like many monocots) has only one in a lateral position. Since the spike of *Piper* is morphologically terminal, all further growth at the flowering node is axillary. The prophyll is almost always found at flowering nodes in early stages but it is usually caducous. In some species the prophyll is a small structure hidden within the sheathing leaf-base. I believe that the minute prophyll with a sheathing leaf-base at all nodes is the primitive condition in *Piper* (cf. Saururaceae). In other species the prophyll develops to enclose and protect the shoot-apex, as does the stipule of *Ficus*. In these latter species the shoot-apex may emerge from the sheathing leaf-base at sterile nodes while at flowering nodes the shoot-apex is first enclosed within the prophyll. In some species this character has apparently become fixed for the upper nodes and all have prophylls, flowering or not. A few species have developed a stipular structure in addition to the enlarged prophyll at the flowering nodes. This stipular development may become somewhat ligule-like and be united adaxially above the petiole. In these species (*P. hispidum* et al.) the shoot-apex is at first enclosed by a stipular structure opening away from the petiole (adaxially) and by a prophyll opening toward the petiole or laterally. This interpretation of the prophyll is in agreement with that of Rousseau, Contribution a l'anatomie comparee des piperacees in Mem. Acad. Roy. Belg. Ser 2. 9:1–45. 1927.

The number of stamens per flower (or pistil) have often been used in grouping the species. I have found it very difficult to ascertain the number of stamens in even the best perserved material and a large percentage of collections lack mature flowering parts entirely. In addition, some species with tightly congested flowers appear to have the stamens come into anthesis at differing times (on the same flower). Since the determination of stamen-number is so difficult for many species and probably quite variable, I have not included these numbers in the descriptions.

There are two groups of pipers within our Flora that present unresolved taxonomic difficulties. One group is centered around *P. obliquum;* tall, large-leaved plants of forest shade and very variable in their morphology. The other group is *P. hispidum* and its allies, morphologically very uniform. The species concepts presented in these groups should be considered first approximations.

PRIMARY KEY TO THE SEVEN KEYS TO PIPER SPECIES

1a. Leaves peltate or the lamina with palmate venation.....KEY I.
1b. Leaves never peltate, the venation never palmate.....2a.
2a. Laminae cordate to sagittate or variously auriculate at the base, with one or two prominent basal lobes; sometimes only the lower laminae cordate. KEY II.
2b. Laminae acute to truncate or slightly (–5 mm.) cordulate only at the petiole; the laminae never cordate.....3a.
3a. Major secondary veins arising from the entire length of the midvein, or gradually diminishing in size distally.....KEY III.
3b. Major secondary veins arising only from the lower two-thirds (or less) of the midvein.....4a.
4a. Shoot-apex and the new leaf emerging from within the leaf-base at flowering nodes, the petiole vaginate or rimmed by scar-tissue for at least half its length or with a sheathing base.....KEY IV.
4b. Shoot-apex and the new leaf emerging from within the prophyll and free of the leaf-base at flowering nodes, the petiole vaginate or with scar-tissue or with a stipular development only at the base at flowering nodes.....5a.
5a. Upper lamina-surface with conspicuous (0.3–3 mm.) hairs over the larger part of the surface.....KEY V.
5b. Upper lamina-surface glabrous or with minute (–0.2 mm.) hairs or with larger hairs only above the major veins.....6a.
6a. Lamina glabrous above and below or with very minute (0.1 mm.) hairs on the veins beneath.....KEY VI.
6b. Lamina puberulent on the veins beneath with hairs 0.2 mm. long or longer, puberulent or glabrous above.....KEY VII.

Key I

1a. Leaves peltate or at least the basal leaves subpeltate with the margins of the lamina united across the petiole.....2a.

1b. Leaves never peltate....4a.

2a. Leaves glabrous and drying pale grayish-green, shoot-apex emerging from within the prophyll at flowering nodes; small (0.5–1.5 m.) and rare plants of the wet Caribbean slopes between sea level and 1,000 m....*P. veraguense.*

2b. Leaves usually puberulent and drying brownish, shoot-apex emerging from within the sheathing leaf-base at flowering nodes; larger plants of higher altitudes or from the Pacific slopes....3a.

3a. Most of the leaves peltate or subpeltate, the smaller tertiary veins not impressed above; 1,000–2,000 m. elevation....*P. maxonii.*

3b. Only the lower leaves occasionally peltate and usually with the smaller tertiary veins impressed above to give a rugose surface; sea level to 1,200 m. on the Pacific slope....*P. fimbriulatum.*

4a. Midvein with prominent secondary veins....5a.

4b. Midvein lacking prominent secondary veins....6a.

5a. Shoot-apex emerging from within the leaf-base at flowering nodes, petioles vaginate and with thin stipular margins at flowering nodes; rare plants of the Caribbean lowlands....*P. multiplinervium.*

5b. Shoot-apex emerging from within the prophyll at flowering nodes, petiole vaginate only at the base at flowering nodes. See groups VI and VII.

6a. Shoot-apex emerging from within the leaf-base at flowering nodes, petioles vaginate and with thin stipular margins at flowering nodes; edge of the laminae with minute hairs, with 7 to 13 primary veins....*P. marginatum.*

6b. Shoot-apex emerging from within the prophyll at flowering nodes, petioles vaginate only at the base at flowering nodes....7a.

7a. Rachis of the spike puberulent and usually visible between the obconic fruit; lamina drying thin-chartaceous with 3 to 7 primary veins, 2–8 cm. broad; common plants of open sites on the Pacific watershed....*P. amalago.*

7b. Rachis of the spike not usually visible between the fruit or glabrous....8a.

8a. Leaves lanceolate to narrowly ovate and quite unequal at the base, 2–8 cm. broad....9a.

8b. Leaves ovate, 4–15 cm. broad, usually equal at the base, primary veins 5 to 9....10a.

9a. Pistil and fruit pedicellate; lamina with 3 to 7 primary veins. *P. yucatanensis.*

9b. Pistil and fruit sessile; lamina with only 3 primary veins. *P. pseudo-lindenii.*

10a. Laminae 4–11 cm. broad, stigmas sessile on the fruit....*P. papantlense.*

10b. Laminae 9–15 cm. broad, stigmas on a small disc-like area at the apex of the fruit....*P. reticulatum.*

Key II

1a. Shoot-apex emerging from within the leaf-base at the flowering nodes, petioles deeply vaginate for at least half their length at flowering nodes, inflorescences usually over 15 cm. long and often pendulous; leaves usually over 15 cm. long....2a.

1b. Shoot-apex emerging from within the prophyll and free of the leaf-base at flowering nodes, petioles usually vaginate only at the base at flowering nodes....13a.

2a. Leaves usually sagittate at the base, narrowly elliptic; spike 2–6 cm. long; small (1 m.) plants of moist forests of lowland (0–1,200 m.) southwestern Costa Rica....*P. sagittifolium.*

2b. Leaves never sagittate....3a.

3a. Inflorescence emerging from within the leaf-base of the same node and subtended by a ridge of scar-tissue continuous with the petiolar margins, often erect; leaves usually broadly ovate and truncate to subcordate; plants of montane (1,000–3,000 m.) forests.....4a.

3b. Inflorescence free of the leaf-base of the same node in early stages.....5a.

4a. Leaf 12–20 cm. broad, petiole vaginate and with thin stipular margins free adaxially.....*P. pittieri.*

4b. Leaf 4–9 cm. broad, petiole with a deciduous ligule-like stipular development.....*P. poasanum.*

5a. Lamina not more than 25 cm. long, rarely very unequally cordate at the base.....6a.

5b. Lamina usually becoming more than 25 cm. long, often very unequally cordate at the base; plants 2–8 m. tall.....8a.

6a. Laminae rounded at the apex and equally or subequally cordate at the base, petiole with thin stipular margins in the lower half; plants 1–2 m. tall.....*P. hebetifolium.*

6b. Laminae acute to acuminate at the apex, usually unequally truncate at the base, petiole with thin stipular margins throughout and these tearing off to produce scars; plants 1.5–6 m. tall.....7a.

7a. Stems and leaves glabrous, laminae ovate to very narrowly triangular, 3–7 cm. broad; usually found between 1,000 and 1,500 m. elevation.
P. aereum.

7b. Stems and leaves puberulent, laminae ovate to elliptic or oblong, 5–12 cm. broad, ranging from 1,400 to 2,400 m. elevation.....*P. gibbosum.*

8a. Lamina with a dense margin of minute (0.1–0.5 mm.) whitish hairs along the edge; flowering parts congested and usually concealed by the whitish bracts, anthers dehiscing laterally, stigmas minute; vegetative parts with the odor of sasparilla when crushed; common plants of open and partly shaded sites.....*P. auritum.*

8b. Lamina with the edge glabrous or sparsely puberulent with longer (0.5–2.5 mm.) hairs; flowering parts loosely crowded, anthers often dehiscing upward, stigmas usually large; plants of forest shade. (The following are a complex of very variable taxa and the specific delimitations are quite arbitrary).....9a.

9a. Nodes and petioles with small tubercles, lamina usually drying stiffly chartaceous with the major veins usually impressed; floral bracts sparsely puberulent, anthers with the thecae parallel or divergent but not in a single plane; sea level to 2,000 m. but most common above 1,000 m...*P. imperiale.*

9b. Node and petioles lacking tubercles or rarely with a few very short (0.5 mm.) projections; floral bracts usually conspicuously puberulent or ciliolate. 10a.

10a. Leaves and/or stems with long (1–3 mm.) hairs, lamina usually very asymmetric at the base with the lower lobe much enlarged and overlapping the petiole; anthers with the thecae almost in a single plane; 0–1,600 m. elevation.....*P. biseriatum.*

10b. Leaves and stems with shorter (0.2–1.5 mm.) hairs, larger lobe of the lamina overlapping the petiole only occasionally.....11a.

11a. Plants with prop-roots at the base, the lamina slightly pandurate in shape; anthers with the thecae often in a single plane; Caribbean slopes 0–1,000 m.
P. cenocladum.

11b. Plants lacking prop-roots, lobes of the lamina rarely divergent to give a pandurate shape; plants rarely collected on the Caribbean slope (in Costa Rica).....12a.

12a. Spikes 2–5 mm. thick at anthesis, anthers with the thecae rarely in a single plane; lamina drying thin with the tertiary veins often impressed and the surface rugose; sea level to 1,200 m. ..... *P. fimbriulatum.*

12b. Spikes 4–7 mm. thick at anthesis, anthers with the thecae often in a single plane; lamina usually drying stiffly chartaceous, the smaller tertiary veins not impressed above; collected from 500 to 2,000 m. in Costa Rica. *P. obliquum.*

13a. Leaves equally or somewhat unequally cordate, usually over 10 cm. broad, smaller leaves may be truncate; pistil without a style ..... 14a.

13b. Leaves very unequally auriculate at the base or less than 5 cm. broad and cordulate at the petiole; pistil often with a short style ..... 21a.

14a. Stems or leaves with long (0.5–2 mm.) hairs ..... 15a.

14b. Stems glabrous or with minute (–0.2 mm.) hairs ..... 16a.

15a. Laminae 15–40 cm. long, cordate and often quite symmetrical at the base ..... *P. riparense.*

15b. Laminae 11–25 cm. long, usually cordulate on only one side. *P. biauritum.*

16a. Only the lower larger leaves cordate, the upper leaves usually truncate to obtuse at the base ..... 17a.

16b. Leaves uniformly cordate or subcordate ..... 19a.

17a. Lamina drying thin-chartaceous and usually dark above, 10–22 cm. long; pistil with distinct (0.1–0.2 mm.) stigmas; spike about 1.5 mm. thick at anthesis; known only from the Caribbean lowlands (0–300 m.) ..... *P. holdridgeianum.*

17b. Lamina drying stiffly chartaceous and usually grayish above; pistil with poorly differentiated stigmas; spikes 2–4 mm. thick at anthesis. 18a.

18a. Lamina 6–22 cm. long and 3–9 cm. broad, glabrous beneath near the lamina-edge and throughout; spikes becoming about 4 mm. thick in fruit; common and widespread plants from 0 to 2,000 m. elevation. *P. aequale.*

18b. Lamina 15–40 cm. long and 9–30 cm. broad, often minutely puberulent near the edge beneath; spikes becoming 5–8 mm. thick; 0–1,500 m. elevation ..... 19a.

19a. Major veins deeply impressed, the lamina usually narrowly ovate and unequal at the base; floral bracts usually flat and dark in color above; Caribbean watershed ..... *P. nemorense.*

19b. Major veins flat above, the lamina usually broadly ovate and equal or subequal at the base ..... 20a.

20a. Major secondary veins usually arising from the lower half or third of the midvein, the narrow area between the lamina-edge and the submarginal vein glabrous beneath; floral bracts flat or slightly convex above; common in Costa Rica ..... *P. carrilloanum.*

20b. Major secondary veins often arising throughout the length of the midvein, narrow area between the lamina-edge and the submarginal vein usually puberulent beneath; floral bracts rounded and pale yellowish above; rare in Costa Rica ..... *P. grande.*

21a. Lamina 14–24 cm. long and long-acuminate, the single basal lobe often 2 or 3 times broader than long; fruit trigonous and depressed apically when dry. *P. otophorum.*

21b. Lamina 5–15 cm. long, cordulate or the single lobe rarely broader than long. 22a.

22a. Lamina cordulate; shrubs 1–3 m. tall; peduncle 5–12 mm. long; fruit trigonous ..... *P. sinugaudens.*

22b. Lamina auriculate, with only a single lobe; herbs less than 40 cm. tall; peduncle 20–50 mm. long; fruit globose ..... *P. perbrevicaule.*

Key III

1a. Inflorescence at first enclosed within the leaf-base of the same node and later subtended by a rim of scar-tissue continuous with the petiolar margins, petiole deeply vaginate or with scar-tissue for much of its length at flowering notes ..... 2a.

1b. Inflorescence free of the leaf-base of the same node in early stages and not subtended by a ridge of scar-tissue continuous with the adaxial margins of the petiole ..... 7a.

2a. Laminae with 10 to 20 pairs of secondary veins, 15–30 cm. long and 10–18 cm. broad ..... *P. biolleyi.*

2b. Laminae with 3 to 10 pairs of secondary veins ..... 3a.

3a. Stigmas 3 or 4, anthers about 0.5 mm. long with the connective inconspicuous above the thecae; spikes usually longer (3–9 cm.) and narrow (2–6 mm.) ..... 4a.

3b. Stigmas 2, anthers 0.6–1 mm. long with the connective developed beyond the thecae; spikes short (1.5–4 cm.) and thick (5–10 mm.); leaves often semi-succulent and drying stiffly chartaceous; Pacific watershed ..... 6a.

4a. Leaves very variable (on different plants) but rarely lanceolate or lanceovate, (3)5–16 cm. broad and usually glabrous beneath; from 0 to 1,800 m. on the Caribbean watershed and above 800 m. on the Pacific side. *P. glabrescens.*

4b. Leaves lanceolate to narrowly ovate and tapering gradually to the apex ..... 5a.

5a. Lamina glabrous beneath, 4–8 cm. broad; below 1,000 m. on the Caribbean side of Costa Rica ..... *P. coilostachyum.*

5b. Lamina hirsute beneath, 2.5–6 cm. broad; below 1,300 m. on the Caribbean side of Costa Rica ..... *P. tonduzii.*

6a. Lamina lanceolate with 3 to 5 pairs of secondary veins; between 400 and 1,200 m. elevation in central and northern Costa Rica ..... *P. artanthopse.*

6b. Lamina broadly elliptic to ovate with 5 to 8 pairs of major secondary veins; southern Costa Rica below 1,000 m. elevation ..... *P. curtispicum.*

7a. Lamina deeply rugose above with the smaller veins deeply impressed; spikes thick (5–10 mm.), pistils with conspicuous styles; in montane habitats (1,500–3,000 m.) ..... *P. lacunosum.*

7b. Lamina generally flat above, the smaller veins not impressed above; rarely found above 1,500 m. (except *P. leptoneuron* and *P. aequale*) ..... 8a.

8a. Marginal vein present in the distal two-thirds of the lamina; 0–200 m. on the Pacific watershed ..... *P. guanacastense.*

8b. Marginal vein absent or if present restricted to the distal third of the lamina. 9a.

9a. Shoot-apex emerging from within the leaf-base at flowering nodes, petioles deeply vaginate or with adaxial rows of scar-tissue at flowering nodes; laminae unequal at the base ..... 10a.

9b. Shoot-apex emerging from within the prophyll and free of the leaf-base at flowering nodes, petioles vaginate and with scar-tissue only at the base .. 12a.

10a. Lamina crisp-hairy beneath with hairs 0.5–1.5 mm. long, unequally cordulate at the base with the sides 0–3 mm. distant on the petiole; 0–1,200 m. on the Caribbean watershed ..... *P. tonduzii.*

10b. Lamina glabrous or minutely (–0.5 mm.) puberulent beneath, obtuse to truncate or rounded on only one side at the base with the sides 2–12 mm. distant on the petiole.....11a.

11a. Lamina abruptly rounded or blunt at the apex, 4–12 cm. long and 2–6 cm. broad, often with tubercles on the petiole; seasonally deciduous (tropical dry) areas of the Pacific slope from sea level to 1,000 m....*P. tuberculatum.*

11b. Lamina acute to acuminate at the apex, 10–25 cm. long and 2–12 cm. broad; moist forests of both slopes between sea level and 1,500 m. *P. arboreum.*

12a. Laminae puberulent on the upper surface or minutely (0.1 mm.) ciliolate along the edge.....13a.

12b. Laminae glabrous above and on the edge (but sometimes puberulent beneath the edge or on the lower surface).....14a.

13a. Laminae 20–40 cm. long and 8–18 cm. broad, with (6)10–16 pairs of secondary veins, usually with minute hairs along the edge.....*P. augustum.*

13b. Laminae 10–22 cm. long and 3–7 cm. broad, with 4 to 8 pairs of secondary veins, with conspicuous hairs throughout the upper surface..*P. deductum.*

14a. Peduncles 4–7 cm. long; lamina narrow and very asymmetric; rare plants of the Caribbean lowlands.....*P. reptabundum.*

14b. Peduncles 3–20 mm. long.....15a.

15a. Leaves usually drying dark in color; anthers with a conspicuous pellucid tip; stigmas conspicuous or borne on the style-like apex of the pistil; spikes often pendulous; not found above 1,500 m. altitude.....16a.

15b. Leaves usually drying pale grayish in color; anthers lacking a conspicuous tip at the apex of the connective.....18a.

16a. Inflorescence 2–4.5 cm. long and pendulous; fruit round in cross-section and obconic.....*P. phytolaccaefolium.*

16b. Inflorescence 4–11 cm. long and usually erect, fruit trigonous and depressed centrally above when dry.....17a.

17a. Secondary veins arising at angles of 30–65 degrees, lamina glabrous to sparsely puberulent beneath; lowland Caribbean forest formations. *P. arieianum.*

17b. Secondary veins arising at angles of 20–40 degrees, lamina puberulent beneath; General Valley.....*P. trigonum.*

18a. Floral bracts 0.5–1 mm. broad above; anthers 0.3–0.5 mm. broad; stigmas prominent or on the style-like apex of the pistil.....19a.

18b. Floral bracts 0.3–0.5 mm. broad above; anthers about 0.2 mm. broad; stigmas minute and poorly differentiated, sessile on the apex of the pistil..20a.

19a. Fruit 4-angled and usually separate on the rachis; small (1 m.) plants of lowland (0–200 m.) Caribbean forest formations.....*P. darienensis.*

19b. Fruit round and fleshy, congested on the rachis; shrubs 1–4 m. tall of montane (500–2,000 m.) forest formations.....*P. decurrens.*

20a. Laminae elliptic or oblong and abruptly caudate-acuminate, conspicuously thickened where the margins join the petiole; fruit transversely flattened (perpendicular to the inflorescence-axis) and becoming separate when dry; in the shade of wet forests below 1,000 m. altitude.....*P. urophyllum.*

20b. Laminae only rarely elliptic to oblong, never abruptly caudate-acuminate; fruit round or trigonous by compression and usually remaining congested dry.....21a.

21a. Laminae glabrous beneath the edge, 2–9 cm. broad; floral bracts triangular and flattened above; common and widespread from sea level to 2,000 m. *P. aequale.*

21b. Laminae minutely puberulent beneath the edge, 9–25 cm. broad; floral bracts rounded and convex above; below 800 m. and rare in Costa Rica..*P. grande.*

Key IV

1a. The 2 stipular margins of the petiole free and separate to near the base of the lamina or tearing off to form 2 rims of scar-tissue adaxially at flowering nodes, the petiole vaginate or scarred throughout its length; style or stigmas prominent; plants of montane habitats or the deep shade of forests.....2a.

1b. The stipular margins forming a ligule-like structure united distally above (adaxially) the petiole at new flowering nodes, the petiole not usually vaginate to the base of the lamina at flowering nodes; leaves rarely over 20 cm. long; spikes usually erect.....12a.

2a. Inflorescence at first included within the leaf-base of the same node and later subtended by a rim of scar-tissue continuous with the petiolar margins; anthers usually dehiscing laterally; spikes usually erect (except in *P. pitteri*).....3a.

2b. Inflorescence free of the leaf-base of the same node in early stages and not subtended by scar-tissue in later stages; anthers often dehiscing upward; spikes long and pendulous.....9a.

3a. Stigmas usually 2, anthers 0.5–1 mm. long with the connective prolonged beyond the thecae; spikes 2–4.5 cm. long and 5–10 mm. thick at anthesis.....4a.

3b. Stigmas 3 or 4, anthers 0.2–0.6 mm. long, lacking a development at the apex; spikes (2)4–25 cm. long and 2–8 mm. thick at anthesis.....7a.

4a. Laminae lanceolate to very narrowly ovate; 400–1,200 m. elevation on the Pacific watershed of northern and central Costa Rica. *P. artanthopse.*

4b. Laminae elliptic to ovate or oblong.....5a.

5a. Laminae ovate, usually widest well below the middle; 1,500–2,000 m. in the central highlands.....*P. cuspidispicum.*

5b. Laminae elliptic to oblong, usually widest at or near the middle; not found above 1,000 m. elevation.....6a.

6a. Stipular margins usually tearing off; plants of the Pacific slope of southern Costa Rica.....*P. curtispicum.*

6b. Stipular margins broad and usually persistent; plants of the Caribbean lowlands.....*P. curtirachis.*

7a. Laminae large (16–28 cm.×12–20 cm.); spikes 10–25 cm. long and becoming pendulous, becoming 15 mm. thick in fruit; (600) 1,500–3,000 m. elevations.....*P. pittieri.*

7b. Laminae smaller; spikes erect and becoming only 6 mm. thick in fruit; not found above 2,000 m.....8a.

8a. Laminae quite variable but usually tapering to the obtuse or acute base; glabrous or occasionally puberulent beneath; spikes (2)3–9 cm. long. *P. glabrescens.*

8b. Laminae abruptly narrowed at the truncate or subtruncate base, glabrous to densely puberulent; spikes 5–15 cm. long.....*P. crassinervium.*

9a. Rare plants of the Caribbean lowlands; laminae usually lanceolate, 4–9 cm. broad.....*P. melanocladum.*

9b. Montane plants from 1,000–2,600 m. elevation.....10a.

10a. Laminae drying subcoriaceous with the major veins impressed above, 15–35 cm. long and 8–22 cm. broad; spikes 15–45 cm. long. *P. euryphyllum.*

10b. Laminae drying chartaceous with the major veins usually flat above, 7–22 cm. long; spikes 8–26 cm. long.....11a.

11a. Laminae minutely puberulent on the veins beneath, narrowly ovate to elliptic or ovate, 5–12 cm. broad.....*P. gibbosum.*

11b. Laminae glabrous beneath, lanceolate to narrowly ovate, 3–7 cm. broad. *P. aereum.*

12a. Lamina smooth or very slightly scabrous above....13a.
12b. Lamina scabrous on the upper surface....17a.

13a. Lamina glabrous beneath, plants of montane (1,200–2,400 m.) forests..14a.
13b. Laminae puberulent beneath....15a.

14a. Floral bracts 0.6–0.8 mm. broad, anthers dehiscing laterally; laminae 6–12 cm. long and 2–5 cm. broad....*P. tenuimucronatum.*
14b. Floral bracts 0.5–0.6 mm. broad, anthers dehiscing upward; laminae 9–20 cm. long and 3.5–9 cm. broad....*P. austini.*

15a. Laminae lanceolate, 2–6 cm. broad; 0–1,200 m. on the Caribbean watershed....*P. tonduzii.*
15b. Laminae elliptic to ovate, 4–12 cm. broad....16a.

16a. Ligulate stipular development 10–15 mm. high, prophyll minutely puberulent along the midvein; pistil with 3 conspicuous (0.3 mm.) stigmas; spike becoming 6 mm. thick in fruit....*P. poasanum.*
16b. Ligulate stipular development 1–3 mm. high (above the petiole), prophyll glabrous or with few large (0.5–2 mm.) hairs; pistil with minute stigmas and obscured by the floral bracts; spike about 3.5 mm. thick in fruit. *P. epigynum.*

17a. Laminae rugose above and all the veins prominent beneath forming a reticuum of small (0.5–2.5 mm.) lacunae; stems densely puberulent. *P. bredemeyeri.*
17b. Laminae flat above or if becoming rugose with much larger lacunae beneath. 18a.

18a. Stipular development less than 3 mm. high (above the petiole) at flowering nodes: KEY VII, dichotomy 10a.
18b. Stipular development 3–15 mm. high (above the petiole) at flowering nodes. 19a.

19a. Prophyll and stipule usually drying very dark in color, laminae drying thin chartaceous; plants of open or partly shaded sites in areas of evergreen forest formations below 1,000 m....*P. sancti-felicis.*
19b. Prophyll and stipule usually drying brownish; laminae thin- to stiffly chartaceous; plants of the shade of wet montane (700–2,200 m.) forests. *P. bisasperatum.*

KEY V

1a. Spikes pendulous from early stages; usually smaller plants of the deep shade in moist and wet forest formations below 1,000 m. elevation; pistils with distinct stigmas or with a style-like apex....2a.
1b. Spikes erect and usually remaining erect in fruit....5a.

2a. Spikes pendulous on peduncles often longer than the flowering part....3a.
2b. Spikes with peduncles never exceeding the length of the flowering part; plants 0.4–1.5 m. tall....4a.

3a. Plants usually 0.5–2 m. tall; laminae 12–25 cm. long and 5–12 cm. broad....*P. urostachyum.*
3b. Plants 15–35 cm. tall; laminae 5–12 cm. long and 2–5 cm. broad, very unequal at the base....*P. perbrevicaule.*

4a. Laminae lanceolate to narrowly ovate and tapering gradually to the apex, venation often pinnate; spikes always deflexed; General Valley. *P. deductum.*

4b. Laminae elliptic to ovate or narrowly oblong, venation never pinnate; spikes often erect; both Caribbean and Pacific watersheds in wet forest. *P. garagaranum.*

5a. Fruit becoming trigonous or round and always glabrous, pistil with distinct stigmas or with a short style; anthers usually dehiscing laterally.....6a.

5b. Fruit becoming laterally compressed and often puberulent above; pistil without a style and the stigmas minute (–0.2 mm. but larger in *P. oblanceolatum*); anthers usually dehiscing upward.....8a.

6a. Laminae usually densely puberulent above and widest at the middle, often somewhat rhombic in shape; spikes becoming 4 mm. thick and the fruit trigonous; pistil with sessile stigmas and becoming truncate apically; common plants of open sites of the semi-deciduous areas of the Pacific watershed.....*P. pseudo-fuligineum.*

6b. Laminae sparsely puberulent above and usually drying dark; spikes becoming more than 4 mm. thick in fruit; pistil with a style or obconic, fruit fleshy and round; uncommon plants of wet forest shade.....7a.

7a. Petioles 4–8(14) mm. long; laminae elliptic to ovate and with variable venation; spikes 2–5 cm. long.....*P. garagaranum.*

7b. Petioles 1–4(7) mm. long; laminae very broadly ovate with the secondary veins arising from the lower third of the midvein; spikes 7–9 cm. long. *P. dryadum.*

8a. Laminae drying thin-chartaceous and usually oblanceolate, hairs on the upper surface minute (0.1–0.3 mm.); floral bracts with obscure pubescence; pistil with conspicuous (0.1–0.3 mm.) stigmas, fruit glabrous; becoming trees on the Caribbean watershed between 600 and 2,000 m.....*P. oblanceolatum.*

8b. Laminae usually stiff-chartaceous and rarely oblanceolate; stigmas usually minute (0.1 mm.); plants rarely exceeding 3 m. in height.....9a.

9a. Laminae 11–25 cm. long and 5–12 cm. broad and drying dark above, quite asymmetric at the base; floral bracts with minute (0.1 mm.) pubescence; fruit very minutely (0.05 mm.) puberulent; 0–1,500 m. elevation in very wet forests of the Caribbean slopes and central highlands...*P. biauritum.*

9b. Laminae usually much narrower and only slightly asymmetric at the base. 10a.

10a. Fruit glabrous above; laminae lanceolate to narrowly ovate; moist evergreen areas below 1,600 m.....11a.

10b. Fruit minutely puberulent above.....12a.

11a. Leaves narrowly elliptic to ovate lanceolate, (2)3–7 cm. broad, often scabrous; spikes erect and straight; floral bracts inconspicuous; in the shade of moist forests of southwestern (Pacific) Costa Rica. *P. polytrichum.*

11b. Leaves lanceolate with subparallel secondary veins, 1.5–3(4.5) cm. broad; spikes erect and curved or arching over; floral bracts conspicuous and whitish; common plants of open weedy sites. *P. friedrichsthalii.*

12a. Hairs relatively short (0.1–0.3 mm.) or sparse on the upper surface of the lamina and very scabrous; a ligule-like stipular development 0–3 mm. high (above the petiole) at new flowering nodes; common and widely ranging (0–2,000 m.) plants of open or partly shaded sites.....*P. hispidum.*

12b. Hairs dense over the upper surface and usually over 0.5 mm. long; a ligule-like stipular development absent or less than 1.5 mm. high. (The following taxa may prove to be no more than subspecific elements of *P. hispidum.*).....13a.

13a. Highland plants not found below 1,000 m. elevation; anthers 0.4–0.5 mm broad.....14a.

13b. Lowland plants not found above 1,200 m.; anthers 0.2–0.4 mm. broad..15a.

14a. Leaves usually rugose; plants often growing over others.*P. perhispidum.*

14b. Leaves usually flat above; erect shrubby plants of the area around Sta. Maria de Dota.....*P. capacibracteum.*

15a. Plants of open weedy habitats, widespread in Costa Rica..*P. villiramulum.*

15b. Plants of forest shade, in and around the General Valley...*P. polytrichum.*

Key VI

1a. Leaf-base at new flowering nodes with a stipular or ligule-like development 2–10 mm. high (above the petiole adaxially), prophyll usually drying brownish and acute at the apex; plants of wet montane (1,200–2,400 m.)forests..2a.

1b. Leaf-base at new flowering nodes lacking a large ligule but often with a stipular development 0–2 mm. high or with a short adaxial ridge.....3a.

2a. Floral bracts 0.6–0.8 mm. broad, anthers dehiscing laterally, fruit glabrous; lamina 6–12 cm. long and 2–5 cm. broad.....*P. tenuimucronatum.*

2b. Floral bracts 0.4–0.5 mm. broad above, anthers dehiscing upward, fruit puberulent above; laminae 9–20 cm. long and 3.5–8 cm. broad..*P. austinii.*

3a. Peduncle more than 4 cm. long; laminae narrowly oblong to oblanceolate and very asymmetric, 11–18 cm. long and 3–5 cm. broad; rare plants of the Caribbean lowland.....*P. reptabundum.*

3b. Peduncle less than 3 cm. long; laminae never oblanceolate.....4a.

4a. Plants climbing with adventitous roots or consistently growing over others (clambering); petioles often very short, secondary veins often subparallel from the lower third or half of the midvein.....5a.

4b. Plants erect and only rarely growing over others.....8a.

5a. Laminae narrowly ovate to lanceolate; anthers dehiscing upward.....6a.

5b. Laminae broadly ovate.....7a.

6a. Laminae often lanceolate, 5–13 cm.×1.4–4 cm.; fruit puberulent above; Pacific watershed of the central highlands (500–1,800 m.)...*P. dolanum.*

6b. Laminae narrowly oblong to ovate, 10–18 cm.×3–8 cm.; fruit glabrous; 0–1,000 m.....*P. xanthostachyum.*

7a. Petiole 6–22 mm. long, lamina drying stiffly chartaceous and dull gray, 16–30 cm. long; anthers opening laterally.....*P. concepcionis.*

7b. Petiole 1–5 mm. long, lamina drying subcoriaceous and lustrous; anthers opening at the top.....*P. scleromyelin.*

8a. Laminae semisucculent but drying thin-chartaceous with conspicuous (10×) pellucid dots near the petiole of younger shoots; anther with a conspicuous pellucid tip; pistil and fruit obconic and fleshy; plants 0.5–1.5 m. tall in the shade of wet lowland (0–1,200 m.) forest.....*P. nudifolium.*

8b. Laminae not succulent, pellucid dots absent or imbedded in the epidermis; pistil and fruit rounded or truncate above.....9a.

9a. Laminae usually small, 6–14 cm. long and 2–6 cm. broad.....10a.

9b. Laminae usually larger, 12–30 cm. long and 3–12 cm. broad.....16a.

10a. Laminae elliptic or oblong and abruptly caudate-acuminate, conspicuously thickened where the margins join the petiole; fruit transversely compressed (perpendicular to the inflorescence-axis); below 1,000 m. elevation in the shade of wet forests.....*P. urophyllum.*

10b. Laminae rarely caudate-acuminate, not thickened at the petiole; fruit never transversely compressed.....11a.

11a. Petiole with a small (0.5–2 mm.) ligulate development at new flowering nodes; laminae drying thin and gray or dark brown....12a.

11b. Petiole lacking a small ligulate development; laminae usually drying grayish in color....15a.

12a. Fruit glabrous above and trigonous; laminae often rhombic in form and drying dark; open sites in areas with a short dry season below 1,200 m. elevation....*P. dilatatum.*

12b. Fruit round or laterally compressed....13a.

13a. Fruit glabrous above and round in cross-section; floral bracts 0.5–0.9 mm. broad; peduncle 8–20 mm. long; wet montane (700–2,000 m.) forest formations....*P. decurrens.*

13b. Fruit minutely puberulent above and usually becoming laterally compressed; floral bracts 0.3–0.5 mm. broad; peduncle 4–12 mm. long..14a.

14a. Lamina drying dark above, 1.5–3.5(4.5) cm. broad; Pacific watershed of the central highlands (500–1,800 m.)....*P. dolanum.*

14b. Lamina drying grayish above, 3–7 cm. broad; lowland Caribbean forests....*P. virgultorum.*

15a. Laminae usually asymmetric with the sides 1–4 mm. distant at the petiole; pistil with a very short style and minute stigmas....*P. verruculosum.*

15b. Laminae symmetric or somewhat asymmetric at the base but with the sides of the lamina arising together from the petiole; pistil lacking a style and the stigmas often poorly differentiated....*P. aequale.*

16a. Prophyll narrowly oblong and often blunt or asymmetric at the apex (unopened), drying grayish or very dark, glabrous or very minutely puberulent throughout; lamina with the sides arising together at the petiole; anthers about 0.2 mm. broad and dehiscing laterally; fruit often becoming trigonous....17a.

16b. Prophyll narrowly triangular and acute at the apex, drying brown, glabrous or minutely puberulent along the midrib adaxially; lamina with the sides usually distant on the petiole, a stipular or ligulate ridge often present at the base of the petiole at new flowering nodes....19a.

17a. A minute stipular ridge present at the base of the petiole at new flowering nodes; lamina often drying dark; stigmas conspicuous (0.1–0.2 mm.); rare plants of deep shade in the Caribbean lowlands....*P. holdridgeianum.*

17b. A stipular ridge usually absent; lamina usually drying pale grayish; stigmas minute or poorly differentiated....18a.

18a. Lamina glabrous beneath the edge, 2–9 cm. broad; common plants of wet and moist forest formations between 0 and 2,000 m. elevation..*P. aequale.*

18b. Lamina minutely puberulent on the veins beneath the edge, 9–22 cm. broad; uncommon plants in wet forest formation below 1,500 m. elevation....*P. carrilloanum.*

19a. Scar-tissue usually present on the lower third of the petiole at older flowering nodes; floral bracts 0.5–1 mm. broad with a margin of conspicuous hairs, anthers about 0.4 mm. broad, stigmas 0.2–0.3 mm. long; fruit becoming laterally compressed and glabrous above; lamina often drying grayish with the major veins impressed above....*P. colonense.*

19b. Scar-tissue present only at the base of the petiole at flowering nodes; floral bracts 0.3–0.7 mm. broad, usually with inconspicuous hairs, anthers 0.2–0.4 mm. broad....20a.

20a. Fruit becoming trigonous by compression, glabrous above; anthers 0.2–0.3 mm. broad and dehiscing laterally; spikes becoming 3.5 mm. thick in fruit; areas of wet forest formations below 1,200 m. elevation....21a.

20b. Fruit becoming laterally compressed; anthers 0.2–0.4 mm. broad and usually dehiscing upward....22a.

21a. Lamina with the secondary veins arising from the lower half of the midvein, usually drying dark, 11–20 cm. long; plants of open sites. *P. dilatatum.*

21b. Lamina with the secondary vein arising from the lower two-thirds of the midvein, rarely drying dark, 12–32 cm. long; plants of shaded sites. *P. terrabanum.*

22a. Floral bracts 0.4–0.5 mm. broad; fruit glabrous above, fruiting spike 4–5 mm. thick; moist forest formations between 500 and 1,300 m. elevation on the Pacific watershed..... *P. umbricola.*

22b. Floral bracts 0.2–0.4 mm. broad; fruit very minutely puberulent above, fruiting spike 2–4 mm. thick.....23a.

23a. Fruiting spike 3–4 mm. thick, becoming 12 cm. long; lamina usually asymmetric only at the base, 10–22 cm. long; Pacific watershed below 1,300 m. *P. chrysostachyum.*

23b. Fruiting spike 2–3 mm. thick, becoming 9 cm. long; lamina often quite asymmetric in the middle, 6–17 cm. long; Caribbean lowlands of southern Costa Rica..... *P. virgultorum.*

Key VII

1a. Spikes erect and arching over or curved, floral bracts with conspicuous whitish hairs; laminae usually very narrowly ovate with the secondary veins strongly ascending and subparallel; anthers dehiscing laterally, fruit glabrous above; common plants of open or partly shaded sites.....2a.

1b. Spikes erect and straight or pendulous.....4a.

2a. Leaves scabrous above; peduncle 8–14 (20) mm. long; widespread plants from 0 to 1,500 m..... *P. aduncum.*

2b. Leaves smooth to the touch above.....3a.

3a. Laminae usually narrowly ovate, 4–9 cm. broad, tertiary veins prominent beneath; peduncle 15–40 mm. long; wet montane areas between 1,200 and 2,800 m..... *P. lanceaefolium.*

3b. Laminae usually lanceolate, 1.5–3 (4.5) cm. broad, tertiary veins not prominent beneath; peduncle 3–11 mm. long; wet evergreen areas between 0 and 1,500 (1,800) m..... *P. friedrichsthalii.*

4a. Spikes pendulous from early stages, on long slender (1 mm.) peduncles; pistil with a distinct style or the stigmas distinct, fruit glabrous above; anthers dehiscing laterally; lamina often cordulate or auriculate at the petiole; plants of forest shade.....5a.

4b. Spikes erect or rarely becoming pendulous in fruit.....7a.

5a. Highland (1,400–2,500 m.) plants; laminae 8–15 cm.×3–7 cm., peduncles 10–30 mm. long..... *P. carpinteranum.*

5b. Lowland (0–1,000 m.) plants.....6a.

6a. Peduncle 5–12 mm. long; laminae 7–15 cm.×2–5.5 cm..... *sinugaudens.*

6b. Peduncle 20–60 mm. long; laminae 12–25 cm.×5–14 cm... *P. urostachyum.*

7a. Leaves deeply rugose above, teritary and smaller veins becoming impressed above; montane (1,000–3,000 m.) plants.....8a.

7b. Leaves flat above or only the major veins becoming impressed above....10a.

8a. Lamina rugose from early stages, lacunae beneath 0.5–3 mm. broad; anthers dehiscing laterally; stigmas conspicuous (0.5 mm.), fruit glabrous above.....9a.

8b. Lamina rugose in later stages, the lacunae usually larger beneath; anthers dehiscing upward; stigmas minute, fruit minutely puberulent above..11a.

9a. Lamina smooth or very slightly scabrous, a ligulate stipular development absent; anthers 0.6–0.9 mm. long, pistil with a style; 1,500–3,000 m. *P. lacunosum.*

9b. Lamina scabrous, a ligulate stipular development present at new flowering nodes and about 7 mm. high; anthers 0.3–0.4 mm. long, style absent; 1,000–2,000 m. in open sites..... *P. bredemeyeri.*

10a. Laminae very scabrous above; fruit becoming laterally compressed and puberulent above..... 11a.

10b. Laminae smooth or only slightly rough to the touch above..... 15a.

11a. A ligule-like stipular development 4–10 mm. high (above the petiole) present at new flowering nodes and deciduous; anthers dehiscing upward; fruiting spike 3–4 mm. thick..... 12a.

11b. A ligule-like stipular development absent or less than 4 mm. high at new flowering nodes (do not confuse this with the prophyll which arises above the leaf-base)..... 13a.

12a. Prophyll and ligulate stipule drying very dark brown or black; lamina 6–10 cm. broad, drying thin-chartaceous flat and usually dark; areas of moist evergreen forest formations below 1,000 m. in open or partly shaded sites..... *P. sancti-felicis.*

12b. Prophyll and ligulate stipule drying brown; lamina 3–8 cm. broad, often rugose above; areas of wet montane (800–2,200 m.) forests and usually found in deep shade..... *P. bisasperatum.*

13a. Petiole vaginate and with scar tissue on the lower third at flowering nodes; laminae 15–27 cm. ×8–13 cm., long-acuminate; anthers dehiscing laterally; stigmas distinct (0.2 mm.); rare plants of the Caribbean coastal plain. *P. peracuminatum.*

13b. Petiole vaginate and with scar-tissue only at the base at flowering nodes; anthers dehiscing upward; stigmas usually minute..... 14a.

14a. Leaf-base usually with a ligulate development 0.5–4 mm. high at new flowering nodes; lamina often short (7–18 cm.) and narrowed to the apex; very common plants of open or partly shaded sites from sea level to 2,000 m..... *P. hispidum.*

14b. Leaf-base lacking a ligule or the stipular development less than 1 mm. high at new flowering nodes; lamina 10–24 cm. long and tapering very gradually to the apex; plants of shaded sites in wet forest formations between 1,000 and 1,800 m..... *P. perhispidum.*

15a. A ligule-like stipular development 4–10 mm. high (above the petiole) present at new flowering nodes; plants of wet montane (700) 1,000–2,600 m. areas. 16a.

15b. A ligule-like stipular development absent or less than 3 mm. high at new flowering nodes (do not confuse this with the prophyll which arises above the leaf-base)..... 18a.

16a. Anthers dehiscing upward; fruit puberulent above with minute stigmas; spikes becoming 3–4 mm. thick in fruit, peduncles 4–18 mm. long and 1–2 mm. thick; laminae becoming 22 cm. long..... *P. bisasperatum.*

16b. Anthers dehiscing laterally; fruit glabrous with conspicuous (0.2–0.4 mm.) stigmas; laminae not over 18 cm. long..... 17a.

17a. Spike 2–3 mm. thick in anthesis and becoming about 4 mm. thick in fruit; peduncle 10–30 mm. long and 0.4–1.4 mm. thick..... *P. carpinteranum.*

17b. Spike 3–4 mm. thick in anthesis and becoming 6 mm. thick in fruit; peduncle 8–20 mm. long and 1–2 mm. thick..... *P. poasanum.*

18a. Pellucid dots conspicuous (10×) on the lower surface of young leaves (dried); anther with a distinct pellucid disc at the apex of the connective, dehiscing laterally; fruit glabrous and never laterally compressed; plants of wet forest formations below 1,200 m..... 19a.

18b. Pellucid dots not conspicuous with a hand-lens (10×), absent or imbedded in the epidermis; anthers lacking a pellucid disc or gland-like apex.....21a.

19a. Leaves semi-succulent (alive) and broadly ovate to elliptic; pistil and fruit obconic and fleshy; subshrubs 0.5–1.5 m. tall.....*P. nudifolium.*

19b. Leaves not semi-succulent, very narrowly ovate to lanceolate or oblong or narrowly elliptic; fruit truncate and depressed centrally above, becoming trigonous; shrubs 1–2 m. tall.....20a.

20a. Lamina sparsely puberulent beneath, secondary veins arising at angles of 30–65 degrees; Caribbean watershed.....*P. arieianum.*

20b. Lamina densely puberulent on the veins beneath, secondary veins arising at angles of 20–40 degrees; General Valley.....*P. trigonum.*

21a. Lamina small, 5–15 cm. long and 2–6 cm. broad at maturity.....22a.

21b. Lamina larger, 12–30 cm. long and 4–12 cm. broad.....27a.

22a. Climbing or clambering plants with usually lanceolate leaves, leafy internodes to 12 cm. long; fruit laterally compressed and puberulent above.
P. silvivagum.

22b. Erect shrubs rarely growing over others, leaves rarely lanceolate....23a.

23a. Fruit compressed and densely yellowish puberulent above; widespread below 1,000 m.....*P. jacquemontianum.*

23b. Fruit round or becoming trigonous, glabrous above.....24a.

24a. Pistil with a short style; laminae usually cordulate on at least one side; plants of forest shade.....25a.

24b. Pistil with sessile stigmas; plants of open sites below 1,200 m.....26a.

25a. Spikes about 2 mm. thick in fruit; floral bracts 0.4–0.7 mm. broad; 0–1,000 m.....*P. sinugaudens.*

25b. Spikes about 4 mm. thick in fruit; floral bracts 0.6–1 mm. broad; 1,400–2,500 m.....*P. carpinteranum.*

26a. Spikes about 3.5 mm. thick in fruit; laminae drying thin and usually dark; widespread.....*P. dilatatum.*

26b. Spikes about 4.5 mm. thick in fruit; laminae drying pale in color and often lustrous above; usually found near the Caribbean shore.....*P. littorale.*

27a. Fruit trigonous or rounded (in cross-section) at maturity, glabrous above; anthers 0.2–0.3 mm. broad and dehiscing laterally.....28a.

27b. Fruit becoming laterally compressed in cross-section or rounded in earlier stages, glabrous or puberulent above.....30a.

28a. Lamina with the secondary veins usually arising from the lower third of the midvein, strongly ascending and subparallel, becoming impressed above and very prominent beneath; prophyll 3–6 cm. long but caducous; plants often scandent in wet forest shade, 1,000–2,200 m.
P. subsessilifolium.

28b. Lamina with the secondary veins not usually becoming impressed above, not very prominent beneath; erect shrubs from sea level to 1,200 m...29a.

29a. Lamina glabrous above and usually drying gray or greenish, often very unequal at the base, secondary veins arising from the lower two-thirds of the midvein; prophyll becoming 20–35 mm. long; usually found in forest shade.....*P. terrabanum.*

29b. Lamina minutely puberulent on the veins above, often drying dark, secondary veins arising from the lower half of the midvein; prophyll 8–20 mm. long; plants of open sites.....*P. dilatatum.*

30a. Fruit puberulent and truncate above, a style absent and the stigmas usually minute (–0.2 mm. but larger in *P. peracuminatum*).....31a.

30b. Fruit glabrous.....34a.

31a. Lamina usually lustrous above, central secondary veins of the same side 3–7 cm. distant on the midvein; fruit densely yellowish puberulent above; widespread plants of open and shaded sites below 1,000 m. *P. jacquemontianum.*

31b. Lamina dull above and the secondary veins arising closer together on the same side of the midvein; puberulence of the fruit usually minute and inconspicuous . . . . . 32a.

32a. Prophyll glabrous or with few long (0.5–2 mm.) hairs; lamina 4–9 cm. broad; floral bracts with inconspicuous hairs, anthers dehiscing upward; wet montane habitats between 1,000 and 2,000 m. . . . . *P. epigynium.*

32b. Prophyll minutely puberulent along the midrib abaxially; lamina 7–13 cm. broad; anthers dehiscing laterally; wet lowland (0–500 m.) forests . . . . 33a.

33a. Plants of the Caribbean watershed; stigmas about 0.1 mm. long; anthers 0.2–0.3 m. broad . . . . . *P. zacatense.*

33b. Plants of the Pacific watershed in southern Costa Rica; stigmas about 0.2 mm. long; anthers 0.3–0.4 mm. broad . . . . . *P. peracuminatum.*

34a. Spikes 4–5 mm. thick in fruit; anthers 0.2–0.3 mm. broad and dehiscing upward; stigmas minute (0.1 mm.); seasonally dry areas of the Pacific watershed . . . . . *P. umbricola.*

34b. Spikes 3–4.5 mm. thick in fruit; anthers about 0.4 mm. broad and dehiscing laterally or upward; stigmas conspicuous (0.1–0.3 mm.) . . . . . 35a.

35a. Laminae drying stiff-chartaceous, petiole with scar-tissue on the lower third at flowering nodes; Caribbean watershed 0–1,600 m. . . . . *P. colonense.*

35b. Laminae drying thin-chartaceous, petioles with scar-tissue only at the base at flowering nodes; wet forests between 600 and 2,000 m. *P. oblanceolatum.*

Piper aduncum L., Sp. Pl. 29. 1753. *P. pseudo-velutinum* var. *flavescens* C.DC., Bull. Soc. Bot. Belg. 30, pt. 1:203. 1891. *P. disparispicum* Trel., Contr. U. S. Nat. Herb. 26:170. 1929. *P. aduncifolium* Trel., l.c. 171. *P. anguillaespicum* Trel., l.c. 175. *P. oblanceolatum* var. *fragilicaule* Trel., l.c. 175. *P. submolle* Trel., l.c. 178. *P. flavescens* (C.DC.) Trel., l.c. 184. Figure 11.

Shrubs or small trees occasionally becoming 8 m. tall, the older nodes somewhat thickened, leafy internodes 1.5–5 cm. long, 1.5–3 (4) mm. thick, sparsely to densely puberulent with yellowish hairs 0.05–0.5 mm. long, glabrate in age; shoot-apex emerging from within the prophyll and free of the leaf-base at flowering nodes, the prophyll becoming 25 mm. long, acute, puberulent along the midrib or throughout (abaxially), drying pale brown. Leaves usually distichous and often evenly spaced along the stem; petioles 2–5 (8) mm. long, 0.7–1.8 mm. thick, puberulent with short (0.2–1 mm.) usually ascending hairs, vaginate only at the base and with a small (–3 mm.) stipule-like structure or with a rim of longer hairs at flowering nodes; laminae 12–22 (25) cm. long, 4–8 (9) cm. broad, lanceolate to narrowly elliptic or very narrowly ovate, tapering very gradually to the long-acuminate apex, narrowed abruptly and rounded or cordulate at the unequal base, sides of the blade 1–3 mm. distant on the petiole, the lower side sometimes forming a little lobe 2–8 mm. long, the lamina drying thin- to thick-chartaceous, scabrous above with minute hairs on the veins, scabrous or smooth beneath with short (0.2–0.8 mm.) hairs, major veins flat or impressed above, the 4 to 6 pairs of major secondary veins usually arising in the lower half of the midvein, arcuate ascending,

upper secondaries arising at angles of 10–30 degrees, tertiary veins usually inconspicuous beneath. Inflorescence free of the leaf-base of the same node in the early stages, but subtended by a ridge of tissue or an articulation, erect in early stages and arching over to produce curved spikes 6–16 cm. long, peduncle 8–14 (20) mm. long, 1–1.8 mm. thick, glabrous or more often sparsely puberulent, flowering portion 2–4 mm. thick at anthesis, becoming 4–5 mm. thick in fruit, the flowers tightly congested; floral bracts 0.4–0.6 mm. broad and triangular or round from above, with a dense margin of white or yellowish hairs 0.1–0.2 mm. long, occasionally forming bands around the spike; anthers 0.2–0.3 mm. long and equally broad, dehiscing laterally but opening wider at the top; pistil with 3 distinct (0.2 mm.) stigmas; fruit becoming 0.7 mm. thick and 1 mm. long, usually obpyramidal and trigonous or rounded, somewhat fleshy, glabrous, truncate or rounded apically with the sessile stigmas deciduous.

A very common species of open or partly shaded sites throughout Costa Rica between sea level and 1,500 m. elevation but restricted to watercourses in the seasonally dry deciduous areas; flowering throughout the year. The species is found over the entire range of the genus in the American tropics.

A very distinctive piper recognized in the field by the drooping yellow-green foliage, arched spikes, and scabrous leaves with petioles shorter than the peduncles. *Piper aduncum* is very closely related to *P. friedrichsthalii* and *P. lanceaefolium*, both with smooth leaves and more prominent venation. These three species are usually easy to separate from the allied and very difficult alliance of pipers related to *P. hispidum* (q.v.).

Piper aequale Vahl, Eclog. Amer. 1:4, pl. 3. 1796. *P. costaricense* C.DC. in DC., Prodr. 16, pt. 1:328. 1869. *P. micranthera* C.DC., Linnaea 37:354. 1872. *P. asymmetricum* C.DC., Anal. Inst. Fis.-Geog. Costa Rica 9:172. 1897. *P. cabagranum* C.DC., l.c. 173. *P. chiriquinum* C.DC., Smiths. Misc. Coll. 71, pt. 6:2. 1920. *P. tenuispicum* C.DC., Bot. Gaz. 70:170. 1920. *P. aequale* var. *elliptico-lanceolatum* C.DC., l.c. 171. *P. dunlapi* Trel., Contr. U.S. Nat. Herb. 26:23. 1927. *P. seductum* Trel., l.c. 135. 1929. *P. tacamahaca* Trel., l.c. 144. *P. caeruleifolium* Trel., l.c. 145. *P. oppressum* Trel., l.c. 161. *P. catacryptum* Trel., l.c. 166. *P. concinnifolium* Trel., l.c. 167. *P. elliptico-lanceolatum* (C.DC.) Trel., l.c. 167. *P. heptaneurum* Trel., l.c. 168. *P. pablense* Trel., l.c. 168. *P. coarctatum* Trel., l.c. 168. *P. colemanense* Trel. in Standl., Field Mus. Bot. 18:337. 1937. *P. crispans* Trel. in Standl., l.c. 339. *P. playa-blancanum* Trel. in Standl., l.c. 355. *P. rubripes* Trel. in Standl., l.c. 358, in part. *P. subdurum* Trel. in Standl., l.c. 362.

P. percome Trel. in Standl., l.c. 1546. 1938. *P. paso-anchoense* Trel. in Woodson & Schery, Ann. Mo. Bot. Gard. 27:295. 1940. Figures 9, 10.

Shrubs to 2 (rarely 4) m. tall, the older nodes conspicuously thickened, leafy internodes 1.5–8 cm. long, 1–2 (3) mm. thick, glabrous or rarely very sparsely minutely (0.2 mm.) puberulent; shoot-apex emerging from within the prophyll and free of the leaf-base at flowering nodes, the prophyll becoming 10–15 mm. long and 1–2 mm. thick (unopened), glabrous and drying grayish or pale brown, the tip usually blunt and asymmetric. Leaves usually distichous, petioles 6–12 (20) mm. long, 0.7–1.5 mm. thick, glabrous, grooved adaxially with scar tissue only at the base and a stipule-like development absent at flowering nodes; lamina 6–15 (22) cm. long, 2.5–7 (9) cm. broad, ovate, elliptic, oblong, or lanceolate, usually tapering gradually to the long-acuminate apex but occasionally caudate-acuminate, acute to obtuse or rounded and occasionally truncate at the base (rarely subcordate in lower leaves), often somewhat oblique but the sides arising together on the petiole, the lamina drying thin- or thick-chartaceous and pale grayish to very dark and usually with the venation paler in color beneath, smooth and glabrous on both surfaces, the major veins slightly raised above, the 2 to 8 pairs of major secondary veins arising throughout the length of the midvein or only in the lower parts (very variable in this respect even on the same branch), the basal 2 pairs of veins usually much more prominent than the upper, the central secondaries arising at angles of 30–70 degrees; upper epidermal cells sometimes undulate in outline. Inflorescence free of the leaf-base of the same node in early stages, erect, 5–10 cm. long, peduncle 5–12 mm. long, about 1 mm. thick, glabrous, flowering portion 2–3 mm. thick at anthesis and becoming 4 mm. thick in fruit, the flowers densely crowded; floral bracts 0.3–0.5 mm. broad and usually triangular from above, minutely (0.1 mm.) ciliolate and glabrous in the center, not forming bands around the spike; anthers 0.1–0.3 mm. long, about 0.2 mm. broad, dehiscing laterally and at the top; pistil glabrous with 3 sessile poorly differentiated stigmas; fruit round or becoming obpyramidal-trigonous, by compression, about 0.8 mm. thick and 1 mm. long, rounded or truncate at the apex, glabrous, stigmas sessile.

Plants of wet or seasonally dry evergreen forest formations throughout Costa Rica from sea level to 2,000 m. elevation; flowering throughout the year but more commonly from December to May. The species ranges from Honduras to northern South America and the West Indies.

This species is distinguished by its glabrous vegetative parts, variable leaf-venation, slender spikes, minute anthers, and poorly differentiated stigmas. Included here are specimens of considerable diversity. At first, the specimens from higher (800–2,000 m.) altitudes with thicker ovate leaves appeared to be different from specimens of lower (0–1,100 m.) wet forest formations with thinner more elliptic leaves that usually dry dark. However, there are too many collections intermediate in form and texture to separate these plants effectively. Likewise, the larger lanceolate-leaved collections from southwestern Costa Rica appear distinctive and very similar to *P.*

grande. It is in fact difficult to separate smaller leaved specimens of that species from *P. aequale*. The two are closely related and together with *P. carrilloanum* and *P. nemorense* form an alliance marked by the glabrous parts, form of the prophyll, variable venation, and similarity of the flowers and fruit.

The species of this alliance are quite distinct in Costa Rica, with little or no intergradation. In northern Central America the situation is quite different, and the keys and descriptions of the Costa Rican taxa are not applicable. This is in part due to the presence of different taxa, such as *P. variabile* C.DC. A study of this alliance in northern Central America may show intergradations that will require a reassessment of the Costa Rican species.

Piper aereum Trel., Contr. U.S. Nat. Herb. 26:144. 1929. Figure 6.

Shrubs to 3 m. tall or rarely arborescent to 6 m. tall, the older nodes somewhat thickened, leafy internodes 1.5–6 cm. long, 1.5–3 mm. thick, glabrous and drying dark brown; shoot-apex emerging from the leaf-base and free of the prophyll at flowering nodes, the prophyll small (2 mm.) and lateral, caducous and often leaving a scar above the leaf-scar at flowering nodes. Leaves distichous, petioles 15–35 mm. long, about 1.5 mm. broad, glabrous, vaginate to the base of the lamina at all nodes, the thin stipule-like margins tearing loose to produce 2 adaxial ridges of scar tissue at most nodes, a ligule-like extension of the petiole-margin sometimes present at the apex of the petiole; lamina (7) 10–20 cm. long, 3–7 cm. broad, lanceolate or narrowly triangular, tapering very gradually to the acute or acuminate apex, tapering abruptly or rounded at the truncate and unequal base, sides of the lamina 2–7 mm. distant on the petiole, the lamina drying chartaceous and usually grayish in color, smooth and glabrous above and below, the 3 or 4 pairs of major secondary veins arising from the lower two-thirds of the midvein, the upper secondaries arising at angles of 20–60 degrees, arcuate-ascending and sometimes forming an arcuate marginal vein in the upper third of the lamina. Inflorescence free of the leaf-base of the same node in early stages, pendulous at anthesis, 8–22 cm. long; peduncle (6) 14–30 mm. long, about 1.5 mm. thick, flowering portion becoming 4–6 mm. thick, the flowers crowded; floral bracts 0.7–1 mm. broad and cupulate or U-shaped from above, glabrous or sparsely and very minutely puberulent, forming inconspicuous bands around the spike in some stages; anthers about 0.4 mm. long and 0.5 mm. broad, the connective slightly developed at the apex but broad at the base and the theceae divergent with upward dehiscence, forming distinct bands around the spike at anthesis; pistil truncate at the apex with three large (0.5 mm.) sessile stigmas; fruit becoming laterally compressed, about 2 mm. by 0.7 mm. in cross-section, truncate at the apex with sessile stigmas, glabrous.

Plants of the wet forest formations of the Caribbean slope between 1,000 and 1,500 m. elevation. Endemic and known only from the collections by Standley around El Muñeco on the Río Navarro

(Cartago) and Skutch (*3733, P. coiturinode* Trel. ined.) near Vara Blanca, Heredia.

The species is easily recognized by the lack of a developed prophyll, petioles with scar tissue at all nodes, long spikes with pistils that become laterally compressed, lack of pubescence, and narrow leaves. *Piper aereum* is closely related to *P. gibbosum* which differs in the form of the pistil, minute puberulence, and broader leaves. These two species appear to form a link between two distinctive groups of pipers: the large leaved allies of *P. obliquum* and the pinnately veined allies of *P. arboreum*. While very different in appearance these groups share the form of the anthers and lack of an apically developed prophyll.

Piper amalago L., Sp. Pl. 29. 1753. *P. realgoanum* C.DC., Linnaea 37:335. 1872. *P. nicoyanum* C.DC., Bot. Gaz. 70:174. 1920. *P. tenuipes* C.DC., l.c. *P. compactum* Trel., Contr. U.S. Nat. Herb. 26:131. 1929. *P. tilaranum* Trel., l.c. 131. *P. adenophlebium* Trel., l.c. 132. *P. recuperatum* Trel., l.c. 132. *P. xanthoneurum* Trel., l.c. 132. *P. conversum* Trel. in Woodson & Schery, Ann. Mo. Bot. Gard. 27:290. 1940. *P. vaccinum* Standl. & Steyerm., Bot. 24, pt. 3:333. 1952. Figure 3.

Shrubs or occasionally small trees to 8 m. tall, stems with the older nodes somewhat thickened, leafy internodes 1.5–8 cm. long, 1.5–2.5 mm. thick, glabrous or less often puberulent, longitudinally ribbed on drying; shoot-apex emerging from the prophyll at flowering nodes and free of the leaf-base, the prophyll 3–8 mm. long and about 0.6 mm. broad at the base (unopened), usually drying dark, glabrous or puberulent. Leaves usually in a spiral, very variable on different plants; petioles 5–15 mm. long at flowering nodes, to 25 mm. at sterile nodes, about 0.7 mm. thick, grooved adaxially but vaginate only at the base at flowering nodes, glabrous to puberulent; a minute (0.5 mm.) stipule-like structure present or absent at the leaf-base; lamina 5–15 cm. long, 2–8 cm. broad, narrowly elliptic to broadly ovate, tapering to the usually acuminate apex, obtuse to truncate or occasionally cordate at the base, the sides of the blade often somewhat (1–2 mm.) unequal on the petiole, drying thin-chartaceous and often dark in color (slightly paler beneath), smooth and glabrous on both surfaces or occasionally puberulent beneath and on the veins above, the hairs brownish, 0.1–0.4 mm. long, venation palmate with 3 to 7 primary veins, the 3 central veins united 1–5 mm. above the base and these reaching the apex of the lamina, the midvein without prominent secondaries, the major veins slightly raised above. Inflorescence free of the leaf-base of the same node in early stages, erect in early stages, 4–10 (15) cm. long; peduncle 5–18 mm. long, 0.7–1.5 mm. thick, flowering portion 2 mm. thick at anthesis and becoming 3.5 mm. thick in fruit, the flowering parts crowded in early stages but the fruit usually becoming separate on the rachis, the rachis with a dense covering of minute (0.05–0.1 mm.) pale-colored hairs; floral bracts about 0.5 mm. broad and triangular or somewhat U-shaped from above, glabrous above but with hairs around the base

and edges; anthers 0.3–0.5 mm. long and equally broad, the connective broader below and the thecae divergent with dehiscence partially upward; pistil with a broad base and tapering to a narrow apex, stigmas 3 or 4, sessile but well differentiated; fruit usually separate but sometimes laterally compressed in early stages, ovoid with broad (1 mm.) base and narrowed apex, becoming 1.5 mm. long, glabrous and usually drying dark, stigmas sessile.

Ranging from sea level along the Pacific side of Costa Rica to 2,200 m. in the central highlands and apparently absent on the wet Caribbean slopes. A wide-ranging species throughout the neotropics; flowering throughout the year in Costa Rica.

A species that varies greatly in different individuals and at different localities but is easily characterized by the palmate venation, shoot-apex protected by the prophyll, and the unusual inflorescence with puberulent rachis and usually conical separate fruit. Specimens from the Nicoya peninsula differ because of their more uniformly cordate leaves but variation within the species in other areas indicates that this is not a specific distinction. The above description is based largely on Costa Rican collections and does not represent the species' variation found in other areas. Yuncker has discussed this variation and considers *P. medium* Jacq. a variety of *P. amalago* (Brittonia 14:189. 1962).

Piper arboreum Aublet, Hist. Pl. Guian. Fr. 1:23. 1775. *P. falcifolium* Trel., Contr. U.S. Nat. Herb. 26:25. 1927. *P. laevibracteum* Trel., l.c. 26. *P. subnudispicum* Trel., l.c. 26. *P. corozalanum* Trel., l.c. 134. 1929. *P. obumbratifolium* Trel., l.c. 134. *P. barriosense* Trel. & Standl., Fieldiana, Bot. 24, pt. 3:288. 1952. Figure 8.

Shrubs or trees to 8 (rarely 11) m. tall, the older nodes conspicuously thickened, leafy internodes 2.5–5 cm. long, 1–3 mm. thick, glabrous or rarely minutely (0.5 mm.) puberulent; shoot-apex emerging from within the sheathing leaf-base and free of the prophyll at flowering nodes, the prophyll less than 1 mm. long and lateral or not apparent, not producing a ring of scar tissue above the leaf-scar. Leaves distichous, petioles 6–12 (24) mm. long, 1–3 mm. thick, pinkish but drying brown, glabrous or rarely puberulent, deeply vaginate at all nodes, the adaxial margins extending beyond the base of the lamina to form a ligule-like structure to 4 mm. long, the margins sometimes torn in older leaves but rarely forming continuous rims of scar tissue; lamina 10–22 (rarely 30) cm. long, 2–10 (rarely 14) cm. broad, usually lanceolate to narrowly ovate or oblong, occasionally broadly ovate, elliptic, or obovate, gradually tapering to the acute or acuminate apex or abruptly acuminate in the broad leaves, acute to obtuse at the very unequal base, the shorter side often rounded at the base and the longer usually decurrent, the sides of the lamina 3–12 mm. distant on the petiole, lamina drying stiffly chartaceous, smooth and glabrous above and below or rarely puberulent beneath, the 6 to 11 pairs of major secondary veins arising throughout the length of the midvein, cen-

tral secondaries arising at angles of 45–70 degrees, arcuate ascending near the margin and occasionally forming a marginal vein in the upper fourth of the blade. Inflorescence free of the leaf-base of the same node in early stages but sometimes subtended by scar tissue in later stages, erect in early stages, 7–18 cm. long; peduncles 5–12 mm. long, 0.8–2 mm. thick, flowering portion 2–5 mm. thick, the flowers densely crowded; floral bracts 0.3–0.6 mm. broad above and triangular with a glabrescent center and densely ciliolate margin, usually forming bands around the spike; anthers about 0.3 mm. long and 0.5 mm. broad, the connective broad at the base and the thecae divergent with upward dehiscence; pistil with 3 or 4 sessile stigmas, becoming laterally compressed; fruit round or oblong in cross-section in late stages, 0.8–1.7 mm. thick, truncate at the apex and often with the sessile stigmas in a depression, surfaces glabrous, the fruit separating when dried and forming distinctive bands around the spike.

A species of moist forest formations on both the Caribbean and Pacific slopes between sea level and 1,500 m. elevation; absent from the deciduous forest formations of Guanacaste. Commonly growing in forest shade and collected in flower and fruit from November to May. The species ranges from Guatemala to northern South America and the West Indies.

The unusual leaves with pinnate venation throughout, unequal base, sheathing petiole at all nodes, ligule-like structure, and laterally compressed fruit distinguish this species. Plants from around Golfo Dulce have unusually broad leaves and these may be worthy of subspecific rank. However, broad leaves have also been collected from Villa Quesada and Tilaran. *Piper arboreum* is related to *P. tuberculatum* and *P. cordulatum* C.DC. of Panama; all share the undeveloped prophyll, sheathing leaf-base at all nodes, and similar form of flowering parts.

Piper arieianum C.DC., Anal. Inst. Fis.-Geog. Costa Rica 9:166. 1897, Photo. *P. machadoanum* C.DC., l.c., photo. *P. acutissimum* Trel., Contr. U.S. Nat. Herb. 26:25. 1927, photo. *P. altevaginans* Trel., l.c. 140, 1929. *P. cufodontii* Trel. in Cufod., Arch. Bot. Fitogeog. & Genet. 10:25. 1934. Figure 8.

Small shrubs 1–2 m. tall (in ours), the older nodes conspicuously thickened, leafy internodes 1.5–8 cm. long, 1.5–4 mm. thick, glabrous or puberulent with short (0.05–0.2 mm.) curved hairs; shoot-apex emerging from within the prophyll and free of the leaf-base at flowering nodes, the prophyll becoming 2 cm. long, drying dark brown, glabrous but with minute (0.05–0.1 mm.) hairs along the back of the midrib. Leaves usually distichous, petioles 3–7 mm. long but becoming 16 mm. long at sterile nodes, 1–2 mm. broad and adaxially grooved at flowering nodes, vaginate with stipule-like margins only at sterile nodes, glabrous or minutely puberulent; lamina 11–20 cm. long, 3.5–6 cm. broad, very narrowly ovate to lanceolate, elliptic or oblong, acute to acuminate at the apex, acute to obtuse at the usually subequal base, sides of the lamina 0–3 mm. distant on the petiole,

the lamina drying thin-chartaceous and somewhat paler beneath than above, smooth and glabrous above, glabrous or minutely (0.1–0.2 mm.) puberulent on the veins beneath, small (0.05 mm.) pellucid or dark gland-dots usually conspicuous below, major veins flat or slightly raised above, the 4 to 7 pairs of major secondary veins usually arising throughout the length of the midvein, the central secondaries arising at angles of 30–65 degrees, forming an arcuate marginal vein only in the distal fourth of the lamina. Inflorescence free of the leaf-base of the same node in early stages, at first erect but becoming pendulous, 4–11 cm. long, peduncle 4–10 mm. long, 0.5–1.2 mm. thick, glabrous or minutely puberulent, flowering portion 1.4–2.4 mm. thick at anthesis and becoming about 4 mm. thick in fruit, the flowers crowded; floral bracts 0.4–0.7 mm. broad and triangular from above, glabrous above but minutely (0.1 mm.) puberulent beneath, not forming distinct bands around the spike; anthers about 0.3 mm. long and 0.3 mm. broad, with a conspicuous (0.1 mm.) disc-like gland at the apex of the connective, thecae dehiscing laterally; pistil with 3 distinct stigmas; fruit obpyramidal-trigonous by compression, about 1.3 mm. long and equally broad, glabrous but with a granular surface above, truncate with the center depressed at the apex, stigmas sessile within the depression.

Plants restricted to the shade of wet lowland (0–500 m.) Caribbean forest formations in Costa Rica. The species ranges from Nicaragua to Trinidad and Colombia.

Piper arieianum is recognized by the pinnate venation, slender spikes, anthers with gland-like tip, trigonous fruit depressed apically when dry, and restricted habitat. This species is very similar to *P. trigonum* of the moist Pacific lowlands and the two species may prove to be conspecific. The material placed here is conspecific with *Piper saltuum* C.DC. of northern South America (Trelease and Yuncker 1950) with specimens from the northern part of our area differing in being puberulent.

Piper artanthopse C.DC., Jour. Bot. 4:161. 1866. *P. oerstedii* C.DC., Linnaea 37:359. 1872. *P. impube* Trel., Contr. U.S. Nat. Herb. 26:142. 1929. Figure 4.

Small shrubs to about 1 m. tall, the lower nodes somewhat thickened, leafy internodes 2–7 cm. long, 2–3 (4.5) mm. thick, glabrous; shoot-apex emerging from within the sheathing leaf-base and partly enclosed in the open prophyll at flowering nodes, the prophyll 12–20 mm. long, glabrous and caducous, producing a circular scar above the leaf-scar and peduncle at flowering nodes. Leaves in a spiral or distichous, petioles 1–3.5 cm. long, 1–2.5 mm. broad, glabrous, deeply vaginate and with 2 margins of scar tissue on the adaxial side at all nodes; lamina 10–18 cm. long, 3.5–5.5 cm. broad, lanceolate to narrowly ovate, tapering very gradually to the acute or acuminate apex, obtuse to rounded at the equal or subequal base, drying stiffly chartaceous and paler in color beneath, smooth and glabrous on both surfaces, the 3 to 5 pairs of major secondary veins usually arising from the lower two-thirds of the midvein, the central secondaries arising at angles of 30–60 de-

grees but usually arcuate ascending, major veins often impressed above and prominent below, the edges curled under on drying. Inflorescences at first enclosed within the sheathing leaf-base of the same node and usually subtended by a ridge of scar tissue continuous with the petiole, erect, 12–35 mm. long; peduncle 6–12 mm. long, 0.7–1.6 mm. thick, glabrous, flowering portion becoming 7–10 mm. thick in fruit and up to 4 cm. long, apex of the spike often with a short (4 mm.) narrow flowerless tip, the flowers loosely aggregated; floral bracts about 1–2 mm. broad and U- or V-shaped from above, minutely puberulent only at the base, not forming definite bands around the spike; anthers 0.4–0.5 mm. long, about 0.3 mm. broad, dehiscing laterally, connective slightly prolonged beyond the thecae, dehiscing laterally, the filaments prominent (0.4×0.1 mm.); pistils stylose from early stages; fruit becoming 2 mm. thick, round in cross-section and not densely crowded, glabrous, narrowed at the apex with a short (0.2 mm.) style and 2 (3) distinct thick stigmas.

Understory plants of wet or moist forest formations between 400 and 1,200 m. elevation on the Pacific slopes of the central highlands and Sierra de Guanacaste. The species is apparently endemic to the Pacific side of Central Costa Rica; it has not been reported from the General Valley or adjacent areas.

Readily recognized plants with very thick short spikes emerging from the sheathing leaf-bases, lanceolate leaves, and short stature. Apparently closely related to *P. curtispicum* and *P. cuspidispicum* among our species. *Piper pubstipulum* of Central Panama has a similar leaf-shape but is densely puberulent and obviously related to *P. colon-insulae* Trel.

Piper augustum Rudge, Pl. Guian. Rar. 1:10, pl. 7. 1805. *P. prismaticum* C.DC., Linnaea 37:342. 1872. *P. turrialvanum* C.DC., l.c. 1872. *P. pseudoumbratum* C.DC., Anal. Inst. Fis.-Geog. Costa Rica 9:171. 1897. *P. ladrillense* Trel., Contr. U.S. Nat. Herb. 26:27. 1927. *P. prismaticum* var. *tilaranum* Trel., l.c. 135. 1929 *P. prismaticum* var. *villosulum* Trel., l.c. 135. *P. delectans* Trel. in Standl., Field Mus. Bot. 18:340. 1937. Figure 7.

Shrubs or small trees to 4 m. tall, usually with a single main stem and horizontal branches near the top, the nodes thickened, prop roots present, leafy internodes 4–12 cm. long, 2.5–8 mm. thick, glabrous or sparsely and minutely puberulent; the shoot-apex loosely enclosed in the prophyll and free of the leaf-base at flowering nodes, the prophyll 2–8 cm. long, glabrous and often drying dark brown. Leaves often distichous, petioles 0.5–4 cm. long or up to 8 cm. long at sterile nodes, 2–4 mm. thick, glabrous or minutely puberulent, grooved adaxially but vaginate only at the base and without winged margins or conspicuous ridges of scar tissue at flowering nodes; lamina 20–40 cm. long, 8–18 cm. broad, elliptic to narrowly ovate or oblong, obtuse to short-acuminate at the apex, tapering abruptly at the obtuse, truncate, or occasionally subcordate base, sides of the blade quite unequal (2–10 mm.) on the petiole, drying membranaceous to thin chartaceous and much

paler in color beneath, the edge of the lamina usually with a margin of minute (0.1 mm.) appressed hairs, upper surface smooth and glabrous or with a few scattered hairs, lower surfaces glabrous or with small (0.1–0.8 mm.) hairs along the veins, the (6) 10–16 pairs of major secondary veins arising throughout the length of the midvein, central secondaries arising at angles of 40–65 degrees. Inflorescence free of the leaf-base of the same node in early stages, erect but becoming pendulous, very variable (10–30 cm.) in length and thickness; peduncle 8–55 mm. long, about 2 mm. thick, glabrous and drying dark brown, flowering portion whitish and slender (4 mm.) in early stages but becoming 12 mm. thick in fruit (dried); floral bracts 0.8–1.4 mm. broad and triangular in outline above, with a margin of dense whitish hairs and glabrous center, not usually forming distinct bands around the spike; anthers about 0.4 mm. long, with a minute gland-like apex on the connective; pistil becoming stylose in later stages; fruit succulent and densely crowded, becoming about 4 mm. long, 2 mm. thick and angular.

Plants of wet forests between sea level and 1,500 m. elevation; apparently absent below 500 m. on the Pacific slope of Costa Rica. Ranging from Costa Rica to northern South America and the Guianas.

An easily recognized species with large thin leaves with many pairs of secondary veins, developed prophyll, and usual presence of minute hairs along the leaf-edge. The prop-roots are an outstanding character that I have seen in only one other Costa Rican piper (*P. cenocladum*). This species is quite unique but may be related to *P. auritum* and *P. pittieri*. It differs in the developed prophyll, stylose fruit, and very different leaves. Like *P. auritum* the thin leaves have a ciliolate margin and sweet spicy odor when crushed; the bracts and early flowering stages are also similar.

Piper auritum H.B.K., Nov. Gen. & Spec. 1:54. 1815. *P. perlongipes* Trel., Contr. U. S. Nat. Herb. 26:154. 1929. Figure 5.

Shrubs or slender trees to about 6 m. tall, stems glabrous and longitudinally ribbed on drying, leafy internodes 5–15 cm. long, 4–10 mm. thick; the shoot-apex enclosed within the sheathing leaf-base at flowering nodes, a prophyll not evident. Leaves quite uniform in shape, the petioles 4–10 cm. long, deeply vaginate at flowering nodes with broad, thin adaxial margins, the thin margins persistent and sheathing the stem at their base, glabrous or minutely puberulent; lamina 20–55 cm. long, 12–30 cm. broad, ovate to elliptic in outline but very unequal at the base, tapering abruptly to the acute, obtuse, or short acuminate apex, somewhat narrowed and unequally cordate at the base with one lobe conspicuously longer than the other, the basal sides of the blade 0.5–3 cm. distant on the petiole, drying membranaceous to thin-chartaceous, the margin of the blade densely ciliolate with whitish hairs 0.1–0.5 mm. long, upper surface smooth to the touch and with scattered hairs 0.2–0.5 mm. long, lower surface with shorter hairs especially dense on the veins, the 4 to 6 pairs of major secondary veins arising from the lower two-

thirds of the midvein, the upper secondaries arising at angles of 30–40 degrees and arcuate ascending, the lowest pair of secondaries forming part of the lamina-margin near the petiole. Inflorescence free of the leaf-base of the same node in early stages, peduncle 4–10 cm. long and about 2–3.5 mm. thick, glabrous, the flowering rachis becoming over 30 cm. long, the spike whitish in most stages, 2–5 mm. thick and becoming 8 mm. thick in fruit (rare in collections); floral bracts rounded or triangular above with a conspicuous fringe of whitish hairs, 0.4–0.8 mm. broad, very numerous and densely congested, not forming bands around the spike; anthers 0.2–0.4 mm. long, the connective narrow, dehiscence lateral; pistils hidden by the bracts; fruit obpyramidal, about 0.5–0.8 mm. long and 0.6 mm. thick, angular and tightly compressed, the 3 stigmas sessile.

A very common species of forest edges and open sites between sea level and 1,200 m. elevation and occasionally as high as 2,000 m. Found in all the moister areas of Costa Rica and in moist situations (stream beds) in the deciduous forest areas of Guanacaste. The species ranges from Mexico to Colombia and to some of the islands of the West Indies.

Easily recognized by the thin leaves of unusual form with a dense margin of short hairs along the edge and the sasparilla-like odor when crushed. Similarly shaped leaves occur in *P. imperiale* and its allies but these differ in flower structure and are, I believe, unrelated. *P. auritum* is very distinctive but may be related to *P. marginatum*, *P. pittieri*, and *P. prismaticum;* species which share characteristics of floral structure, pubescence, and petiolar morphology but differ greatly in leaf-form.

Piper austinii Trel. in Standl., Field Mus. Bot. 18:1546. 1938. *P. austini* var. *aequilaterum* Trel. in Standl., l.c. Figure 13.

Shrubs 1.5–4 m. tall, older nodes only slightly thickened, leafy internodes 2–10 cm. long, 1.5–3.5 mm. thick, glabrous; shoot-apex emerging from within the prophyll and partly enclosed by the ligule-like development of the leaf-base at flowering nodes, prophyll 15–40 mm. long, acute, glabrous and drying brown. Leaves usually distichous, petioles 6–14 mm. long, 0.8–2 mm. thick, vaginate only at the base and with a ligule-like stipular development 4–10 mm. long at flowering nodes; laminae 9–18 (22) cm. long, 3.5–7 (9) cm. broad, elliptic to lanceolate or ovate, tapering gradually to the slender acuminate apex, obtuse or rounded at the oblique base, sides of the lamina 0–4 (8) mm. distant on the petiole, the lamina drying thin-chartaceous and often dark above, smooth and glabrous on both surfaces, venation becoming impressed above only in old leaves, the 3 or 4 pairs of major secondary veins usually arising from the lower half of the midvein, upper secondaries arising at angles of 15–35 degrees, arcuate-ascending. Inflorescence free of the leaf-base of the same node in early stages, erect, 4–10 cm. long, peduncle 5–15 mm. long, 0.8–1.5 mm. thick, glabrous, flowering portion 2–3 mm. thick at anthesis, 3–4 mm. thick in fruit, the flowers congested; floral bracts 0.4–0.5 mm. broad and triangular above, glabrous centrally with a dense margin of minute

(0.1 mm.) yellowish hairs, forming conspicuous bands around the spike in early stages; anthers 0.1–0.2 mm. long, 0.3–0.4 mm. broad, connective very broad basally with the thecae divergent and dehiscing upward; pistil obscured by anthers and bracts; fruit becoming laterally compressed and tetragonous, 0.6×0.9 mm. thick, truncate above with a slight depression around the minute sessile stigmas, minutely puberulent above and reddish pellucid muricate on the sides.

Plants of deep shade in the wet montane forests between 1,400 and 2,400 m. elevation subject to the wet Caribbean winds; known only from areas near Zarcero, Alajuela, and north of San Isidro, Heredia. Collected in flower from January to March and in fruit in early June.

Piper austinii is characterized by the glabrous vegetative parts, large stipular development and prophyll, and restricted montane habitat. The form of the floral bracts, anthers, and fruit indicate a close relationship with *P. hispidum* and its allies. This species, together with *P. epigynium*, could be considered as no more than relatively glabrous and smooth leaved montane forms within the hispidum complex; see the discussion under *P. hispidum*.

Piper biauritum C.DC., Anal. Inst. Fis.-Geog. Costa Rica 9:161. 1897. *P. tortuosipilum* Trel., Contr. U.S. Nat. Herb. 26:148. 1929. *P. insolens* Trel., l.c. 156. Figure 12.

Shrubs 1–2 m. tall, older nodes not conspicuously thickened, leafy internodes 1.5–8 cm. long, 1.2–3.6 mm. thick, hirsute with long (1–3.5 mm.) crooked yellowish hairs; shoot-apex emerging from the prophyll and free of the leaf-base at flowering nodes, the prophyll 15–25 mm. long, drying pale brown, acute, with long crooked hairs along the back of the midrib. Leaves usually distichous, petioles 4–9 (20) mm. long, 0.8–2 mm. thick, hirsute, vaginate only at the base and a ligule-like process absent or minute at flowering nodes; laminae 11–25 cm. long, 5–12 cm. broad, asymmetrically ovate or elliptic, one side often much broader than the other, short-acuminate at the apex, narrowed below the middle to the unequal base, the shorter side obtuse with the longer side rounded or cordulate, sides of the lamina 2–6 mm. distant on the petiole, the lamina drying chartaceous and dark in color above, smooth or scabrous above with evenly spaced crooked yellowish hairs 0.8–3 mm. long, the hairs more concentrated on the veins beneath, venation flat above, the 4 or 5 pairs of major secondary veins usually arising from the lower half of the midvein, the upper secondaries arising at angles of 15–40 degrees, arcuate ascending. Inflorescence free of the leaf base of the same node in early stages, erect, 7–12 cm. long, peduncle 8–22 mm. long, 1–1.8 mm. thick, glabrous or hirsute, flowering portion 3–4 mm. thick at anthesis, becoming about 4 mm. thick in fruit, the flowers congested; floral bracts about 0.4 mm. broad, triangular or rounded to cupulate above, glabrous centrally with inconspicuous (0.1 mm.) hairs on the margin, not forming bands around the spike and inconspicuous in fruit; anthers 0.1–0.2 mm. long, 0.3–0.4 mm. broad, connective broad basally with the divergent thecae dehiscing upward; pistil usually obscure, stigmas small and sessile; fruit

becoming laterally compressed and tetragonous, 0.8×0.5 mm. and truncate above with very minute (0.05 mm.) whitish hairs above.

Plants of the very wet Caribbean slopes and central mountains, ranging from near sea level to 1,600 m. elevation. Collected in flower and fruit from December to May. I have only seen material from Costa Rica but expect that the species ranges considerably further along the Caribbean.

Piper biauritum is recognized by the asymmetric leaves with long evenly spaced hairs on the dark upper surface, slender spikes with inconspicuous bracts, and minutely puberulent fruit compressed laterally. This species is closely related to *P. polytrichum*. Characters of the prophyll, anthers, and fruit ally these species to *P. hispidum* and related taxa (q. v.). The photo of the type in the Herbarium Candolleanum (FM negative 31687) appears to be quite different from isotypes at the U. S. National Herbarium. I am using the name as represented by the material of *Tonduz 9270* in U.S.N.H.

Piper biolleyi C.DC., Bull. Soc. Bot. Belg. 30, pt. 1:210. 1891. *P. sublineatum* O. Ktze., Rev. Gen. 2:565. 1891. Figure 7.

Shrubs to 4 m. tall, older nodes somewhat thickened, leafy internodes 3–11 cm. long, 3–6 mm. thick, glabrous; shoot-apex emerging from the sheathing leaf-base and partially enclosed by the open prophyll at flowering nodes, the prophyll becoming 5 cm. long, glabrous and drying pale brown, usually leaving a circular scar 2–3 mm. above the leaf-scar. Leaves usually distichous, petioles 2–5 cm. long, 2–4 mm. broad, essentially glabrous, deeply vaginate to the base of the lamina and the stipule-like margins tearing off to produce 2 adaxial rims of scar tissue at all nodes; lamina 15–30 cm. long, 10–18 cm. broad, broadly elliptic and broadest at or just below the middle, tapering abruptly to the obtuse to short-acute apex, tapering abruptly to the obtuse or somewhat rounded base, equal or subequal with the sides of the base 0–3 mm. distant on the petiole, drying stiffly chartaceous and often gray-green with the margin revolute, surface smooth to the touch and glabrous on both surfaces, the 10 to 20 pairs of major secondary veins arising throughout the length of the midvein, the central secondaries arising at angles of 30–50 degrees and ascending, arcuate near the margin. The major veins often deeply impressed above and very prominent beneath. Inflorescence at first enclosed in the sheathing leaf-base of the same node and later subtended by a ridge of scar tissue continuous with the petiole, erect, 5–13 cm. long; peduncles 8–14 mm long, 2–3 mm. thick, glabrous or sparsely and very minutely (0.1 mm.) puberulent, flowering portion becoming 6–8 mm. thick in fruit, the flowers numerous and tightly congested; floral bracts 0.7–1.6 mm. broad and U-, V-, or Y-shaped from above (by compression of the fruit), the edges with very minute (0.05 mm.) hairs, not forming distinct bands around the spike; anthers about 0.4 mm. long and equally broad, dehiscing laterally, the connective broad at the base of the thecae but narrowed and inconspicuous above; pistil with very short (0.2 mm.) style and 3 or 4 stigmas; fruit becoming densely congested and round or angled in cross-

section, 2–3 mm. thick, truncate at the apex with the style very short or the stigmas sessile, glabrous.

A species of shaded sites and stream edges in wet forest formations between sea level and 1,400 m. altitude. Endemic to Nicaragua and Costa Rica where it has been collected on the Caribbean watershed, and the General Valley and Golfo Dulce area on the Pacific side. Collected in flower and fruit from December to May.

Piper biolleyi belongs to a distinctive group of pipers that possess the following characters: spikes at first enclosed in the sheathing leaf-base, prophyll open and caducous, pistils with short styles and 3 or 4 stigmas, and short anthers. The unusual venation and stiff leaves distinguish this species from its close allies (*P. glabrescens* and *P. yzabalanum*) and from all other Costa Rican pipers. *Piper latibracteatum* C.DC. of southern Panama is quite similar to *P. biolleyi* and indicates a relationship with the very distinctive pipers with short thick spikes such as *P. curtispicum* and its allies.

Piper bisasperatum Trel., Contr. U.S. Nat. Herb. 26:173. 1929. *P. blepharilepidum* Trel., l.c. 160. *P. coactoris* Trel., l.c. 161. *P. pubens* Trel., l.c. 163. *P. emollitum* Trel., l.c. 181. *P. ventoleranum* Trel., l.c. 184. Figure 13.

Shrubs 1–3 m. tall or rarely tree-like plants 5 m. tall, older nodes slightly thickened, leafy internodes 2–10 cm. long, 1.2–3.5 mm. thick, glabrous or crisp-puberulent with yellowish hairs 0.3–1.5 mm. long; shoot-apex emerging from within the prophyll and partly enclosed by the leaf-base at flowering nodes, prophyll 12–25 mm. long, acute, puberulent along the midrib abaxially or occasionally glabrous, the glabrous margins drying brown. Leaves usually distichous, petioles (4) 6–16 mm. long, 1–2 mm. thick, glabrous or crisp-puberulent, vaginate only at the base and with a ligule-like stipular development (2) 4–10 mm. long at flowering nodes; laminae 10–22 cm. long, (3) 4–8.5 cm. wide, ovate to narrowly elliptic, tapering gradually to the often long-acuminate apex, the midvein occasionally extending a few millimeters beyond the tip, rounded or obtuse at the unequal base, sides of the lamina 2–6 mm. distant on the petiole, the lamina drying thin to stiffly chartaceous, glabrous or with few scattered minute (0.2 mm.) hairs above, scabrous or rarely smooth above, crisp-puberulent on the veins beneath with crooked yellowish hairs 0.3–1.5 mm. long, venation often becoming impressed in age and occasionally forming a bullate upper surface in older leaves, often prominent beneath, the 4 or 5 pairs of major secondary veins usually arising from the lower half of the midvein, upper secondaries arising at angles of 15–30 degrees and arcuate-ascending. Inflorescence free of the leaf-base of the same node in early stages, erect, 6–12 cm. long, peduncle 4–14 (18) mm. long, 1–1.8 mm. thick, glabrous or sparsely crisp-puberulent, flowering portion 2.5–3.5 mm. thick at anthesis, 3–4 mm. thick in fruit, often with a slender flowerless tip, the flowers congested; floral bracts rounded to broadly triangular or slightly cupulate and 0.4–0.5 mm. broad above, glabrous centrally with a margin of minute (0.1 mm.) hairs, forming bands around

the spike in some stages; anthers 0.1–0.2 mm. long, 0.4–0.5 mm. broad, connective very broad basally and the divergent thecae opening upward; pistil obscured by bracts and anthers; fruit becoming laterally compressed, about 0.6×1.0 mm. thick, truncate and densely puberulent above, the short (0.1–0.2 mm.) stigmas borne in a slight depression on the dry fruit and usually breaking off.

Plants of the shade of wet montane forest formations between (700) 1,000 and 2,200 m. elevations, most commonly in areas subject to the wet Caribbean winds; collected in flower from late December to May. This species ranges from Tilaran, Guanacaste to the western part of the Cordillera de Talamanca but is to be expected over a wider area and may be conspecific with plants from highland Chiriqui, Panama, identified as *P. hispidum* by Yuncker (see below).

Piper bisasperatum is recognized by its relatively large long-acuminate scabrous leaves, large stipular development, broad anthers dehiscing upward, puberulent fruit, and wet montane forest habitat. This species is part of a complex of taxa closely related to *P. hispidum* and it may be no more than a subspecific element of *P. hispidum* (in a wide sense). The two entities differ in Costa Rica in leaf-form, general morphology of the shoot-tip, and very different habitats. A number of collections from highland Chiriqui appear to be intermediate between *P. bisasperatum* and *P. hispidum* (as defined here) but a transition between the two is absent in Costa Rica. The situation in Costa Rica is complicated by other elements of the *P. hispidum* complex, such as *P. perhispidum* and *P. polytrichum*. In addition, *P. austini* and *P. epigynium* may be no more than unusual forms of *P. bisasperatum*. See the discussion under *P. hispidum*.

Piper biseriatum C.DC., Bot. Gaz. 70:178. 1920. *P. dasypogon* C.DC., l.c. 187. *P. ciliatifolium* Trel., Contr. U.S. Nat. Herb. 26: 152. 1929. *P. signatum* Trel., l.c. 152. *P. tinctum* Trel., l.c. 153. *P. auritifolium* Trel., l.c. 154. *P. longevillosum* Trel., l.c. 155. *P. hians* Trel. in Standl., Field Mus. Bot. 18:346. 1937. *P. quebradense* Trel. in Standl., l.c. 357. *P. sanrafaelense* Trel. in Standl., l.c. 1547. 1938. Figure 5.

Shrubs or slender-stemmed trees to 5 m. tall, leafless nodes only slightly thickened, leafy internodes 3–15 cm. long, 3–8 mm. thick, sparsely to densely puberulent with long (1–3 mm.) crooked usually brownish hairs; shoot-apex emerging from the sheathing leaf-base at all nodes, the prophyll small (2 mm.) and lateral, hidden by the sheathing leaf-base. Leaves in a spiral or distichous, petioles 2–7 cm. long, 4–8 mm. broad, often obscured by the lower lobe of the lamina, usually with small tubercles and crooked hairs 1–3 mm. long, deeply vaginate and with

broad thin adaxial margins at all nodes and sheathing the stem; lamina 20–38 cm. long, 10–15 (20) cm. broad, elliptic to oblong in general outline, usually short-acuminate at the apex, narrowed to the very unequal base, obtuse to cordate on the shorter side but with the other side developed into a much (2–8 cm.) prolonged basal lobe 3–7 cm. wide and overlapping the petiole by as much as 5 cm., the sides attached 3–20 mm. distant on the petiole, the lamina usually drying stiffly chartaceous and often dark in color, smooth and usually with long crooked hairs on the upper surface, more densely puberulent beneath and the hairs usually shorter (0.3–1.5 mm.), the major veins often impressed above and giving a slightly bullate appearance, the 4 or 5 pairs of major secondary veins usually arising from the lower half of the midvein (lower two-thirds of the lamina), upper secondaries arising at angles of 20–45 degrees, the tertiary venation often prominent beneath. Inflorescence free of the leaf-base of the same node in early stages, pendulous, to 40 cm. long, peduncles 2–6 (12) cm. long, 1–3 mm. thick, sparsely puberulent or glabrous, the flowering portion 4–6 mm. thick at anthesis and becoming 10 mm. thick in fruit, the flowers crowded; floral bracts 0.3–0.7 mm. broad, usually round in outline from above, glabrous in the center above and with margins of short (0.2 mm.) whitish hairs, readily visible and forming bands around the spike in early stages; anthers about 0.2 mm. long and 0.5 mm. broad, the connective greatly broadened below and the thecae almost in a single plane with upward dehiscence, anthers persisting into fruiting stages; pistil with 3 broad stigmas, usually obscured by the anthers; fruit densely crowded and difficult to distinguish, about 1 mm. long and equally broad, with 3 broad (0.3 mm.) flat stigmas (or style-branches) to 0.8 mm. long.

Plants of wet evergreen forest formations between sea level and 1,600 m. altitude. Endemic to Costa Rica (as here defined) but undoubtedly present in western Panama and with closely related forms in northern South America. The species has been collected on the Caribbean slopes, around the Meseta Central, and above 600 m. on the Pacific slope of southeastern Costa Rica.

One of the large-leaved tree-like pipers of forest shade distinguished by the presence of long hairs, unusual anthers, small floral bracts with short pale colored hairs, and unusual leaf-shape (in most). The plants placed under this name are closely related to *P. obliquum* and part of a complex of forms allied to that species; see the discussion under *P. obliquum*. A few collections lack the unusual leaf-base with large overlapping basal lobe and have a leaf rather like *P. auritum*. These plants (*Molina et al. 17128, Burger & Matta 4184D*, and *Standley 48773*, the type of *P. auritifolium*) may prove to be worthy of specific recognition but the pistils and fruit are unknown.

Piper bredemeyeri Jacq., Eclog. 1:125. 1815. *P. pseudopsis* C.DC., Anal. Inst. Fis.-Geog. Costa Rica 9:164. 1897. *P. pelliticaule*

Trel., Contr. U.S. Nat. Herb. 26:157. 1929. *P. alveolatifolium* Trel., Journ. Wash. Acad. Sci. 19:329. 1929. Figure 11.

Shrubs 1.5–3 m. tall, leafy internodes 2–10 cm. long, about 2–3 mm. thick, densely hirsute or velutinous with yellowish hairs 0.5–1 mm. long, shoot-apex emerging from within the prophyll and stipule at flowering nodes, the prophyll becoming 10–25 mm. long, puberulent along the midrib (abaxially) and usually glabrate and becoming dark brown near the edges. Leaves usually distichous, petioles 8–18 mm. long at flowering nodes, 1.5–3 mm. broad, densely puberulent, vaginate in the lower part and often with scar tissue where the stipule has torn loose, a stipule-like outgrowth to 8 mm. long and 3 mm. broad usually present at the base of the petiole in early stages; laminae 10–22 (26) cm. long, 4–10 cm. broad, narrowly to broadly ovate, tapering gradually to the acuminate apex, narrowed abruptly and usually rounded at the unequal base, sides of the blade 1–4 mm. distant on the petiole, the base occasionally with small (5 mm.) unequal lobes, the lamina drying stiffly chartaceous, minutely hispidulous and scabrous above, all the veins deeply impressed above to form a rugose surface, all the veins very prominent beneath to form a reticulum of small (0.5–2.5 mm.) lacunae, hispidulous beneath with brownish hairs 0.3–1 mm. long, the 4 to 7 pairs of major secondary veins arising from the midvein in the lower two-thirds of the midvein, upper secondaries arising at angles 15–40 degrees. Inflorescences partly enclosed by the stipule in early stages and later subtended by a ridge of scar tissue, apparently erect, 6–12 cm. long, peduncles 12–23 mm. long, 1.2–2 mm. thick, densely hispidulous, flowering portion 3–4 mm. thick in anthesis, 4–5 mm. thick in fruit, the flowers congested; floral bracts about 0.8 mm. broad and triangular or crescent-shaped above, glabrous centrally and with a dense margin of conspicuous yellowish hairs 0.2–0.6 mm. long, forming bands around the spike; anthers 0.3–0.4 mm. long, about 0.3 mm. broad, dehiscing laterally; pistils obscured by the bracts, with 3 slender stigmas about 0.5 mm. long; fruit about 1 mm. long and 0.8 mm. thick, obpyramidal-trigonous by compression, glabrous and truncate apically but usually covered by the bracts.

Plants of shrubby thickets in regions of evergreen montane forest formations, collected between 1,000 and 2,000 m. elevation around the Meseta Central in Costa Rica; flowering throughout the year. The species ranges from Honduras to Venezuela and Colombia.

A distinctive piper with rugose-bullate leaves that are usually quite scabrous above, dense pubescence, and floral bracts with dense margin of long often parallel hairs. This species is quite similar to *P. lacunosum* but the latter is not stipulate, lacks scabrous leaves, and has very different flowering parts. The developed prophyll and stipule indicate a relationship with *P. hispidum* and its allies. One of these species is *P. perhispidum* which is often rugose but the reticulation is much coarser and the tertiary veins tend to be recognizable. In *Piper bredemeyeri* the tertiary and quaternary veins are equally impressed above (prominent beneath) forming a finer reticulum.

Piper capacibracteum Trel., Contr. U.S. Nat. Herb. 26:183. 1929. Figure 12.

Shrubs 1–3 m. tall, older nodes slightly thickened, leafy internodes 1.5–8 cm. long, 1–4 mm. thick, densely tomentulous with whitish usually retrorse hairs 0.3–1.3 mm. long; shoot-apex emerging from within the prophyll and free of the leaf-base at flowering nodes, prophyll 10–15 mm. long, acute, densely puberulent along the back of the midrib with the glabrous sides drying dark brown. Leaves usually distichous, petioles 4–12 (20) mm. long, 0.8–1.8 mm. thick, usually densely tomentulose, vaginate only at the base and with a stipular development absent or minute (0.5 mm.) at flowering nodes; laminae 10–17 cm. long, 3.5–7 cm. wide, narrowly ovate to ovate-lanceolate, usually broadest below the middle, tapering gradually to the acuminate apex, obtuse or rounded at the unequal base, sides of the lamina 1–4 mm. distant on the petiole, lamina drying chartaceous, usually grayish in color and whitish beneath, scabrous and hispidulous above and below, the hairs about 0.5 mm. long above, more dense and about 0.7 mm. long beneath, the larger veins becoming slightly impressed in age, the 3 to 5 pairs of major secondary veins usually arising from the lower half of the midvein, upper secondaries arising at angles of 10–35 degrees, arcuate-ascending. Inflorescence free of the leaf-base of the same node in early stages, erect, 5–12 cm. long, peduncles 5–16 mm. long, 0.7–2 mm. thick, densely whitish tomentulose, flowering portion 3–4 mm. thick at anthesis, becoming 5 mm. thick in fruit, the flowers congested, floral bracts 0.5–0.8 mm. broad and rounded or triangular from above with conspicuous (0.2–0.4 mm.) whitish hairs around a glabrous center forming bands around the spike in many stages; anthers 0.2–0.3 mm. long, 0.4–0.5 mm. broad, connective broad basally and the divergent anthers dehiscing upward; pistil obscured by bracts and anthers; fruit becoming laterally compressed and tetragonous, 1×1.5 mm. thick, truncate above with a depression around the minute sessile stigmas (dry), puberulent above and pellucid-muricate on the sides, the fruit usually obscured by the bracts.

Plants of shaded sites between 1,200 and 1,800 m. elevation in the area around Sta. Maria de Dota, San Jose. This taxon is endemic to this region of Costa Rica and has only been collected in December.

Piper capacibracteum is characterized by the densely pubescent vegetative parts, lack of a stipular development (at flowering nodes), and relatively thick spikes with large floral bracts and large anthers. The larger anthers may indicate a higher chromosome number than in the very closely related *P. villiramulum* of lower altitudes. These taxa together with *P. perhispidum* are very similar to *P. hispidum* and its close allies but differ in the pubescence of the upper leaf-surface and lack of the large ligule-like stipular development.

Piper carpinteranum C.DC., Anal. Inst. Fis.-Geog. Costa Rica. 9:165. 1897, photo. *P. ejuncidum* Trel., Contr. U.S. Nat. Herb. 26:164. 1929. *P. rotundibaccum* Trel., l.c. 164. *P. rotundibaccum*

var. *fraijanesanum* Trel., l.c. 164. *P. zonulatispicum* Trel., l.c. 164. Figure 10.

Small shrubs 1–2 (3 m.) tall, leafy internodes 1–8 (12) cm. long, 1–4 mm. thick, densely to very sparsely puberulent with minute (0.1–0.5 mm.) curved hairs; shoot-apex emerging from within the prophyll and free of the leaf-base at flowering nodes, the prophyll becoming 2 cm. long, minutely puberulent along the midrib abaxially, usually glabrous and drying brown on the margins. Leaves usually distichous, petioles 2–8 mm. long and about 1 mm. thick at flowering nodes, usually densely puberulent with stiff hairs about 0.2 mm. long, a stipule-like development 1–5 mm. long often present but early caducous; laminae 8–15 cm. long, 3–7 cm. broad, narrowly ovate or elliptic, tapering gradually to the acuminate apex, occasionally with a bristle-tip at the apex 1–2 mm. long, narrowed to the acute or rounded base, often cordulate on one side and conspicuously unequal, the basal lobe rarely exceeding 5 mm. in length, sides of the lamina 1–4 mm. distant on the petiole, the lamina drying thin-chartaceous and usually darker above than below, smooth and glabrous above, densely appressed puberulent on the veins beneath, the major veins usually flat above, the 3 or 4 pairs of major secondary veins arising from the lower half of the midvein, arcuate ascending, upper secondaries arising at angles of 25–45 degrees. Inflorescence free of the leaf-base of the same node in early stages, often subtended by a puberulent ridge, apparently pendulous from early stages, 3–8 cm. long, peduncle 1–3 cm. long, 0.4–1.4 mm. thick, minutely (0.1–0.4 mm.) puberulent, flowering portion 2–3 mm. thick at anthesis, about 4 mm. thick in fruit, the flowers crowded, often with a slender flowerless apex; floral bracts 0.6–1 mm. broad and triangular or crescent-shaped above, glabrous centrally and with a margin of pale yellowish hairs 0.1–0.3 mm. long, forming indistinct bands around the spike in certain stages; anthers 0.3–0.4 mm. long and equally broad, dehiscing laterally; pistil short stylose or with 3 sessile recurved stigmas about 0.2–0.3 mm. long; fruit about 1.1 mm. thick and equally long, round in cross-section and apparently fleshy, glabrous, truncate or rounded apically with sessile stigmas.

Plants of the moist montane forest floor between 1,400 and 2,500 m. elevation. Known only from the eastern slopes of the Meseta Central and the western part of the Cordillera de Talamanca; flowering throughout the year.

A small piper of forest shade distinguished by the smaller leaves unequal at the base, developed stipule (when present), puberulent prophyll, and slender spikes often borne on relatively long thin peduncles. The puberulence and slightly lobed lamina-base distinguished *P. carpinteranum* from the closely related *P. tenuimucronatum*. *Piper boquetense* Yuncker (1966) of Chiriqui, Panama, may represent a southern population of *P. carpinteranum*. All these species are part of a closely related group of montane pipers: compare *P. decurrens*, *P. tenuimucronatum*, and *P. scalarispicum* Trel. of the cloud forests of Nicaragua and Honduras.

Piper carrilloanum C.DC., Bull. Soc. Bot. Belg. 30, pt. 1:209. 1891. *P. vallicolum* C.DC., l.c. 222. *P. paulownifolium* C.DC.,

Anal. Inst. Fis.-Geog. Costa Rica 9:173. 1897. *P. omega* Trel., Contr. U. S. Nat. Herb. 26:146. 1929. *P. zarceroense* Trel. in Standl., Field Mus. Bot. 18:1548. 1938. Figure 9.

Shrubs to 3 (5) m. tall, the older nodes conspicuously thickened, leafy internodes (3) 5–15 cm. long, 2–5 mm. thick, glabrous; shoot-apex emerging from within the prophyll and free of the leaf-base at flowering nodes, the prophyll becoming 5 cm. long, usually drying grayish and blunt at the apex. Leaves usually distichous, petioles 4–10 cm. long and 1–3 mm. broad at flowering nodes, becoming 20 cm. long and deeply vaginate on lower leaves at sterile nodes, grooved adaxially with scar-tissue only at the base and a stipule-like development absent at flowering nodes, glabrous or very minutely (0.05 mm.) puberulent at the apex; lamina 12–30 cm. long and 9–22 cm. broad at flowering nodes, to 42 cm. long and 28 cm. broad at sterile nodes, narrowly to broadly ovate, usually acuminate at the apex, rounded and cordate to subcordate at the base, the basal lobes equal or subequal with the sides of the blade arising together on the petiole, base of the lamina often thickened at the juncture with the petiole, the lamina drying grayish-green and chartaceous, smooth and glabrous above, glabrous or very minutely (0.05–0.1 mm.) puberulent on the veins beneath, major veins usually flat or slightly raised above, the 4 to 7 pairs of major secondary veins usually arising in the lower half of the midvein, upper secondaries arising at angles of 25–50 degrees, arcuate ascending, the lower secondaries descending into the basal lobes, tertiary veins often subparallel between the secondaries. Inflorescence free of the leaf-base of the same node and erect in early stages, 10–22 cm. long, peduncle 6–20 mm. long, 1–2.5 mm. thick, glabrous, flowering portion 2–3 mm. thick, becoming 4 mm. thick in fruit, the flowers congested; floral bracts about 0.3 mm. broad, flat or concave and triangular from above, glabrous or minutely ciliolate along the edge, not forming bands around the spike; anthers about 0.2 mm. long and 0.2 mm. broad, connective broad at the base with the thecae somewhat divergent and dehiscing laterally and upward; pistil with 2 or 3 sessile poorly differentiated stigmas; fruit about 0.8 mm. thick and 1 mm. long, obpyramidal-trigonous by compression, truncate and often with a cap-like apex.

Plants of deep shade in wet forest formations between sea level and 1,500 m. elevation, on both the Caribbean and Pacific slopes in Costa Rica. The species ranges from Nicaragua to Colombia and Ecuador.

A very distinctive piper with large leaves glabrous or minutely puberulent on the veins beneath, secondary veins usually restricted to the lower half of the midvein, and long spikes. This species is very closely related to *P. grande* and *P. nemorense*. They are readily recognized by their variable but usually large cordate leaves that are equal at the base, lack of pubescence on stems and petioles, slender spikes, and pistil with poorly differentiated sessile stigmas. These taxa are in turn related to *P. aequale;* all have leaves which become gray on drying and they share characters of prophyll, flowering parts,

and lack of conspicuous pubescence. See the discussion under *P. grande.*

Piper cenocladum C.DC., Anal. Inst. Fis.-Geog. Costa Rica 9:168. 1897. *P. pentagonum* Trel., Contr. U.S. Nat. Herb. 26:153. 1929. Figure 5.

Shrubs or slender few-branched tree-like plants to 5 m. tall, with prop-roots at the base in those seen, the older nodes slightly thickened, leafy internodes 4–14 cm. long, 4–7 mm. thick, densely puberulent with short (0.3–1 mm.) yellowish-brown hairs; shoot-apex emerging from within the sheathing leaf-base at all nodes, the prophyll lateral, 2–4 mm. long, usually obscured by the sheathing leaf-base. Leaves usually distichous, petioles 4–8 cm. long, 3–8 mm. broad, densely puberulent with minute brownish hairs, deeply vaginate and with thin adaxial margins at all nodes, clasping the stem at the base; lamina 15–35 cm. long, 8–17 cm. broad, elliptic to oblong or narrowly ovate, acute to short-acuminate at the apex, often narrowed in the lower third and slightly pandurate in form, unequally cordate at the base or occasionally subequal, the lobes often somewhat divergent, the larger (2–6 cm.) lobe occasionally overlapping the petiole, the sides of the lamina arising close (0–5 mm.) together on the petiole, the lamina drying thin- to stiff-chartaceous, smooth and glabrous above, minutely (0.3 mm.) puberulent on the veins beneath, the 4 or 5 pairs of major secondary veins arising from the lower two-thirds of the midvein, the upper secondaries arising at angles of 20–45 degrees and arcuate ascending. Inflorescence free of the leaf-base of the same node in early stages, erect or becoming pendulous, 8–18 (30) cm. long, peduncles 0.3–1.5 cm. long, 3–5 mm. thick, densely puberulent with minute (0.2–0.4 mm.) brownish hairs, flowering portion about 4–6 mm. thick at anthesis and becoming 11 mm. thick in fruit, the flowers crowded; floral bracts 0.4–0.9 mm. broad and triangular, rounded, or slightly cupulate from above, with conspicuous hairs about 0.3 mm. long, forming bands around the spike in early stages; anthers about 0.2 mm. long and 0.5 mm. broad, on short filaments articulate beneath the anther (but difficult to see), the connective very broad at the base with the divergent thecae opening upward; the edges of the thecae forming angles of more than 90 degrees; pistil short stylose; fruit about 1 mm. thick, glabrous, truncate and very short (0.2 mm.) stylose with 3 small stigmas.

Plants of wet evergreen forest formations between sea level and 1,000 m. altitude on the Caribbean side of Costa Rica. The species is endemic to Costa Rica.

One of the large-leaved tree-like pipers of forest shade distinguished by its short prop-roots, short peduncles, unusual anthers, and leaves often somewhat pandurate. These plants were first pointed out to me by Dr. Leslie Holdridge near the Rio Puerto Viejo (Sarapiqui). While very distinct in the field, assignment of herbarium material lacking description of the habit is difficult. I have relied on the leaf-form, short peduncle, anthers, and area of origin in placing the newer collections together with the old. Only *Piper*

augustum among Costa Rican pipers also possesses prop-roots. *Piper cenocladum* is part of a complex of taxa related to *P. obliquum*. It may in fact be no more than a form of that species; see the discussion under *P. obliquum*. The hollow stems are inhabited by ants.

Piper chrysostachyum C.DC., Bull. Soc. Bot. Belg. 30, pt. 1:207. 1891. *P. subaspericaule* C.DC., Anal. Inst. Fis.-Geog. Costa Rica 9:162. 1897. *P. stenocladum* C.DC., l.c. photo, in part. *P. trichocladum* C.DC., l.c. 167. 1897. *P. davidianum* C.DC., Smiths. Misc. Coll. 71, pt. 6:9. 1920. *P. callibracteum* C.DC., l.c. 13. *P. chamissonis* var. *rubellibracteum* C.DC., l.c. *P. nitidifolium* C.DC., l.c. 14. *P. diquisanum* C.DC., Bot. Gaz. 70:185. 1920. *P. surubresanum* Trel., Contr. U.S. Nat. Herb. 26:148. 1929. *P. vicinum* Trel., l.c. 157. *P. alajuelanum* Trel., l.c. 158. *P. verruculigerum* Trel., l.c. 165. *P. hanckeli* Trel. in Standl., Field Mus. Bot. 18:345. 1937. *P. luridispicum* Trel. in Standl., l.c. 348. *P. papulaecaule* Trel. in Standl., l.c. 352. *P. rubripes* Trel. in Standl., l.c. 358, in part. *P. tacaresense* Trel. in Standl., l.c. 364. Figure 13.

Shrubs 1–3 m. tall, older nodes somewhat thickened, leafy internodes 2–8 cm. long, 1–4 mm. thick, glabrous or very minutely (0.1 mm.) papillate-puberulent in early stages; shoot-apex emerging from within the prophyll and free of the leaf-base at flowering nodes, prophyll 8–18 mm. long, acute, glabrous or minutely (0.05–0.2 mm.) puberulent, drying brown. Leaves usually distichous, petioles 5–15 mm. long, 0.8–1.8 mm. thick, glabrous, vaginate only at the base and with a minute (0.2–2 mm.) ligule-like development at flowering nodes; laminae 10–22 cm. long, 4–9 cm. broad, narrowly to broadly ovate or elliptic, acute to acuminate at the apex, obtuse or somewhat rounded at the unequal base, sides of the lamina 1–3 mm. distant on the petiole, occasionally cordulate at the very base, the laminae drying thin-chartaceous and dark or pale-gray in color, smooth or very slightly scabrous on both surfaces, glabrous above, glabrous or obscurely (0.1 mm.) puberulent beneath, venation only rarely becoming impressed in age, the 3 to 5 pairs of major secondary veins arising from the lower two-thirds of the midvein, upper secondaries arising at angles of 15–40 degrees, arcuate ascending but variable. Inflorescence free of the leaf-base of the same node in early stages, erect, 5.5–12 cm. long, peduncles 6–14 (18) mm. long, 0.8–2 mm. thick, glabrous, flowering portion 2–3 mm. thick at anthesis, 3–4 mm. thick in fruit, the flowers congested; floral bracts about 0.2–0.4 mm. broad and rounded above, glabrous centrally with minute (0.1 mm.) hairs on the margins or beneath, occasionally forming bands around the spike together with the anthers; anthers 0.1–0.2 mm. long, 0.2–0.4 mm. broad, the connective broad at the base with the diverging thecae dehiscing upward, usually persisting; pistil obscured by bracts and anthers; fruit 0.5–0.7 mm. thick, rounded or laterally compressed truncate above with a depression around the 3 minute sessile stigmas, minutely puberulent above.

Plants of the seasonally dry evergreen forest formations between sea level and 1,200 m. elevation on the Pacific watershed; flowering

from December to April. The species has been collected between Tilaran, Guanacaste, and Chiriqui, Panama.

Piper chrysostachyum is characterized by the smooth or very slightly scabrous leaves essentially glabrous, very small floral bracts with minute puberulence, anthers dehiscing upwards, puberulent fruit, and restriction to the Pacific slope. This species is very closely related to *P. umbricola* and the two taxa may prove to be conspecific. Together these species are related to the scabrous-leaved *P. hispidum* and its allies. All the "species" of this alliance must be considered first approximations and no more. *Piper dotanum* (q.v.) may, in fact, be no more than a form of this species with smaller lanceolate leaves.

Piper coilostachyum C.DC., Bull. Bot. Soc. Belg. 30, pt. 1:212. 1891. *P. ducis* Trel. in Standl., Field Mus. Bot. 37:341. 1937. Figure 4.

Herbs or subshrubs to 1.5 m. tall, older nodes only slightly thickened, leafy internodes 2.5–8 cm. long, 1–3 mm. thick, glabrous; shoot-apex emerging from the sheathing leaf-base and enclosed within a prophyll at flowering nodes; the prophyll 10–20 mm. long, drying brown and glabrous, caducous and leaving a distinct scar above the leaf-scar and peduncle. Leaves usually distichous, petioles 8–20 mm. long or up to 40 mm. at sterile nodes, 1–2 mm. broad, glabrous, vaginate to the base of the lamina and with 2 adaxial margins of scar tissue (formed when the sheathing stipule-like margins tear off) at all nodes; lamina 12–22 cm. long, 4–8 cm. broad, lanceolate to narrowly ovate, widest at or well below the middle, tapering very gradually to the acute or long-acuminate apex, tapering abruptly or rounded at the obtuse to subtruncate base, the base usually slightly unequal with the sides 1–5 mm. distant on the petiole, often with the longer side somewhat cordulate and overlapping the petiole by 1–3 mm., the lamina slightly succulent but drying chartaceous or thin-chartaceous and usually gray-green, surfaces smooth and glabrous above and below, with 4 to 8 prominent secondary veins arising from the lower three-quarters of the midvein or with 10 to 17 less prominent secondary veins arising throughout the length of the midvein, the central secondaries arising at angles of 30–80 degrees, ascending near the margin and usually joining to form an arcuate submarginal vein in the distal third of the lamina, the major veins flat or slightly impressed above and prominent beneath. Inflorescence at first enclosed within the sheathing leaf-base of the same node and later subtended by scar tissue continuous with the petiole, erect, 3–6 cm. long; peduncle 4–10 mm. long, 1–2 mm. thick, glabrous, the flowering portion 2–3 cm. long and 2–3 mm. thick at anthesis and becoming 5–6 mm. thick in fruit, the flowers densely congested, the spike often with a short slender (3×1 mm.) tip; floral bracts 0.8–1.5 mm. broad above and at first U-shaped but becoming V- or Y-shaped by compression of the fruit, glabrous or very sparsely and minutely puberulent near the base; anthers 0.2–0.3 mm. long and equally broad, dehiscing laterally, the connective inconspicuous; pistil rounded at the apex and with a short (0.2 mm.) style and 3 or 4 stigmas; fruit becoming

rhomboid or laterally compressed but usually round in cross-section at maturity, about 3 mm. long and 1.5 mm. thick, the surface smooth or slightly rugose and glabrous, stigmas sessile or on a very short (0.1 mm.) style often in a depression at the apex of the dried fruit.

Small plants in the shade of moist evergreen forests between sea level and 1,000 m. elevation. Endemic to the Pacific slope of southeastern Costa Rica in the General Valley and lowland forest west of the border with Panama. Collected in flower and fruit from November to March.

The unusual venation and leaf-form is very similar to *P. arboreum* and *P. deductum* but the spike emerging from the sheathing leaf-base, the developed prophyll, and the form of the floral bracts and fruit indicate a close relationship to *P. glabrescens*.

Piper colonense C.DC., Smiths. Misc. Coll. 71, no. 6:11. 1920. *P. culebranum* C.DC. ex Schroeder, Candollea 3:136. 1926. *P. varablancanum* Trel. in Standl., Field Mus. Bot. 18:1547. 1938. Figure 14.

Shrubs 2–5 m. tall or rarely trees to 8 m., older nodes conspicuously thickened, leafy internodes 0.5–6 cm. long, 1–3 mm. thick, sparsely and minutely (0.1–0.3 mm.) puberulent at the nodes, or with longer crooked hairs throughout, glabrescent; shoot-apex emerging from within the prophyll and free of the leaf-base at flowering nodes, prophyll 6–14 mm. long, acute, very minutely puberulent along the back of the midrib or at its base, drying dark brown. Leaves usually distichous, petioles 4–10 (16) mm. long, 1–2.5 mm. thick, puberulent or glabrous, vaginate in the lower part and without a ligule-like development at flowering nodes, scar tissue usually present adaxially on the lower third of the petiole at flowering nodes; laminae 12–27 cm. long, 3–9 cm. broad, elliptic to oblanceolate or obovate, tapering gradually to the acuminate apex, narrowed below the middle to the unequally cuneate or obtuse base, sides of the lamina 2–6 mm. distant on the petiole, the lamina drying stiffly chartaceous and usually grayish above, smooth or very slightly roughened above, glabrous or rarely with scattered whitish hairs about 0.5 mm. long or minutely puberulent at the base of the midvein, glabrous or hirsutulous beneath, major veins becoming impressed above, the 3 or 4 pairs of major secondary veins usually arising in the lower half of the midvein, but quite variable with prominent secondaries occasionally in the upper part or with the secondaries arising only from the lower third, the upper secondaries arising at angles of 20–40 (55) degrees. The inflorescence free of the leaf-base of the same node in early stages, erect, 5–12 cm. long, peduncle 8–16 mm. long, 1–2 mm. thick, glabrous or puberulent, flowering portion 2–3 mm. thick at anthesis, 3–4 mm. thick in fruit, the flowers crowded; floral bracts 0.5–1 mm. broad and triangular above, glabrous with a conspicuous fringe of yellowish hairs 0.2–0.5 mm. long, forming conspicuous bands around the spike in most stages; anthers about 0.2 mm. long and 0.4 mm. broad, connective broad at the base with the divergent thecae dehiscing partly upward; pistil with 3 papillate-puberulent stigmas 0.2–0.3 mm. long and recurved;

fruit about 1 mm. thick, round or laterally compressed, truncate or rounded above, fleshy, glabrous, stigmas sessile.

Plants of moist forests between sea level and 1,600 m. elevation. Known in Costa Rica from the Caribbean slopes and lowlands, the General Valley and the Osa Peninsula. The species ranges to central Panama.

This species is characterized by the smooth leaves shiny and with the larger veins impressed above, petioles with scars, conspicuous floral bracts, anthers with thecae forming a 90 degree angle, large stigmas, and glabrous fruit. *Piper colonense* is closely related to *P. oblanceolatum* with thin leaves and inconspicuous bracts. Both species are very similar to smooth-leaved members of the *P. hispidum* complex. I have placed some rather different plants under this name but I believe they form a natural group. Further collections may show that the Costa Rican plants with more glabrous parts and slender spikes are worthy of specific rank. *Piper hirtellipetiolum* of the Pacific lowlands of Panama with smaller lanceolate leaves is very closely related to this species.

Piper concepcionis Trel., Contr. U.S. Nat. Herb. 26:159. 1929. Figure 11.

Scandent or (?) epiphytic shrubs usually found on tree trunks, the older nodes somewhat thickened and often with adventitous roots, leafy internodes 2–10 cm. long, 1–3 mm. thick, glabrous or very minutely (0.05 mm.) papillate-puberulent; shoot-apex emerging from within the prophyll and free of the leaf-base at flowering nodes, the prophyll becoming 14 mm. long, glabrous or minutely puberulent over the entire abaxial surface. Leaves usually distichous, petioles 6–22 mm. long, 1.5–2.8 mm. thick, glabrous or minutely (0.05–0.2 mm.) puberulent, terete and lacking a stipule-like development at flowering nodes; lamina 16–30 cm. long, 6–17 cm. wide, ovate or broadly elliptic, acuminate at the apex, rounded at the abruptly narrowed base, the sides of the blade subequal and 1–4 mm. distant on the petiole, often thickened and occasionally forming a small (2 mm.) apparently fleshy lobe at the petiole, the lamina drying stiffly chartaceous and usually grayish, smooth and glabrous above and below, major veins flat above and prominent beneath, the 3 to 5 pairs of major secondary veins arising from the lower half of the midvein, upper secondaries arising at angles of 15–30 (40) degrees, arcuate ascending, tertiary veins subparallel, prominulous beneath and pale in color. Inflorescence free of the leaf-base of the same node in early stages, apparently erect, about 4 cm. long in early (preanthesis) stages and purplish in color, peduncle 5–12 mm. long, 1–1.6 mm. thick, glabrous or very minutely (0.07 mm.) puberulent, flowering portion about 3 mm. thick (preanthesis), the flowers congested; floral bracts 0.3-0.5 mm. broad and triangular from above, glabrous centrally with a dense margin of short (0.1–0.2 mm.) purplish hairs, not forming bands around the spike in early stages; anthers about 0.2 mm. long and 0.2 mm. broad, the connective broad at

the base and the thecae diverging basally, dehiscing laterally; pistil and fruit not seen. (See below.)

Climbers of the wet evergreen forest formations of the Caribbean lowlands between sea level and 900 m., collected between Villa Quesada and Guapiles. The species ranges from Costa Rica to Ecuador.

One of the few pipers with scandent habit in Costa Rica; it is further distinguished by the large leaves, purplish spikes, and lowland habitat. This species has not been collected with spikes in full anthesis or in fruit but the fruit should be very similar to *P. xanthostachyum* or *P. subsessilifolium*. These three species are closely allied and all have been reported as scandent or with scandent branches. *Piper concepcionis* possesses the unusual thickening of the lamina-base of *P. xanthostachyum* and the purple-tinged spikes of *P. subsessilifolium*. *Piper concepcionis* may be the only piper in our flora that is solely scandent. Material of this species from South America has been placed under *P. brachypodon* (Benth.) C.DC. but the original figure has rather different leaf-venation and I believe that Trelease and Yuncker (1950) have placed more than one species under that name.

Piper crassinervium H.B.K., Nov. Gen. & Sp. 1:48. 1815. *P. pseudopropinquum* C.DC., Linnaea 37:341. 1872. *P. rufescens* C.DC., Bull. Soc. Bot. Belg. 30, pt. 1:218. 1891. *P. dumetorum* C.DC., Anal. Inst. Fis.-Geog. Costa Rica 9:172. 1897. *P. submultiplinerve* C.DC., Bot. Gaz. 70:184. 1920. *P. papyraceum* Trel., Contr. U.S. Nat. Herb. 26:31. 1927. *P. annulatum* Trel., l.c. 139. 1929. *P. escasuense* Trel., l.c. 144. *P. san-luisense* Trel. in Standl., Field Mus. Bot. 37:1547. 1938. *P. novae-helvetiae* Trel. in Woodson & Schery, Ann. Mo. Bot. Gard. 27:294. 1940. Figure 4.

Shrubs or small trees to 4 (rarely 6) m. tall, older nodes conspicuously thickened, leafy internodes 2.5–8 (12) cm. long, 2–4 mm. thick, glabrous to densely puberulent, the slender yellow or brownish hairs to 1.2 mm. long; shoot-apex emerging from within the sheathing leaf-base and included within the prophyll at flowering nodes, the prophyll 20–45 mm. long, glabrous or with small hairs along the midrib abaxially, drying pale to dark brown. Leaves usually distichous, petioles 12–25 (38) mm. long, 1–2 mm. broad, glabrous to densely puberulent with hairs about 0.5 mm. long, vaginate with the stipule-like margins tearing off to produce 2 rows of scar tissue at all nodes, the stipular margins united and developed adaxially below the lamina to form a ligule-like structure in early stages; lamina 12–22 cm. long, 6–12 (15) cm. broad, narrowly to broadly ovate or rarely somewhat oblong, gradually tapering to the acuminate or sharply acute apex, tapering abruptly or rounded at the obtuse to truncate base, equal or somewhat

unequal with the sides of the lamina 0–3 mm. distant on the petiole, drying membranaceous to chartaceous and usually dark green above and below, the surfaces smooth and glabrous or puberulent, the 3 or 4 pairs of major secondary veins arising from the lower half of the midvein, the upper secondaries arising at angles of 20–40 degrees and arcuate ascending. Inflorescence at first enclosed in the sheathing leaf-base of the same node and subtended by scar tissue continuous with the petiole in later stages, erect, 5–15 cm. long; peduncle 5–18 mm. long, 1–2.5 mm. thick, glabrous to densely puberulent, flowering portion becoming 4–6 mm. thick in fruit, the flowers crowded; floral bracts 0.6–1 mm. broad above, rounded or triangular and with a distinct margin of short (0.1 mm.) yellowish or whitish hairs, forming bands around the spike in early stages and anthesis; anthers about 0.4 mm. long and equally broad, dehiscing laterally, connective slightly apiculate at the tip, the filaments often conspicuous; pistil narrowed at the apex and short stylose with 3 conspicuous stigmas, becoming laterally compressed as the fruit develops; fruit about 1.5 mm. thick, round in cross-section at maturity, glabrous and rounded at the apex, short stylose (0.2 mm.) or the large (0.2–0.4 mm.) recurved stigmas sessile.

Plants of partially shaded forest edges and the more deeply shaded forest interior between sea level and 2,000 m. elevation. Most common between 800 and 1,800 m. on the Caribbean slopes of the Central Highlands and in the wet forest formation of the Pacific slope above 1,000 m. Apparently flowering and fruiting throughout the year. The species ranges from Costa Rica southward to Ecuador and Venezuela.

This quite variable species can be recognized by the emergence of the spike from the leaf-base (and consequently longer ridges of scar tissue on the petiole), relatively long inflorescence with fimbriate floral bracts, stylose pistils with large stigmas, and ovate leaves with the secondary veins arising from the lower half of the midvein. The very pubescent specimens seem to differ in no other way from the almost glabrous collections; few other pipers vary so much within a single species. The leaves are said to have a celery- or tomatoe-like odor when crushed. This species is probably closely related to *P. poasanum* in which the ligule-like process of the petiolar margins is even further developed. There is a more distant relationship with *P. glabrescens* and its allies but in these the floral bracts are quite different. I have not seen the type material and am using the name following Yuncker's interpretation.

Piper curtirachis W. Burger, n. sp. Figure 4.

Frutices ad 3 m. altis, ramuli amentiferi 2–4 mm. crassi, glabri; apex surculi ex petiolo semper emergit, prophyllum 10–14 mm. longum. Folia glabra, petiolis ad laminam semper vaginatis; laminae ellipticae 14–26 cm. longae, 7–15 cm. latae, apicibus brevis acuminatis, basibus obtusis subaequalis, nervis secondariis 4–6 utrinque. Inflorescentiae ex petiolis ad eosdem nodos emergunt, erectae, 2–3.8 cm.

longis, 6–9 mm. crassae, plerumque apicibus mucronulatis, pedunculis 6–12 mm. longis, 1.5–2.2 mm. crassis, flores laxe aggregati, bracteae apicibus 1–1.5 mm. latis, U- vel V-formis; antherae circa 0.8 mm. longae, dehiscentes laterales, apice connectivi acuto; pistillum glabrum, apice stilifero, stilo circa 1 mm. longo, stigmatibus 2–3 recurvatibus; drupae ignotae. HOLOTYPUS: *Austin Smith 1768*, Field Museum 996725; Isotypus: US 1807461.

Shrubs to 3 m. tall, the older nodes not conspicuously thickened, leafy internodes 4–9 cm. long, 2–4 mm. thick, glabrous; shoot-apex emerging from within the sheathing leaf-base at flowering nodes and partly enclosed by the open prophyll, the prophyll about 10–14 mm. long, usually caducous, glabrous and drying dark. Leaves in a spiral, petioles 3–4 cm. long but up to 7 cm. long at sterile nodes, 2–8 mm. broad, deeply vaginate and with broad thin stipule-like adaxial margins at all nodes (the sheathing margins persisting and not tearing off to produce two straight ridges of scar tissue), glabrous; lamina 14–26 cm. long, 7–15 cm. broad, broadly elliptic or slightly ovate, usually widest at or just below the middle, tapering to the acute or very short acuminate apex, tapering to the obtuse or sometimes rounded base, equal or subequal with the basal sides of the lamina 0–2 mm. distant on the petiole, drying chartaceous, and often slightly revolute at the edges, smooth and glabrous on both surfaces, the 4 to 6 pairs of major secondary veins arising from the lower two-thirds of the midvein, upper secondaries arising at angles of 20–40 degrees and arcuate ascending, the major veins flat or slightly impressed above and prominent beneath, epidermal cells often visible with a hand lens (10×). Inflorescence enclosed within the leaf-base of the same node in early stages and later subtended by a rim of tissue continuous with the petiole margins, erect, 2–3.8 cm. long; peduncle 6–12 mm. long, 1.5–2.2 mm. thick, glabrous, flowering portion 6–9 mm. thick, and often with a slender (2×0.5 mm.) flowerless tip, the flowers loosely crowded with stamens and pistils in anthesis at about the same time; floral bracts 1–1.5 mm. broad above, broadly U- or V-shaped, glabrous except near the base; not forming bands around the spike; anthers about 0.8 mm. long and 0.5 mm. broad, dehiscing laterally, the connective prolonged slightly beyond the thecae; pistil glabrous, stylose from early stages, the style becoming 1 mm. long with 2 or 3 stigmatic lobes; mature fruit not seen but probably conical at the apex and stylose.

Plants of the shade of wet forest formations between 200 and 800 m. altitude on the Caribbean slopes of central Costa Rica. Presently known from only the following collections (all collected near Villa Quesada, Pcia. Alajuela): *Austin Smith 1768* and *2579*, and *Williams et al. 29076;* flowering in February and March.

A member of a very distinctive group of species with very short thick spikes emerging from the sheathing leaf-bases, stylose pistil, long apiculate anthers, and open caducous prophyll. Closely related to *P. cuspidispicum* and *P. curtispicum* and differing in the retention of the broad stipule-like margins of the petiole, leaf-form and venation, slightly thicker peduncles, and lower altitude habitat on the Caribbean slope. See the discussion under *P. curtispicum*.

Piper curtispicum C.DC., Anal. Inst. Fis.-Geog. Costa Rica 9:171. 1897. *P. ripicola* C.DC., l.c. 171. *P. pubinerve* C.DC., Bot. Gaz. 70:172. 1920. Figure 4.

Slender tree-like shrubs to 2 (rarely 3) m. tall, the older nodes slightly thickened; leafy internodes 3–7 (12) cm. long, 2–4 mm. thick, glabrous or becoming so; shoot-apex emerging from within the leaf-base at flowering nodes and partly enclosed in the caducous prophyll, prophyll to 2 cm. long, not usually persisting after the emergence of the inflorescence. Leaves distichous or in a spiral; petioles 1–3.5 cm. long, 1–3 mm. broad, glabrous or sparsely and minutely puberulent, vaginate to the base of the lamina at all nodes, the thin stipule-like margins tearing off (rarely persistent) to produce two adaxial ridges of scar tissue; lamina 12–23 cm. long, 6–12 cm. broad, usually broadly elliptic or somewhat ovate, broadest at or slightly below the middle, bluntly short-acuminate to obtuse at the apex, broadly obtuse or somewhat rounded at the base, slightly unequal with the sides of the lamina 1–3 mm. distant on the petiole, semi-succulent but drying chartaceous with the margins usually revolute, surfaces smooth and glabrous above and below or sparsely and very minutely (0.1 mm.) puberulent on the veins beneath, the 5 to 8 pairs of major secondary veins usually arising from the lower three-fourths of the midvein, the central secondaries arising at angles of 30–50 degrees, the major veins flat or impressed above and prominent beneath, punctate on both surfaces, the epidermal cells often visible with a hand lens (10×). Inflorescences enclosed in the sheathing leaf-base of the same node in early stages and later subtended by scar tissue continuous with the petiole, erect, 14–30 mm. long at anthesis; peduncle 4–12 mm. long, 1–2 mm. thick, glabrous, flowering portion becoming 8–10 mm. thick and 35 mm. long in fruit, flowering parts crowded; floral bracts 1–2 mm. broad and U- or V-shaped from above, glabrous or minutely puberulent on the edges, not forming bands around the spike; anthers about 0.7 mm. long and 0.4 mm. broad, borne on a conspicuous (0.5×0.2 mm.) filament, the prominent connective with conical apex prolonged beyond the thecae; pistil stylose from early stages, reaching anthesis about the same time as the stamens; fruit crowded and round or angular in cross-section, about 2 mm. thick, glabrous and with a short (0.5 mm.) style with two stigmas.

Plants of the shade of moist forests of the Pacific slopes of southern Costa Rica below 1,000 m. elevation. Endemic to Costa Rica from the Rio Naranjo and General Valley to the Osa Peninsula and Golfo Dulce. Apparently flowering from January to March and again from August to October.

Part of a very distinctive group of pipers with very short thick spikes emerging from the sheathing leaf-bases, stylose pistil, long apiculate anthers, and open caducous prophyll. Closely related to *P. curtirachis* and *P. cuspidispicum* and differing from these only in the more succulent leaves, leaf-venation, and habitat. These may prove to be geographical subspecies of a single polymorphic taxon which might include *P. davidsonii, P. distigmatum, P. pubi-*

stipulum, *P. colon-insulae* (all from Panama), and *P. bella* of northern South America. Unusual individuals of *P. glabrescens* with very short spikes and broad leaves may be mistaken for this species.

Piper cuspidispicum Trel., Contr. U.S. Nat. Herb. 26:138. 1929. Figure 4.

Shrubs to 2 or 3 (rarely 5) m. tall, older nodes not conspicuously thickened, leafy internodes 4–10 cm. long, 2–4 mm. thick, glabrous; shoot-apex emerging from within the leaf-base and partly enclosed in a prophyll at flowering nodes, the prophyll caducous with the emergence of the inflorescence, 10–25 mm. long, glabrous. Leaves distichous or in a spiral, petioles 1.5–3 cm. long but to 7 cm. long at sterile nodes, about 2 mm. thick, glabrous, vaginate to the base of the blade with the thin stipule-like margins tearing off to form two adaxial ridges of scar tissue at all nodes; lamina 12–18 cm. long, 7–15 cm. broad, broadly ovate and usually widest in the lower part of the lamina, short-acuminate or acute at the apex, very abruptly narrowed to the rounded or truncate base, equal or subequal at the base with the sides 0–2 mm. distant on the petiole, drying chartaceous and grayish green, often very pale green beneath, smooth and glabrous on both surfaces, the 3 to 5 pairs of major secondary veins usually arising from the lower half of the midvein, the upper secondaries arising at angles of 20–40 degrees and arcuate-ascending, the major veins flat or impressed above and prominent beneath, the upper epidermal cells often visible with a hand lens (10×). Inflorescence enclosed in early stages by the leaf-base of the same node and later subtended by scar tissue continuous with the petiole, erect, 15–38 mm. long at anthesis; peduncle 6–16 mm. long, 0.8–1.6 mm. thick, glabrous, flowering portion becoming 5–8 mm. thick, often with a short narrow (2×0.5 mm.) flowerless tip, the flowers loosely crowded with stamens and pistils in anthesis at about the same time; floral bracts 1–2 mm. broad and U- or V-shaped from above, glabrous above and with a few whitish hairs near the base, not forming bands around the spike; anthers 0.7–0.9 mm. long, about 0.6 mm. broad, dehiscing laterally, the connective conspicuous and enlarged beyond the thecae; pistils stylose from early stages, the style becoming more than 1 mm. long with 2 distinct stigmatic lobes; mature fruit not seen.

Plants of the wet montane forest formations between 1,500 and 2,000 m. elevation under the influence of moist Caribbean winds along the eastern side of the Meseta Central. Endemic to Costa Rica and reported from the areas between Zarcero and the Rio Grande de Orosi. Flowering from February to May.

Part of a very distinctive group of pipers with very short thick spikes emerging from the sheathing leaf-bases, stylose pistils, long apiculate anthers, and open caducous prophyll. Closely related to *P. curtispicum* and *P. curtirachis*. The Panamanian *P. distigmatum* Yuncker and *P. davidsonii* Yuncker may be conspecific with *P. cuspidispicum* but differ in leaf-shape. These species may prove to be part of a single polymorphic taxon with *Piper wagneri* C.DC. of Panama the earliest name; see the discussion under *P. curtispicum*.

Piper darienense C.DC. in DC., Prodr. 16, pt. 1:374. 1869. *P. acuminatissimum* C.DC., Bot. Gaz. 70:189. 1920. *P. permari* Trel. in Woodson & Schery, Ann. Mo. Bot. Gard. 27:295. 1940. *P. fagopyricarpum* Trel. in Woodson & Schery. l.c. 28:426. 1941. Figure 9.

Small shrub-like plants usually less than 1 m. tall, the older nodes slightly thickened, leafy internodes 2–6 cm. long, 1–2.5 mm. thick, glabrous and often drying with longitudinal ridges; shoot-apex emerging from within the prophyll and free of the leaf-base at flowering nodes, the prophyll becoming 8 mm. long, glabrous and drying grayish-green. Leaves usually distichous, petioles 4–12 mm. long, 0.7–2 mm. thick, glabrous and deeply grooved adaxially, the adaxial margins without scar tissue and a stipular development absent or minute (–1 mm.) at flowering nodes; lamina 8–15 (20) cm. long, 4–8 (10) cm. broad, ovate to lanceolate and usually broadest at or near the base, tapering very gradually to the acuminate apex, tapering or occasionally rounded at the obtuse to subtruncate base, sides of the lamina arising together or 1–2 mm. distant on the petiole with the edge sometimes thickened above the petiole, the lamina drying thin-chartaceous and grayish-green, smooth and glabrous on both surfaces, major veins usually prominulous above, prominent beneath, the 6 to 10 pairs of major secondary veins arising throughout the length of the midvein, central secondaries arising at angles of 40–80 degrees, the secondaries sometimes interconnecting near the margin to form an arcuate marginal vein, epidermal cells undulate in outline (100×) on the upper surface. Inflorescence free of the leaf-base of the same node in early stages, apparently erect, 2–7 cm. long; peduncle 4–8 mm. long, 0.7–1.3 mm. thick, glabrous, flowering portion 1–4 mm. thick at anthesis, the flowers loosely crowded or separate and the rachis often visible; floral bracts 0.5–1 mm. broad and cupulate or concave viewed from above, glabrous, not forming bands around the spike; anthers about 0.5 mm. long and dehiscing laterally, apparently with 2 stamens per pistil; pistils conical and substylose with 4 (3) well differentiated stigmas; fruit becoming about 3 mm. long and 2 mm. thick, ellipsoid with 4 prominent longitudinal ribs, glabrous, smooth or slightly rugose, often separate and never tightly congested, stigmas borne on the conical apex or on a very short (0.2–0.5 mm.) style.

Plants of the lowland (0–200 m.) Caribbean wet forest formations, ranging from Nicaragua to northern Colombia. The species is known from only four collections in Costa Rica: *Herb. C.R. 16321, Orozco 106, Shank & Molina 4148,* and *de la Cruz s.n.* (23 VI 1956).

A very distinctive species recognized by its low stature, pinnate venation, glabrous parts, loosely arrayed flowers, ribbed fruit, and unusual epidermal cells. Probably related to the palmately veined *P. tabasaranum* of Panama and more distantly to *P. aequale* and its allies. This species is often called *alcotán*; the leaves and roots are used to treat toothache.

Piper decurrens C.DC., Seem. Journ. Bot. 4:215. 1866, photo. *P. leptoneuron* C.DC., Bot. Gaz. 70:184. 1920. *P. gracilipedunculum* Trel., Contr. U. S. Nat. Herb. 26:148. 1929. Figure 10.

Shrubs 1–3 (rarely 5) m. tall, older nodes conspicuously thickened, leafy internodes 0.7–6 cm. long, 1–3.5 mm. thick, glabrous; shoot-apex emerging from within the prophyll and free of the leaf-base at flowering nodes, the prophyll becoming 2 cm. long, glabrous and drying dark brown. Leaves usually distichous, petioles 4–14 mm. long, 0.7–1.5 mm. broad, grooved adaxially but vaginate and with scar tissue only at the base at flowering nodes, glabrous, a very small (0.5–2 mm.) open stipule-like structure present at the leaf-base but caducous; laminae 6–16 cm. long, 2.5–7 cm. broad, elliptic to obovate, usually broadest at or above the middle, abruptly short acuminate at the apex, gradually narrowed to the acute or obtuse equal or subequal base, sides of the blade 0–4 mm. distant and decurrent on the petiole, lamina drying chartaceous and somewhat paler below than above, smooth and essentially glabrous on both surfaces, major venation flat above, the 2 or 3 pairs of major secondary veins arising from the lower half of the midvein but often with distinct smaller secondaries arising from the upper half, central secondaries arising at angles of 30–50 degrees, arcuate ascending. Inflorescence free of the leaf-base of the same node in early stages, often articulate at the base but not subtended by scar tissue, probably erect, 2.5–6 cm. long, peduncles 8–25 mm. long, 0.4–1.2 mm. thick, glabrous, flowering portion 2.5–3.5 mm. thick at anthesis, the flowers congested, occasionally with a very short (1 mm.) flowerless tip; floral bracts 0.5–0.9 mm. broad and triangular or U-shaped from above, glabrous centrally and with a margin of minute (0.1–0.2 mm.) hairs, forming bands around the spike in fruiting stages; anthers about 0.5 mm. long and 0.5 mm. broad, dehiscing laterally; pistil with 3 short (0.2–0.3 mm.) recurved stigmas; fruit often laterally compressed during development (parallel with the rachis), about 2 mm. thick and round in cross-section at maturity, apparently fleshy, glabrous, truncate apically with the 3 stigmas often persisting.

Plants of the moist montane forest formations between (500) 700 and 2,000 m. elevation. Known only from Santa Clara–Las Delicias and near Tilaran, Guanacaste, and the eastern portion of the Meseta Central; flowering collections have been made between January and April.

A small piper of shaded sites distinguished by the smaller leaves, short spikes, large anthers, and lack of pubescence on vegetative parts. The species is very closely related to *P. tenuimucronatum* which differs in the development of the stipule. These species are part of a complex of smaller leaved montane pipers including *P. carpinteranum*. *Piper decurrens* may resemble *P. aequale*, but the latter is usually found at lower elevations and the stigmas are poorly differentiated.

Piper deductum Trel. in Standl., Field Mus. Bot. 18:340. 1937. *P. opinatum* Trel. in Standl., l.c. 351. Figure 8.

Small shrubs 0.5–1.5 m. tall, the older stems with slightly thickened nodes, leafy internodes 2–8 cm. long, 1–3 mm. thick, crisp-hairy, the hairs 0.4–1.5 mm. long; shoot-apex emerging from within the prophyll and free of the leaf-base at

flowering nodes, the prophyll becoming 10–15 mm. long, with small (0.5 mm.) yellowish hairs along the back of the midrib or glabrous, drying russet-brown, acute at the tip. Leaves usually distichous, petioles 2–6 mm. long (to 18 mm. at sterile nodes), 1–2 mm. broad, grooved adaxially and with a minute (0.5 mm.) stipular development at the leaf-base at flowering nodes, the petiole deeply vaginate and rimmed with scar tissue at flowering nodes, crisp-hairy; lamina 10–22 cm. long, 3–7 cm. broad, lanceolate to narrowly ovate or elliptic, tapering very gradually to the acute to long-acuminate apex, obtuse to acute at the somewhat unequal base, sides of the lamina 0–4 mm. distant on the petiole, the lamina drying thin-chartaceous and grayish-green beneath, smooth and glabrous above or slightly roughened to the touch by the presence of long (0.5–2 mm.) evenly distributed hairs, crisp-hairy beneath, major veins flat or slightly raised above, the 4 to 8 pairs of major secondary veins usually arising throughout the length of the midvein, central secondaries arising at angles of 30–60 degrees, arcuate ascending in the distal fourth of the lamina. Inflorescence free of the leaf-base of the same node in early stages, pendulous from early stages, 2–4 cm. long, peduncles 4–9 mm. long, about 0.6 mm. thick, crisp-hairy, flowering portions 2–4 mm. thick at anthesis, becoming 8 mm. thick in fruit, the flowers crowded; floral bracts 0.4–0.9 mm. broad and triangular from above, the upper surface glabrous with a minutely (0.1 mm.) fimbriate margin, not forming bands around the spike and often obscured by flowers and fruit; anthers about 0.4 mm. long and 0.4 mm. broad, the connective expanded apically to form a gland-like disc, thecae dehiscing laterally; fruit conical (substylose) with 2 or 3 distinct stigmas; the apex becoming elongated in fruit; fruit apparently fleshy, about 2 mm. thick and round in cross-section, obconic and the stigmas sessile on the narrowed (substylose) apex, glabrous and submuricate, drying black.

Plants of forest shade in evergreen forests of the Pacific slope of Costa Rica between sea level and 1,000 m. elevation. The species is known only from the collections by Skutch in the General Valley (*2611*, *2971*, and *4082*) and Burger & Stolze on the Osa Peninsula (*5450*, *5457*, and *5557*); in December, January, February, and June.

Piper deductum is recognized by the lanceolate leaves with pinnate venation and unusual pubescence, small spikes, gland-tipped anthers, and fleshy fruit with a narrow apex. The species is closely related to the glabrous *P. phytolaccaefolium* and it resembles *P. tonduzii* with smaller leaves cordulate at the base and spikes subtended by scar-like tissue. A number of collections of *P. phytolaccaefolium* from southwestern Costa Rica appear to be intermediate with that species and *P. deductum*. This may indicate that *P. deductum* does not deserve specific rank. However, *P. deductum* (whatever its rank) represents a form of variation that I have not seen elsewhere in the geographic range of *P. phytolaccaefolium*.

Piper dilatatum L. C. Richard, Act. Soc. Hist. Nat. Paris, 105. 1792. *P. leptocladum* C.DC., Anal. Inst. Fis.-Geog. Costa Rica 9:

184. 1897, ex char. *P. subsericeum* Trel., Contr. U. S. Nat. Herb. 26:141. 1929. *P. echeverrianum* Trel., l.c. 172. *P. cookii* Trel., l.c. 174. *P. obiter-sericeum* Trel. in Standl., Field Mus. Bot. 18:350. 1937. *P. triquetrofructum* Trel. in Standl., l.c. 366. Figure 14.

Shrubs 1–3 m. tall, the older nodes somewhat thickened, leafy internodes 1–10 cm. long, 1–3.5 mm. thick, sparsely to densely minutely (0.1–0.6 mm.) puberulent and becoming glabrous; shoot-apex emerging from within the prophyll and free of the leaf-base at flowering nodes, prophyll 8–20 mm. long, acute, puberulent along the midrib abaxially, the glabrous edges drying dark brown. Leaves usually distichous, petioles 4–15 mm. long, 0.8–1.6 mm. thick, puberulent or glabrescent, vaginate near the base and usually with a minute (0.5–2 mm.) ligule-like development at flowering nodes; laminae 11–20 cm. long, 4–8 (10) cm. broad, narrowly ovate to elliptic or somewhat rhombic, tapering gradually or abruptly to the acute or acuminate apex, narrowed and often obtuse at the unequal base, often rounded at the petiole or on the longer side, sides of the lamina 1–6 mm. distant on the petiole, the lamina drying thin-chartaceous and often dark in color above, smooth or slightly scabrous above, minutely (0.05–0.3 mm.) puberulent on the veins above or occasionally glabrous, usually puberulent beneath, venation becoming slightly impressed in age, the 3 or 4 pairs of major secondary veins arising from the lower half of the midvein, the upper secondaries arising at angles of 15–30 degrees and arcuate ascending. Inflorescence free of the leaf-base of the same node in early stages, erect, 4–11 cm. long, peduncle 8–18 mm. long, 0.8–1.4 mm. thick, sparsely puberulent, flowering portion 1.5–2.5 mm. thick at anthesis, becoming 3.5 mm. thick in fruit, the flowers congested; floral bracts about 0.5 mm. broad and triangular above, glabrous centrally with a margin of whitish hairs 0.1–0.3 mm. long, not usually forming conspicuous bands around the spike; anthers 0.2–0.3 mm. long, 0.2–0.3 mm. broad, connective only slightly broadened beneath with the thecae hardly diverging and dehiscing laterally; pistil with 3 sessile stigmas; fruit about 0.7 mm. thick, obpyramidal-trigonous, truncate above and sometimes slightly depressed around the small stigmas, glabrous.

Plants of open sites between sea level and 1,200 m. elevation throughout Costa Rica but absent from the seasonally dry (premontane) moist forest formations and deciduous formations of the Pacific slope; flowering throughout the year. The species ranges southward to northern South America and the West Indies.

Piper dilatatum is recognized by its weedy habitat, the thin sparsely puberulent leaves occasionally rhombic in form, slender spikes with small anthers, and glabrous trigonous fruit. This species is very closely related to *P. pseudo-fulgineum* and the latter may only be a more puberulent form adapted to drier habitats. Both taxa are easily confused with *P. hispidum* and its allies which differ in important characters of anther and fruit.

Piper dotanum Trel., Contr. U. S. Nat. Herb. 26:165. 1929. Figure 10.

Shrubs, erect or somewhat scandent 1–4 m. tall, older nodes conspicuously thickened, leafy internodes (0.7) 1.5–6 (8) cm. long, 1–2 (3) mm. thick, glabrous; shoot-apex emerging from within the prophyll and free of the leaf-base at flowering nodes, prophyll 6–14 mm. long, narrow and glabrous, acute and drying dark brown. Leaves usually distichous, petioles 2–7 mm. long, 0.7–1.5 mm. thick, glabrous, vaginate only at the base and with a short (0.5–2 mm.) stipular development at flowering nodes; laminae 5–13 cm. long, 1.5–3 (4.5) cm. broad, very narrowly elliptic to lanceolate or ovate-lanceolate (rarely a few ovate), tapering very gradually to the long-acuminate apex, rounded or obtuse at the oblique base, sides of of the lamina 0–4 mm. distant on the petiole, the lamina drying chartaceous and usually dark above and much paler beneath, smooth and glabrous on both surfaces, venation flat above or rarely slightly impressed in age, the 3 pairs of major secondary veins usually arising from the lower half of the midvein, upper secondaries arising at angles of 20–45 degrees, arcuate-ascending. Inflorescences free of the leaf-base of the same node in early stages, apparently erect, peduncles 4–12 mm. long, 0.5–1.1 mm. thick, glabrous, flowering portion 1.5–2.5 mm. thick at anthesis, 2–3 mm. thick in fruit, the flowers congested; floral bracts 0.2–0.4 mm. broad and triangular or rounded above, glabrous centrally and sparsely puberulent on the margins with very minute (0.05 mm.) hairs, occasionally forming bands around the spike; anthers 0.1–0.2 mm. long, 0.2–0.3 mm. broad, connective very broad basally with the divergent thecae dehiscing upward; pistil obscure; fruit becoming laterally compressed, about 0.3×0.5 mm. thick, truncate above with a depression around the small sessile stigmas (dry), very minutely puberulent above.

This species is only known from the Pacific side of the Meseta Central near San Ramon, Alajuela, and near Sta. Maria de Dota, San Jose at elevations between 500 and 1,800 m.

Piper dotanum is recognized by its relatively small narrow leaves smooth to the touch, general lack of pubescence, and slender spikes with minute bracts and small fruit. The stems are quite distinctive, those with short internodes having a zig-zag form and those with very long internodes apparently clambering. This species is very closely related to *P. chrysostachyum* and may be no more than an unusual form with smaller lanceolate leaves. *Piper silvivagum* of the Caribbean side is also closely related. The puberulent fruit, anthers opening upward, and stipular development relate these taxa to the scabrous *P. hispidum* and its allies.

Piper dryadum C.DC., Bull. Soc. Bot. Belg. 30, pt. 1:221. 1891. *P. negritosense* Trel. in Cufod., Archivio Bot. Sist. Fitogeog. & Genet. 10:25. 1934, photo. Figure 7.

Shrubs to 3 m. tall, older nodes conspicuously thickened, leafy internodes 1.5–5 cm. long, 1.2–4. mm. thick, puberulent with crooked yellowish hairs 0.1–1.5 mm. long, the longer hairs breaking off in age; shoot-apex probably emerging from within the prophyll and free of the leaf-base at flowering nodes, prophyll not seen. Leaves apparently distichous, petioles 1–4 (7) mm. long, about 1.5 mm. thick,

densely puberulent, vaginate only at the base and without a stipular-like development at flowering nodes; laminae 10–16 cm. long, 4–8 (9.5) cm. broad, broadly elliptic to elliptic-oblong or ovate, often asymmetric with the broader side more rounded, tapering abruptly to the short-acuminate apex, rounded or obtuse at the equal or subequal and asymmetric base, sides of the lamina 0–2 mm. distant on the petiole, the lamina drying chartaceous and dark in color, smooth and with slender hairs 0.2–0.7 mm. long on the upper surface, more densely puberulent beneath, larger veins becoming impressed above, the 3 to 4 pairs of major secondary veins arising from the lower half or lower third of the midvein, upper secondaries arising at angles of 15–30 degrees and arcuate-ascending. Inflorescence free of the leaf-base of the same node in early stages, erect but becoming pendulous in fruit, about 7–9 cm. long, peduncle 5–10 mm. long, 1.2–2 mm. thick, densely puberulent with yellowish hairs of varying (0.05–1 mm.) lengths, flowering portion 3.5–5 mm. thick at anthesis, the flowers loosely crowded; floral bracts 0.5–0.7 mm. broad and triangular or rounded above, glabrous above but with the distal margin or distal surface densely puberulent with brownish hairs 0.1–0.3 mm. long, not forming bands around the spike; anthers about 0.6 mm. long and 0.2 mm. broad, connective very slender and forming a minute (0.07 mm.) tip at the apex, thecae narrow and dehiscing laterally, filaments becoming 1.3 mm. long; pistil with a distinct (0.3–0.8 mm.) style and 2 or 3 slender recurved stigmas 0.2–0.5 mm. long; fruit not seen but probably stylose, glabrous, and round in cross-section.

This species is known only from the collection by Pittier (*3193*) from the forests of Siquirres, at about 100 m. elevation, and that of Cufodontis (*528*) near the mouth of the Rio Reventazon, both in the province of Limon.

Piper dryadum is easily recognized by the broadly elliptic almost sessile leaves with the secondary veins arising from the lower part of the blade and puberulent surfaces. The narrow anthers on the long slender filaments and stylose pistil with distinct stigmas further distinguish this species. I believe that these are primitive characters within the genus and relate *P. dryadum* to species such as *P. urostachyum* and *P. crassinervium*.

Piper epigynium C.DC., Linnaea 37:346. 1872 (photo). *P. villosisquamulum* Trel., Contr. U. S. Nat. Herb. 26:162. 1929. *P. villistipulum* Trel., l.c. 162. *P. subdivaricatum* Trel., l.c. 163. Figure 13.

Shrubs or occasionally small trees, 1.5–6 m. tall, older nodes only slightly thickened, leafy internodes 1.4–10 cm. long, 1–3 (4) mm. thick, glabrous; shoot-apex emerging from within the prophyll and free of the leaf-base at flowering nodes, prophyll 14–40 mm. long, acute, sparsely puberulent along the back of the midrib with long (0.5–2 mm.) hairs or occasionally glabrous, the glabrous margins usually drying pale yellowish-brown. Leaves usually distichous, petioles 4–14 (20) mm. long, 1–1.5 mm. thick, vaginate only at the base and with a ligule-like stipular development 1–3 mm. long at flowering nodes, the stipule usually with long (0.5–2 mm.) crooked hairs; laminae 12–26 cm. long, 4–9 cm. broad, elliptic to narrowly

ovate or somewhat rhombic, tapering gradually to the long-acuminate apex, narrowed to the obtuse and oblique base or somewhat rounded on the longer side, sides of the lamina 2–10 mm. distant on the petiole, the lamina usually drying thin-chartaceous and dark green above, glabrous and smooth or very slightly scabrous above, with whitish ascending hairs 0.5–1 mm. long on the veins beneath, venation becoming impressed only in old leaves, the 3 or 4 pairs of major secondary veins usually arising from the lower half of the midvein, upper secondaries arising at angles of 20–40 degrees, arcuate-ascending. Inflorescence free of the leaf-base of the same node in early stages, erect, often reddish or purple in early stages, 6–15 cm. long, peduncles 8–16 mm. long, 0.8–1.5 mm. thick, glabrous, flowering portion 2–3 mm. thick at anthesis, about 3.5 mm. thick in fruit, the flowers congested; floral bracts 0.2–0.3 mm. broad and triangular or rounded above, glabrous above with the proximal upper surface umbonate and paler in color, minute (0.05–0.1 mm.) hairs present beneath the margin but not usually apparent, not forming conspicuous bands around the spike; anthers 0.1–0.2 mm. long, about 0.3 mm. broad, the connective broad basally and the divergent thecae dehiscing upward; pitil obscured by the anthers and bracts; fruit becoming laterally compressed and tetragonous, about 0.4 ×0.6 mm. thick, truncate above with a depression around the small sessile stigmas, minutely puberulent above, pellucid muricate beneath.

Plants of the eastern slopes of the Meseta Central subject to the wet winds from the Caribbean between 800 and 1,800 m. elevation. The species is only known from the area between Vara Blanca de Sarapiquí and Orosi, Cartago. An unusual collection (*Williams et al. 28605*) from the Cordillera de Talamanca above San Isidro del General may be this species. Flowering material has only been collected in February and March.

Piper epigynium is characterized by the large prophyll glabrous or with few long hairs, large thin leaves smooth to the touch, reddish bracts with little or no pubescence, and wet-forest habitat. The fruit and anthers relate this species to *P. hispidum*. I have only seen a photograph of the type and though the immature fruit are described as glabrous, I am quite certain that the name applies to this group of plants. Like the closely related *P. austini*, I consider these plants sufficiently different from *P. hispidum* and *P. bisasperatum* to merit specific status. Superficially, the plants resemble *P. terrabanum* with trigonous fruit and *P. glabrescens* with very different spikes. *Piper phanaropus* Trel. in Standl. (Field Mus. Bot. 18:354. 1937) appears to be a completely glabrous form of this species and is known only from a single collection (*1775*) by Stork near Sta. Maria at 2,000 m. elevation.

Piper euryphyllum C.DC., Bot. Gaz. 70:178. 1920. *P. triserale* C.DC., l.c., 187. *P. mirabile* Trel., Contr. U. S. Nat. Herb.

26:154. 1929. *P. san-cristobalanum* Trel. in Standl., Field Mus. Bot. 18:359. 1937. Figure 6.

Shrubs or slender few-branched trees to 8 m. tall, the older nodes conspicuously thickened, leafy internodes 4–15 cm. long, 4–12 mm. thick, sparsely puberulent with small (0.2–0.4 mm.) brownish hairs but soon becoming glabrous, short gland-like tubercles occasionally present beneath the nodes; shoot-apex emerging from within the sheathing leaf-base at all nodes, the prophyll lateral, 2–5 mm. long and usually obscured by the leaf-base. Leaves usually distichous, petioles 3–8 cm. long, 4–12 mm. broad, puberulent or glabrescent and occasionally with short tubercles, deeply vaginate and with thin adaxial margins at all nodes, clasping the stem at the base; lamina 15–35 cm. long, 8–22 cm. broad, ovate to narrowly oblong, tapering gradually or abruptly to the obtuse or acute apex, usually unequally truncate at the base but occasionally obtuse or somewhat cordate, sides of the lamina 2–15 mm. distant on the petiole, the lamina drying subcoriaceous and often grayish-green above, smooth and glabrous above, minutely puberulent on the veins beneath, primary and secondary veins deeply impressed above, prominent beneath, the 4 to 6 pairs of major secondary veins arising from the lower two-thirds of the midvein, upper secondaries arising at angles of 12–25 degrees and arcuate ascending. Inflorescence free of the leaf-base of the same node in early stages, pendulous, 15–45 cm. long; peduncles 2–5 cm. long, 1.5–4 mm. thick, sparsely and minutely puberulent or glabrous, flowering portion 5–10 mm. thick at anthesis, becoming 16 mm. thick in fruit, the flowers crowded; floral bracts 0.7–1.8 mm. broad and triangular or cupulate from above, usually with a fringe of brownish hairs 0.2–0.4 mm. long, forming bands around the spike in early stages; anthers about 0.3 mm. long and equally broad, connective somewhat broadened at the base and the thecae slightly divergent, the filament apparently articulated; pistil stylose; fruit round or angular by compression, becoming 2 mm. thick, truncate above and with a short style or the 3 stigmas sessile, glabrous.

Plants of wet evergreen forest subject to the moist Caribbean winds between 1,000 and 2,100 m. elevation. Known only from the area between San Ramon (Alajuela) and Tapanti (Cartago).

Piper euryphyllum is characterized by the large very stiff unequally truncate leaves, deeply impressed venation, long pendulous spikes, large habit, and restricted range. At first I had thought that this taxon was a form of *P. imperiale* but I have since seen a very uniform population at Río Vueltas on the eastern slope of Volcan Barba. This species differs from *P. imperiale* in the thicker and narrower leaves with very different form. Both species are part of a complex related to *P. obliquum*. *Piper euryphyllum* is also closely related to the smaller *P. gibbosum*.

Piper fimbriulatum C.DC., Bull. Soc. Bot. Belg. 30, pt. 1:207. 1891. *P. neurostachyum* C.DC., l.c. 213. *P. silvicola* C.DC., Anal. Inst. Fis.-Geog. Costa Rica 9:159. 1897. *P. bullulaefolium* Trel., Contr. U. S. Nat. Herb. 26:152. 1929. *P. exiguispicum* Trel., l.c.

153. *P. pseudo-fimbriulatum* Trel., l.c. 153. *P. piedadesense* Trel. in Standl., Field Mus. Bot. 13:354. 1937. *P. squalidum* Trel. in Standl., l.c. 361. *P. cooperi* Yuncker, Ann. Mo. Bot. Gard. 37:21. 1950. Figures 2, 5.

Shrubs or slender few-branched trees to 6 m. tall, the older nodes slightly thickened, leafy internodes 3–12 (20) cm. long, 2.5–7 cm. thick. puberulent and only rarely with small (0.5 mm.) tubercles; shoot-apex emerging from within the sheathing leaf-base at all nodes, the prophyll lateral, less than 2 mm. long and obscured by the leaf-base. Leaves usually distichous, petioles 4–8 cm. long, 2.5–7 mm. broad, usually minutely (0.3 mm.) and densely brownish puberulent, deeply vaginate and with thin adaxial margins at all nodes, clasping the stem at the base; lamina 16–35 cm. long, 8–16 (20) cm. broad, elliptic to oblong or narrowly ovate, usually short-acuminate at the apex, very unequal at the base and occasionally peltate, the shorter lobe truncate to cordate, the longer lobe cordate or expanded and overlapping the petiole, the lower lobe to 5 cm. long and equally broad, the sides of the blade 0–15 mm. distant on the petiole or rarely united and the lamina peltate (peltate and unequally cordate laminae present on the same plant), the lamina drying thin chartaceous, smooth and minutely puberulent above the veins on the upper surface, minutely (0.2–0.7 mm.) and usually densely brownish puberulent on the veins beneath, the venation flat or impressed above and often bullate with the tertiary veins impressed, the 4 to 6 pairs of major secondary veins usually arising from the lower half of the midvein (lower two-thirds of the lamina), the upper secondaries arising at angles of 20–40 degrees, arcuate ascending. Inflorescence free of the leaf-base of the same node in early stages, pendulous, 15–40 cm. long; peduncles 1.2–5 cm. long, 0.8–2 mm. thick at anthesis, brownish puberulent with crooked hairs 0.2–0.7 (1) mm. long, flowering portion 2–4.5 mm. thick at anthesis, the flowers loosely to densely crowded; floral bracts about 0.8 mm. broad and round in outline from above, with crooked brownish hairs 0.3–1 mm. long, forming bands around the spike in early stages; anthers 0.3–0.4 mm. long and equally broad, often on conspicuous articulated filaments, the connective broad at the base and the thecae divergent with lateral or upward dehiscence, the edges of the open thecae forming angles of 60–90 degrees; pistils usually with 3 distinct stigmas (style-branches) from early stages; fruit usually angular by compression, 1–2 mm. thick, truncate at the apex and minutely puberulent, style minute or absent but the 3 stigmas (style-branches) as much as 1 mm. long and 0.2 mm. thick.

Plants of evergreen forest formations between sea level and 1,200 m. altitude but rarely collected below 500 m. Probably restricted to shaded sites. The species ranges from Costa Rica to western Panama. It is apparently common on the Pacific slope between 600 and 1,200 m.

One of the large-leaved tree-like pipers of forest shade distinguished by the unusual leaf-form, thin laminae, floral bracts with long hairs, long stigmas (apparently stylose), and puberulent fruit. The specimens placed here vary in many characteristics; they are closely related to *P. maxonii* and *P. obliquum* and its allies. Indi-

vidual collections differ greatly and account for the profuse synonymy; see the discussion under *P. obliquum*. The stems are often hollow and may harbour ants (*Burger & Matta 4399, 4414,* and *4427*).

Piper friedrichsthalii C.DC. in DC., Prodr. 16, pt. 1:327. 1869. *P. linearifolium* C.DC., Linnaea 37:355. 1872. *P. goergeri* Trel. in Standl., Field Mus. Bot. 18:344. 1937. Figure 11.

Shrubs 1–4 (6) m. tall, the older nodes somewhat thickened, leafy internodes 1–8 cm. long, 1–4 mm. thick, minutely (0.1–0.4 mm.) and densely puberulent in early stages, often sparsely puberulent and marked with purple on older parts, the hairs yellowish-brown and usually ascending; shoot apex emerging from within a prophyll and free of the leaf-base at flowering nodes, the prophyll becoming 10 mm. long, acute, minutely puberulent along the midrib abaxially and glabrous on the brown (dry) outer surfaces. Leaves usually distichous and often congested at the ends of stems, petioles 2–5 mm. long (to 15 mm. at lower sterile nodes), 1–1.5 mm. broad, densely puberulent, vaginate only at the base and a stipule-like structure absent at flowering nodes; laminae 7–16 cm. long, 1.5–3 (4.5) cm. broad, lanceolate to very narrowly ovate, tapering very gradually to the long-acuminate apex, narrowed to the acute and unequal base, sides of the blade 1–3 mm. distant on the petiole and the longer side occasionally forming a small (2 mm.) lobe, the lamina drying thin- to stiff-chartaceous, smooth on both surfaces, glabrous or appressed puberulent (especially near the base) above, puberulent beneath with ascending hairs 0.2–0.4 mm. long, the major veins becoming impressed above and prominent below, the 4 to 6 pairs of major secondary veins arising from the lower half of the midvein, arcuate-ascending, upper secondaries arising at angles of 5–20 degrees, tertiary veins obscure beneath. Inflorescence free of the leaf-base of the same node in early stages but subtended by a rim of hairs continuous with the leaf-base and apparently articulated at the base, usually with an erect peduncle and slightly arching spike, 4–9 cm. long, peduncle 3–8 (11) mm. long, 0.5–1.2 mm. thick, glabrous or sparsely and minutely puberulent, flowering portion 2–3 mm. thick at anthesis, becoming 3–4 mm. thick in fruit, the flowers tightly congested; floral bracts about 0.6 mm. broad and triangular from above, glabrous in the center and with a dense margin of whitish hairs 0.1–0.2 mm. long, not usually forming bands around the spike; anthers about 0.2 mm. long and equally broad, thecae dehiscing laterally; pistil with 3 short (0.1–0.2 mm.) slender stigmas; fruit 0.5–0.7 mm. thick, about 0.7 mm. long, obpyramidal-trigonous by compression, truncate apically with the sessils stigmas usually breaking off, glabrous, usually obscured by the bracts.

Plants of open sunny sites between sea level and 1,500 (1,800) m. elevation in areas of wet evergreen forest formations; flowering throughout the year. The species is restricted to Costa Rica and the western half of Panama.

A striking species of roadsides and open sites along streams and areas of recent clearing. The lanceolate leaves with subparallel venation, smooth surfaces, and often arched whitish spikes make recog-

nition easy. This species is closely related to *P. aduncum* and *P. lanceaefolium*.

Piper garagaranum C.DC., Smiths. Misc. Coll. 71, pt. 6:15. 1920. *P. viridispicum* Trel., Contr. U. S. Nat. Herb. 26:138. 1929. *P. conceptum* Trel. in Standl., Field Mus. Bot. 18:338. 1937. Figure 8.

Herbs or subshrubs 0.3–1 m. tall, leafy internodes 1–5 cm. long, 1.5–4 mm. thick, crisp puberulent or glabrate in age, the hairs crooked, 0.5–2.5 mm. long; the shoot-apex emerging from within the prophyll and free of the leaf-base at flowering nodes, the prophyll becoming 6–12 mm. long, glabrous or puberulent along the midvein, drying dark brown. Leaves in a spiral or the upper distichous, petioles 4–8 mm. long but becoming 14 mm. long at the sterile nodes, about 2 mm. broad, densely hirsute, stipule-like structures absent at flowering nodes; laminae 11–22 cm. long, 5–12 cm. broad, elliptic to ovate or narrowly oblong, acute to short-acuminate at the apex, narrowed to the obtuse or slightly rounded and cordulate base, basal lobes less than 5 mm. long or absent, sides of the lamina 0–8 mm. distant on the petiole with the lower side usually more rounded, the lamina drying membranaceous to thin-chartaceous, dark green above and paler beneath, slightly rough to the touch with long (1–2.5 mm.) hairs on both surfaces, the 3 or 4 pairs of major secondary veins arising from the lower half of the midvein or occasionally with prominent secondary veins in the upper half, the central secondaries arising at angles of 20–40 degrees, usually arcuate-ascending. Inflorescence free of the leaf-base of the same node in early stages and erect, 2–5 cm. long, peduncle 4–10 mm. long, about 1 mm. thick, with slender yellowish crooked hairs (0.4–2 mm.), flowering portion 2–4 mm. thick at anthesis, becoming 7 mm. thick in fruit, occasionally with a slender tip; floral bracts 0.3–1 mm. broad and triangular from above, glabrous above and fimbriate beneath the upper edge, not forming bands around the spike; anthers 0.4–0.5 mm. long, 0.3–0.4 mm. broad, the connective expanded to produce a gland-like disc 0.1–0.2 mm. broad, thecae dehiscing laterally; pistils with a short (0.2–0.5 mm.) thick style with 2 or 3 small stigmas; fruit obconic and short (0.5 mm.) stylose, round in cross-section and becoming 2 mm. thick, apparently fleshy and drying very dark, glabrous and somewhat muricate.

Plants of the deeply shaded forest floor in wet evergreen forests between sea level and 1,200 m. elevation. The Costa Rican collections come from the lowland Caribbean slope, General Valley, and Osa Peninsula. The species ranges from eastern Nicaragua to Darien, Panama.

This is one of our small pipers, averaging less than a meter tall. The long yellowish hairs, short spikes, gland-tipped anthers, and stylose fleshy fruit are unusual characteristics that ally this species to *P. deductum* and *P. phytolaccaefolium*.

Piper gibbosum C.DC., Bull. Soc. Belg. 30, pt. 1:212. 1891. *P. deflexispicum* Trel., Contr. U. S. Nat. Herb. 26:144. 1929. Figure 6.

Shrubs to 4 m. tall, the older nodes slightly thickened, leafy internodes 3–10 cm. long, 2–6 mm. thick, usually densely to sparsely puberulent with short (0.2–0.6 mm.) pale brownish hairs but occasionally glabrous; shoot-apex emerging from the sheathing leaf-base at all nodes, the prophyll lateral and small (1–2 mm.). Leaves usually distichous, petioles 2–4 cm. long at flowering nodes and becoming 6 cm. long at sterile nodes, 2–6 mm. broad, minutely puberulent with the hairs often in longitudinal rows or rarely glabrous, deeply vaginate with the thin adaxial margins tearing off in irregular strips to produce margins of scar tissue on most petioles, clasping the stem at the base; lamina 10–22 cm. long, 5–12 cm. broad, elliptic to ovate or oblong, acute to acuminate at the apex, usually unequal and obliquely truncate to subcordate at the base with the sides of the lamina attached together on the petiole, occasionally equal at the base or rarely equal and cordate but the basal lobes divergent and never overlapping the petiole; the lamina drying thin- or thick-chartaceous, and often much paler in color beneath; smooth and glabrous above, minutely (0.1–0.4 mm.) puberulent on the veins beneath, the veins usually flat above and prominent beneath, the 3 or 4 pairs of major secondary veins usually arising in the lower half of the midvein, upper secondaries arising at angles of 20–35 degrees, arcuate ascending. Inflorescence free of the leaf-base of the same nodes in early stages, pendulous, (6) 10–26 cm. long; peduncles 1.5–4 cm. long, 0.8–1.6 mm. thick, flowering portion 4–7 mm. thick at anthesis, the flowers crowded; floral bracts 0.5–1.1 mm. broad and cupulate or slightly U-shaped from above, sparsely and very minutely (0.03–0.1 mm.) puberulent, forming indistinct bands around the spike in early stages; anthers 0.2–0.5 mm. long and equally wide, borne on a conspicuous filament articulate with the usually paler upper antheriferous part, the thecae parallel or divergent with the connective broadened beneath, the dehiscence lateral or upward, the connective often apiculate at the apex; pistils difficult to see in the early stages; fruit angular by compression, becoming 2 mm. thick and rounded at maturity, truncate at the apex with a short (0.5 mm.) style and 3 stigmas (but these difficult to see among the persistent filaments), glabrous.

Plants of evergreen montane forests between 1,400 and 2,400 m. elevation. Known only from the central highlands in Costa Rica and probably confined to shaded forest sites.

This species is recognized by its pendulous spikes, long articulated filaments, cupulate floral bracts, lack of a developed prophyll, and leaves often obliquely truncate. *Piper gibbosum* is closely related to *P. aereum* and *P. euryphyllum* and is part of a complex of forms allied to *P. obliquum*. It differs from the latter group in shorter habit and smaller leaves with less developed basal lobes. However, these characteristics vary greatly and the treatment of these species must be considered tentative: see the discussion under *P. obliquum*. The unusual collections (with smaller leaves and very small spikes) by Austin Smith near Zarcero (*660, 867, 1020, 2268*) are, I believe, immature specimens of this species.

Piper glabrescens (Miq.) C.DC. in DC. Prodr. 16, pt. 1:271. 1869. *P. macrophyllum* H.B.K., Nov. Gen. & Sp. 1:46. 1815, non

Swartz 1788. *Artanthe glabrescens* Miq. in Hook., London Journ. Bot. 4:461. 1845. *P. calvirameum* C.DC., Bull. Soc. Bot. Belg. 30, pt. 1:200. 1891. *P. brevistylum* C.DC., Anal. Inst. Fis.-Geog. Costa Rica 9:158. 1897. *P. zhorquinense* C.DC., l.c. 159. *P. xiroresanum* C.DC., l.c. 169. *P. longistipulum* C.DC., Bot. Gaz. 70:175. 1920. *P. brenesii* C.DC., l.c. 180. *P. chirripoense* C.DC., l.c. 186. *P. calcaratum* C.DC., l.c. 188. *P. viridifolium* Trel., Contr. U. S. Nat. Herb. 26:139. 1929. *P. jubatum* Trel., l.c. 140. *P. operosum* Trel., l.c. 141. *P. detonsum* Trel., l.c. 141. *P. figlinum* Trel., l.c. 142. *P. tarrazuense* Trel., l.c. 142. *P. subzhorquinense* C.DC. ex Trel., l.c. 142. *P. arcessitum* Trel., l.c. 143. *P. allisum* Trel. in Standl., Field Mus. Bot. 18:331. 1937. *P. lincolnense* Trel. in Standl., l.c. 347. 1937. *P. onus* Trel. in Standl., l.c. 351. *P. rubrospadix* Trel. in Standl., l.c. 358. *P. tapantiense* Trel. in Standl., l.c. 1547. 1938. Figure 4.

Small shrubs 1–2.5 m. tall, the older nodes not conspicuously thickened, leafy internodes 2.5–9 cm. long, 1.5–4 mm. thick, glabrous to densely and minutely (0.3 mm.) puberulent, the hairs often in longitudinal rows; the shoot-apex emerging from the sheathing leaf-base and enclosed within the prophyll at flowering nodes, the prophyll 5–35 mm. long and often hidden by the leaf-base, glabrous or with minute hairs along the abaxial side of the midrib, drying brown. Leaves usually distichous, petioles 8–20 (40) mm. long, 1.5–4 (8) mm. broad, glabrous or minutely puberulent, the thin stipule-like margins united adaxially to form a projection 4–8 mm. broad opening adaxially and similar to the prophyll in color and texture, the margins usually tearing off to produce 2 lines of scar tissue on the adaxial side of the petiole at all nodes; lamina 12–22 (28) cm. long, (3) 5–13 (16) cm. broad, narrowly to broadly elliptic, tapering very gradually (in narrow leaves) or abruptly (in broad leaves) to the short or long-acuminate apex, obtuse or rounded at the subequal or unequal base, sides of the blade 0–5 mm. distant on the petiole, the margins of the petiole often projecting beyond the base of the lamina to form a ligule-like structure, the lamina drying thin- to stiff-chartaceous, smooth or rugose above, glabrous above and below or puberulent beneath with crisp hairs to 0.5 mm. long, the 4 to 6 pairs of major secondary veins usually arising from the lower two-thirds of the midvein, the central secondaries arising at angles of 20–45 degrees and arcuate ascending, the major veins flat or impressed above and prominent beneath. Inflorescence at first enclosed within the sheathing leaf-base of the same node and later subtended by scar tissue continuous with the petiole, erect, 3–9 cm. long; peduncle (4) 6–18 mm. long, 1–2 (3) mm. thick, glabrous or sparsely puberulent, the flowering portion 2–4 mm. thick at anthesis and 4–6 mm. thick in fruit, the flowers densely crowded, a slender flowerless tip sometimes present; floral bracts 0.5–1.8 mm. broad above, U-, V-, or Y-shaped (with a round or triangular center) from above, glabrous or sparsely and minutely puberulent, not usually forming conspicuous band around the spike; anthers 0.2–0.4 mm. long and equally broad, dehiscing laterally; pistil with a style of variable (0.1–1.5 mm.) length arising from the truncate apex of the ovary; fruit congested but round or rhombic in

cross-section, becoming 1.5 mm. thick, glabrous, often with the 2 or 3 recurved stigmas sessile or on a short style in a depressed area at the apex of the fruit.

Plants of shaded sites in moist forest formations between sea level and 2,000 m. elevation on the Caribbean slopes, central highlands, and on the Pacific slopes of central and southern Costa Rica above 800 m. Collected in flower and fruit during July and August and from November to March. The species ranges from Nicaragua to Ecuador, British Guiana, and the West Indies.

Piper glabrescens is recognized by the spike emerging from the leaf-base, developed stipular margins and prophyll, pistils truncate at the apex and stylose (in ours), and usually glabrescent bracts. Different plants vary greatly in leaf-form, development of styles, and pubescence but very puberulent plants are rare. This variation seems to be greater in Costa Rica than elsewhere and accounts for the many names. I have been unable to correlate the many variations among our collections and am forced to conclude that they represent a single plastic species. *Piper yzabalanum* C.DC. (?*P. chinantlense* Mart & Gal.) of northern Central America and southern Mexico is very closely related to *P. glabrescens* in the wide sense and may prove to be a northern element of this species. The stigmas are usually sessile in South American and West Indian collections.

Piper grande Vahl, Eclog. Am. 2:3, pl. 11, 1798. *P. borucanum* C.DC., Bull. Soc. Bot. Belg. 30, pt. 1:219. 1891. *P. subvariabile* Trel., Contr. U. S. Nat. Herb. 26:145. 1929. *P. cercidiphyllum* Trel., l.c. 146. 1929. Figure 9.

Slender shrubs to 3 (rarely 5) m. tall, the older nodes conspicuously thickened, leafy internodes, 3–12 cm. long, 2–4 mm. thick, glabrous; shoot-apex emerging from within the prophyll and free of the leaf-base at flowering nodes, the prophyll becoming 3 cm. long and 2 mm. broad (unopened), glabrous and drying grayish or pale brown. Leaves usually distichous, petiole 1.5–4 cm. long and about 2 mm. broad at flowering nodes, grooved adaxially with scar tissue only at the base and a stipule-like development absent at flowering nodes, becoming 10 cm. long and deeply vaginate at lower sterile nodes; lamina 15–25 (33) cm. long, 9–16 (25) cm. broad, broadly to narrowly ovate, tapering gradually to the acuminate apex, rounded to the truncate or subcordate base, the larger laminae at lower nodes becoming deeply cordate and abruptly acuminate, sides of the lamina somewhat unequal but attached to the same point on the petiole and often thickened at that point, the lamina drying chartaceous and usually grayish, smooth on both surfaces, glabrous above and glabrous on the central areas beneath but very minutely (0.05–0.2 mm.) puberulent on the marginal vein and areas near the edge, the 4 to 9 pairs of major secondary veins arising from throughout the length of the midvein, usually diminishing gradually in size toward the apex, the central secondaries arising at

angles of 35–70 degrees. Inflorescence free of the leaf-base of the same node in early stages, erect, 7–14 cm. long, peduncle 6–15 mm. long, 1–3 mm. thick, glabrous, flowering portion about 4 mm. thick at anthesis and becoming 6 mm. thick in fruit, the flowers congested; floral bracts about 0.4 mm. broad, rounded to triangular and usually umbonate above, lustrous and glabrous above but minutely (0.1 mm.) fimbriate at the edge and beneath, not forming distinct bands around the spike; anthers 0.2–0.3 mm. long and about 0.2 mm. broad, connective occasionally broadened somewhat at the base and the thecae slightly divergent, dehiscing laterally; pistil with sessile stigmas; fruit densely congested, obpyramidal-trigonous by compression, about 1 mm. long and 0.6 mm. thick, truncate and with a cap-like thickening of the apex, glabrous, stigmas sessile and undifferentiated, the fruit usually hidden by the bracts.

Plants of evergreen wet forest formations below 800 m. elevation on both Caribbean and Pacific slopes in Central America and Panama. Known from only a few collections at the following sites in Costa Rica: Tilaran and adjacent areas in Guanacaste, Boruca and the General Valley in southern Puntarenas. Ranging from Nicaragua to northern South America.

An uncommon species distinguished by the broadly ovate leaves usually with pinnate venation and glabrous beneath except for the edges, and the unusual floral bracts. This species is closely related to *P. aequale* and *P. carilloanum* which share the glabrous stems, form of the prophyll, small anthers, poorly differentiated stigmas, and leaves that turn gray on drying. *Piper grande* is difficult to separate from these two species if the floral bracts cannot be seen. The upper surface of the floral bract is completely glabrous, somewhat lustrous, and often yellowish but densely puberulent beneath. This upper surface is convex with a pronounced umbo or raised area on the proximal end. *Piper nemorense* (*corrugatum*) has rather similar floral bracts but without the distinctly raised part on the upper surface. These characteristics are best seen in young spikes just prior to anthesis, older material may be very difficult to separate; see the discussion under the above mentioned species. I am using the name *Piper grande* in the sense of Yuncker and consider the floral bracts diagnostic; I have not seen type material.

Piper guanacastense C.DC., Linnaea 37:356. 1872, as *guanacostense*. Figure 8.

Slender shrubs to 3 m. tall, the older nodes conspicuously thickened, leafy internodes 1–4 cm. long, 1–3 mm. thick, glabrous or sparsely and very minutely (0.1 mm.) puberulent; shoot-apex emerging from within a slender prophyll at flowering nodes, the prophyll 4–12 mm. long, glabrous and drying dark, leaving a small circle of scar tissue above the leaf-base at flowering nodes. Leaves dis-

tichous, petioles 3–8 mm. long, about 1 mm. thick, sparsely and minutely puberulent or glabrous, deeply grooved adaxially but without thin margins and vaginate only at the base, scar tissue of the petiole only at the base at flowering nodes; lamina 8–18 cm. long, 2.5–5 cm. broad, lanceolate to narrowly oblong, gradually tapering to the acuminate apex, acute to obtuse and somewhat unequal at the base, sides of the lamina 1–3 mm. distant on the petiole, drying chartaceous and often grayish in color, smooth and glabrous above and below, the 6 to 12 pairs of secondary veins arising throughout the length of the midvein, the lowest 2 or 3 pairs of veins arcuate-ascending and forming a distinct submarginal vein (3–7 mm. from the edge) in the distal two-thirds of the lamina, the central minor secondaries arising at angles of 40–80 degrees, the midvein impressed above and prominent beneath, margin of the lamina often revolute on drying. Inflorescence free of the leaf-base of the same node in early stages, erect, 4–8 cm. long; peduncle 6–10 mm. long, 1–2 mm. thick, glabrous or sparsely and very minutely (0.1 mm.) puberulent, flowering portion 2–3 mm. thick at anthesis, becoming 5–7 mm. thick in fruit, flowers tightly crowded; floral bracts 0.4–0.7 mm. broad above, triangular in outline above and with a margin of minute (0.1 mm.) hairs around the edge, forming conspicuous bands around the spike; anthers 0.2–0.3 mm. long, 0.3–0.5 mm. broad, connective broad at the base and the thecae diverging with lateral or upward dehiscence; pistil with 3 sessile but prominent (0.3 mm.) stigmas; fruit round in cross-section at maturity, about 1 mm. thick, truncate at the apex with sessile stigmas, surface smooth and glabrous.

A species of the Pacific slopes between sea level and 200 m. elevation; apparently growing under the shade of evergreen trees. The species is found only in Costa Rica from the eastern part of Guanacaste and the Nicoya peninsula to Golfo Dulce; flowering from January to March.

The pinnate venation with prominent marginal vein and small geographic range distinguish this species. The terminal prophyll is developed but caducous and rarely seen. This species is apparently closely related to *P. cordulatum* C.DC. of Panama and more distantly to *P. tuberculatum* and *P. arboreum*. It shares with these the form of anthers and pistil but differs in the developed prophyll. These species may represent a transition in which the prophyll, rather than the leaf-base, protects the shoot-apex at flowering nodes. This development must have occurred independently in several groups of pipers: see the discussion under the genus.

Piper hebetifolium W. Burger, n. sp. Figure 6.

Suffrutices ad 1.5 m. altis, ramuli amentiferi 2–8 mm. crassi, lineis minute hirsutulis; apex surculi ex petiolo semper emergit, prophyllum circa 1 mm. longum, occultum. Folia in secco grisea, petiolis ad medium semper vaginatis; laminae ellipticae vel oblongae, 14–26 cm. longae, 6–16 cm. latae, apicibus obtusis, basibus cordatis vel cordulatis, nervis secondariis 4–6 utrinque, paginis infernis minute puberulis. Inflorescentiae initio petiolorum ad eosdem nodos librae, pendulae, circa 11 cm. longae, 5 mm. crassae, pedunculis circa 35 mm. longis, circa 1 mm.

crassis, minute puberulis, flores laxe aggregati, bracteae apicibus 1–1.5 mm. latis, cupulatis ciliatis, antherae 0.6–0.7 mm. longae, 0.4–0.6 mm. latae, dehiscentes laterales; pistillum glabrum apice stiliferum, stilo circa 0.4 mm. longo, stigmatibus 3, circa 0.7 mm. longis; drupae ignotae. HOLOTYPUS: *Burger & Stolze 4898*, Field Museum 1682433; Isotypi: US, CR.

Small shrubs about 1.5 m. tall, the older nodes not conspicuously thickened, leafy internodes 3–16 cm. long, 2–8 mm. thick, minutely (0.1 mm.) puberulent with the stiff hairs in longitudinal rows; shoot-apex emerging from the sheathing leaf-base and free of the prophyll at flowering nodes, the prophyll about 1 mm. long, broadly triangular, hidden within the sheathing leaf-base. Leaves apparently distichous, petioles 3–8 cm. long, 2–7 mm. broad, with longitudinal rows of very short (0.1 mm.) hairs, deeply vaginate and with broad thin stipule-like margins in the lower half at all nodes; lamina 14–26 cm. long, 6–16 cm. broad, elliptic or oblong, tapering abruptly to the bluntly obtuse apex, somewhat narrowed below the middle and cordate to subcordate at the base, the basal lobes extending 5–22 mm. below the petiole attachment, equal or slightly unequal, sides of the lamina arising at about the same point on the petiole, the lamina drying stiffly chartaceous and grayish in color, smooth on both surfaces, glabrous above and minutely puberulent beneath, the 4 to 6 pairs of major secondary veins arising from the lower two-thirds of the midvein, the upper secondaries arising at angles of 15–30 degrees, arcuate-ascending, the major veins slightly raised above, prominent beneath. Inflorescence free of the leaf-base of the same node in early stages, pendulous or becoming so, about 11 cm. long; peduncles about 35 mm. long and 1 mm. thick, densely and minutely (0.1–0.2 mm.) puberulent, flowering portion about 5 mm. thick at anthesis, the flowers loosely crowded; floral bracts 1–1.5 mm. broad above, cupulate or U-shaped from above, with a dense margin of hairs about 0.2 mm. long and pellucid punctate upper surface, forming whitish bands around the spike in certain stages; anthers 0.6–0.7 mm. long, 0.4–0.6 mm. broad, the connective sometimes broadened at the base of the thecae and these divergent or parallel, dehiscing laterally; pistil conical at the apex to form a short (0.4 mm.) style with 3 divergent stigmas, the stigmas about 0.7 mm. long, minutely papillate-puberulent; fruit not seen.

Small plants of the very wet Caribbean slopes at around 1,000 m. elevation in the deep shade of the forest floor. The species is endemic and known from only two collections: *Skutch 3739*, vicinity of Vara Blanca, Heredia (*P. hebetatum* Trel. ined.) and *Burger & Stolze 4898*, Rio Hondura below La Palma, San Jose; flowering in May.

A very unusual species of small stature having oblong leaves with small often equal basal lobes, minute prophyll, and a long-pedunculate spike. The only close relationship appears to be with another unusual and isolated species: *P. sagittifolium*. Both possess relatively long anthers with conspicuous connectives and stylose pistils with very large stigmas (style-branches). The species are also similar in venation, pubescence, habit and lack of an apically developed prophyll. *Piper hebetifolium* is also related to the *P. obliquum* complex and *P. gibbosum* may actually be intermediate between the two.

Piper hispidum Swartz, Prodr. Veg. Ind. 15: 1788, typus in S vidi! *P. cartagoanum* C.DC., Linnaea 37:350. 1872, photo. *P. hirsutum* var. *tonduzii* C.DC., Bull. Soc. Bot. Belg. 30, pt. 1:203. 1891. *P. gonagricum* Trel., Contr. U. S. Nat. Herb. 26:171. 1929. *P. pejivallense* Trel., l.c. *P. genuflexum* Trel., l.c. 172. *P. pergeniculatum* Trel., l.c. 172. *P. pavasense* Trel., l.c. 173. *P. scalpens* Trel., l.c. 176. *P. caudatifolium* Trel., l.c. 177. *P. inhorrescens* Trel., l.c. 177. *P. torresanum* Trel., l.c. 177. *P. trichophlebium* Trel., l.c. 177. *P. valetudinari* Trel., l.c. 178. *P. carminis* Trel., l.c. 179. *P. coronatibracteum* Trel., l.c. 179. *P. baculiferum* Trel., l.c. 180. *P. punctiunculatum* Trel., l.c. 180. *P. albuginiferum* Trel., l.c. 181. *P. injucundum* var. *praecalvinervium* Trel., l.c. 181. *P. injucundum* var. *praepubinervium* Trel., l.c. 181. *P. lanatibracteum* Trel., l.c. 182. *P. lanosibracteum* Trel., l.c. 182. *P. phanerolepidum* Trel., l.c. 182. *P. pullibracteatum* Trel., l.c. 182. *P. curridabatanum* Trel. l.c. 183. *P. fusco-bracteatum* Trel. l.c. 183. *P. aquacalientis* Trel. in Standl., Field Mus. Bot. 18:330. 1937. *P. articulosum* Trel. in Standl., l.c. 332. *P. humoense* Trel. in Standl., l.c. 346. *P. subasperatum* Trel. in Standl., l.c. 362. Figure 13.

Shrubs 1–3 (4) m. tall, older nodes often conspicuously thickened, leafy internodes 1–12 (16) cm. long, 1–3.5 mm. thick, glabrous to densely crisp-puberulent, hispid, or hirsutulous, the whitish or yellowish straight or curved hairs 0.2–1 (1.5) mm. long; shoot-apex emerging from within the prophyll and partly enclosed by the leaf-base at flowering nodes, prophyll 6–18 mm. long, acute, puberulent along the midrib abaxially or occasionally glabrous, the glabrous margins drying brown. Leaves usually distichous, petioles 4–18 mm. long, 0.8–2 mm. thick, glabrous to densely puberulent, vaginate only at the base and with a small (0–3 mm.) ligule-like stipular development present at flowering nodes; laminae 7–18 (21) cm. long, 3–10 cm. broad, ovate to elliptic or oblong (obovate) usually broadest below the middle, tapering gradually or abruptly to the acuminate apex, obtuse or rounded at the unequal base, sides of the lamina 2–6 mm. distant on the petiole, the lamina drying thin to stiffly chartaceous, scabrous and glabrous or sparsely puberulent above, sparsely to densely puberulent on the veins beneath with stiff straight or curved hairs 0.2–1.3 mm. long, venation flat above or occasionally becoming impressed in old leaves, the 3 to 5 pairs of major secondary veins usually arising from the lower half of the midvein, sides of the lamina often unequal in area with the narrower side with fewer veins, upper secondaries arising at angles of 12–35 degrees and arcuate-ascending. Inflorescence free of the leaf-base of the same node in early stages but with a line or ridge beneath the peduncle, erect, 5–12 cm. long, peduncles 4–18 (22) mm. long, 0.8–2 mm. thick, glabrous or puberulent, flowering portion 2–3.5 mm. thick at anthesis, becoming 3–5 mm. thick in fruit, the flowers congested; floral bracts 0.3–0.6 mm. broad and rounded or triangular from above, usually glabrous centrally with a margin of dense hairs 0.1–0.3 mm. long, forming conspicuous bands around the spike in many stages; anthers about 0.2 mm. long, (0.2) 0.3–0.5 mm. broad, connective broadened at the base with the divergent

thecae dehiscing upward, often with the connective forming a minute (0.1 mm.) rounded tip at the apex; pistil obscured by bracts and anthers; fruit becoming laterally compressed, 0.5×1 mm. thick, truncate and sparsely to densely puberulent above, the 3 minute stigmas sessile in a slight depression (dry) on the fruit.

Plants of open or shaded sites between sea level and 2,000 m. elevation throughout Costa Rica but absent below 500 m. altitude on the Pacific slope; flowering material has been collected from November to August. This taxon represents a very difficult group of pipers probably extending throughout the range of the genus in this hemisphere.

Piper hispidum (as here defined) is recognized by the scabrous leaves glabrous or sparsely puberulent above, leaf-base forming a short ligule-like structure, erect spikes with conspicuously pubescent bracts, anthers opening upward, and laterally compressed fruit truncate and puberulent above. The anthers and fruit are important in distinguishing this species and its allies from species very similar in appearance but not as closely related, such as *P. dilatatum* and *P. colonense*. I do not include *P. santi-felicis* (*P. scabrum* Sw.) under this species as it differs in characters of the shoot-apex, ligulate stipule, leaf-form, and habitat.

Piper hispidum and its allies are taxonomically the most difficult group of pipers in Costa Rica. The use of pubescence, texture, and development of the ligulate leaf-base to distinguish species within this complex is dictated by the lack of other morphological distinctions but has resulted in grouping most of the specimens into homogeneous units with definite ecological limits. *Piper hispidum* should be considered as no more than a first approximation in treating a very difficult group of plants. For example, specimens placed here from the area near Zarcero are very similar to *P. austinii* and the latter may be no more than a very glabrous form of this species. Specimens placed in this species from near Tilaran exhibit characteristics of *P. chrysostachyum* and material from the wet montane forests of the Caribbean slopes is very difficult to separate from *P. bisasperatum*. *Piper capacibracteum* of the Sta. Maria de Dota area may be conspecific with this species, differing only in the pubescence of the upper leaf-surface and consistently large anthers. I am sure that this kind of variation is not restricted to Costa Rica and that these problems can only be solved with field work over a broad area. The basic question is whether we are dealing with many specific entities or a single polymorphic complex. I have attempted to take a middle road between recognizing many small populations as species, on the one hand, and throwing the whole mess into a single

basket, on the other. This middle road, however, has necessitated recognizing some small populations (*P. austinii, P. capacibracteum,* et al.) as well as creating something of a waste-basket (*P. hispidum* s.l.). The species accepted in this Flora that are most closely related to *P. hispidum* and may prove to be subspecific elements of *P. hispidum* (in a wider sense) are: *P. austinii, P. bisasperatum, P. biauritum, P. capacibracteum, P. epigynium, P. perhispidum, P. polytrichum, P. sancti-felicis, P. silvivagum,* and *P. villiramulum.* Hybridization may account for some of the difficulty in separating the elements of this complex. However, this brings up the same question in a different form: is this hybridization between species or is it hybridization between subspecific elements of a single polymorphic species?

Piper holdridgeianum W. Burger, n. sp. Figure 7.

Frutices 1–2 m. altis, ramuli amentiferi 1–4 mm. crassi, glabri vel minutissimi puberuli; apex surculi ex prophyllum ad nodum floriferum emergit, prophyllum 4–10 mm. longum glabrum hebetatum. Folia valde variabilia in eadem planta, glabra vel minutissima puberula, petiolis 8–15 (50) mm. longis vaginatis prope basin ad nodos floriferos; laminae ovatae, 10–22 cm. longae, 3.5–13 cm. latae, apicibus acuminatis, basibus truncatis vel cordatis, nerviis secondariis 2–4 utrinque. Inflorescentiae initio petiolorum ad eosdem nodos librae, erectae, 6–10 cm. longae, 1.5–3 mm. crassae, pedunculis 10–18 mm. longis, 0.6–1.3 mm. crassis, glabris, flores aggregati, bracteae apicibus 0.2–0.4 mm. latis, transverse triangularibus, antherae 0.2–0.3 mm. longae, 0.2–0.3 mm. latae, dehiscentes laterales; pistillum sine stylo, stigmatibus 3, 0.1–0.2 mm. longis; drupae 0.7–0.8 mm. crassae, rotundae vel trigonae vel tetragonae, glabrae. HOLOTYPUS: *Burger & Stolze 5776,* Field Museum 1682488; ISOTYPI: US, CR, BM.

Small, few-branched shrubs 1–2 m. tall, older nodes somewhat thickened, leafy internodes 2–10 cm. long, 1–4 mm. thick, glabrous or sparsely and very minutely (0.05 mm.) puberulent in early stages; shoot-apex emerging from within the prophyll and free of the leaf-base at flowering nodes, prophyll 4–10 mm. long, narrow and blunt apically, usually drying dark and difficult to distinguish from the young leaf, glabrous. Leaves usually distichous, petioles 8–15 mm. long at flowering nodes, becoming 5 cm. long at lower sterile nodes, 0.9–3 mm. broad, glabrous or very minutely (0.05 mm.) papillate-puberulent, vaginate in the lower part and with a minute ligule-like rim 0.2–0.6 mm. high at flowering nodes; laminae 10–22 cm. long, 3.5–13 cm. broad, ovate-lanceolate to broadly ovate and very variable on the same stem, acuminate at the apex, rounded and truncate to deeply cordate at the equal or subequal base, sides of the lamina arising together or 1–3 mm. distant on the petiole, the lamina drying thin-chartaceous and dark green above, smooth and glabrous above, glabrous or very minutely puberulent beneath and often with slender whitish hairs 0.3–1 mm. long at the base of the lamina and at the apex of the petiole (but these are only found on older leaves and do not appear

to be attached nor are they the characteristic multicellular hairs of other pipers), venation flat or slightly raised above, the 2 to 4 pairs of major secondary veins usually arising from the lower half of the midvein, upper secondaries arising at angles of 20–45 degrees and arcuate-ascending. Inflorescence free of the leaf-base of the same node in early stages, erect, 6–10 cm. long, peduncles 10–18 mm. long, 0.6–1.3 mm. thick, glabrous flowering portion about 1.5 mm. thick at anthesis, becoming 2–3 mm. thick in fruit, the flowers congested; floral bracts 0.2–0.4 mm. broad and rounded or somewhat triangular above, glabrous above with a margin of short (0.1 mm.) hairs, forming inconspicuous bands around the spike in certain stages; anthers 0.2–0.3 mm. long, 0.2–0.3 mm. broad, thecae divergent at the base but dehiscing laterally, forming an angle of about 60 degrees; pistil with 3 conspicuous (0.1–0.2 mm.) sessile stigmas; fruit round or 3- or 4-angled by compression, 0.7–0.8 mm. thick, glabrous, apparently succulent, truncate above (dry) and often with a depression around the sessile stigmas.

Plants of the deep shade of the very wet lowland Caribbean forest formations. This species is only known from the former "Finca La Selva" of Dr. Leslie Holdridge on the Rio Puerto Viejo near the confluence with the Rio Sarapiqui, Heredia. It has been collected in flower and fruit in January, March, and June (*Burger & Matta 4176*, *Raven 20999*, and *Burger & Stolze 5776*, respectively).

Piper holdridgeianum is recognized by the thin variable leaves (some cordate), generally glabrous parts, very slender erect spikes, small fruit with distinct stigmas, and deep forest habitat. The form of the glabrous prophyll and cordate leaves indicate a relationship with *P. grande* and its allies but the pistil is very different. The floral parts are very similar to those of *P. multiplinervium* and this may be the closest relative among Costa Rican pipers, though the prophyll is very different.

Piper imperiale (Miq.) C.DC. in D.C., Prodr. 16, pt. 1:339. 1869. *Artanthe imperialis* Miq. in Seem., Bot. Voy. Herald, 198. 1854. *Piper magnilimbum* C.DC., Bot. Gaz. 70:177. 1920. *P. escuadranum* Trel., Contr. U. S. Nat. Herb. 26:150. 1929. *P. aserrianum* Trel., l.c. 151. *P. cincinnatum* Trel., l.c. 151. *P. clavuliger* Trel., l.c. 151. *P. irrasum* Trel., l.c. 151. *P. palmanum* Trel., l.c. 151. *P. evasum* Trel., l.c. 155. *P. affectans* Trel. in Woodson & Schery, Ann. Mo. Bot. Gard. 27:287. 1940. *P. gigas* Trel. in Woodson & Schery, l.c. 292. 1940. Figure 5.

Shrubs or slender few-branched trees to 6 (rarely 10) m. tall, the older nodes conspicuously thickened, leafy internodes 4–15 cm. long, 4–14 mm. thick, glabrous or more often puberulent with small (0.2–0.6 mm.) brownish hairs, gland-like tubercles to 1.8 mm. long usually present beneath the nodes; shoot-apex emerging from within the sheathing leaf-base at all nodes, the prophyll lateral, 2–4 mm.

long and usually obscured by the sheathing leaf-base. Leaves usually distichous, petioles 3–12 cm. long, 4–12 mm. broad, puberulent or glabrescent and usually tuberculate, deeply vaginate and with thin adaxial margins at all nodes, clasping the stem at the base; lamina 20–60 cm. long, 15–35 cm. broad, elliptic to narrowly ovate or oblong, tapering gradually or abruptly to the obtuse to short-acuminate apex, usually unequally cordate at the base but varying from subequal to deeply cordate with the lower lobe much enlarged and overlapping the petiole, the lamina usually drying stiffly chartaceous and grayish-green above, smooth and glabrous above, minutely puberulent beneath, primary and secondary veins usually becoming impressed above, prominent beneath, the 4 to 7 pairs of major secondary veins arising in the lower two-thirds of the midvein, the upper secondaries arising at angles of 20–40 degrees and arcuate ascending. Inflorescence free of the leaf-base of the same node in early stages, pendulous, 15–55 cm. long; peduncles 1–3 (7) cm. long, 1.5–4 mm. thick, sparsely puberulent or glabrous, flowering portion 4–8 mm. thick at anthesis and becoming 15–20 mm. thick in fruit, the flowers crowded; floral bracts 0.7–1.5 mm. broad and triangular to rounded or cupulate from above, usually sparsely puberulent or with a fringe of minute (0.03–0.2 mm.) hairs, forming indistinct bands around the spike in early stages; anthers 0.3–0.6 mm. long and equally wide, borne on an articulated filament, the connective often broadened at the base and the thecae divergent with upward or lateral dehiscence; pistil stylose and glabrate; fruit round or angular by compression, truncate and with a short style or the 3 stigmas sessile, becoming 2 mm. thick.

Plants of moist evergreen forest formations between sea level and 2,000 m. elevation but most commonly found between 1,000 and 1,800 m. and flowering throughout the year; in Costa Rica and Panama.

One of the tree-like pipers of forest shade distinguished by the unusual tubercles on stems and leaves, very large stiff leaves, and sparsely puberulent floral bracts. *Piper imperiale* is part of a complex of taxa related to *P. obliquum* and may in fact be no more than an unusual form of that species. This alliance is extremely variable and the delimitation of species within it must be considered tentative; see the discussion under *P. obliquum*.

Piper jacquemontianum Kunth, Linnaea 13:631. 1839, ex char. *P. pilibaccum* C.DC., Bot. Gaz. 70:179. 1920. *P. uvitanum* C.DC., l.c. 182. *P. barbulatum* C.DC. ex Schroeder, Candollea 3:135. 1926. *P. orosianum* Trel., Contr. U. S. Nat. Herb. 26:143. 1929. *P. tabanicidum* Trel. l.c. 162. *P. aeruginosibaccum* Trel., Journ. Wash. Acad. Sci. 19:336. 1929. *P. dedititium* Trel., l.c. 331. *P. onerosum* Trel., l.c. 335. *P. vexans* Trel., l.c. 336. *P. catalinianum* Trel. in Standl., Field Mus. Bot. 18:335. 1937. *P. siquirresense* Trel. in Standl. l.c. 361. Figure 14.

Shrubs 2–3 m. tall, leafy internodes 1.5–11 cm. long, 1.2–4.5 mm. thick, minutely (0.1–0.4 mm.) puberulent or glabrous; shoot-apex emerging from within the

prophyll and free of the leaf-base at flowering nodes, the prophyll becoming 12–20 mm. long, acute, usually puberulent along the midrib (abaxially) with the glabrous margins drying dark brown. Leaves usually distichous, petioles 6–12 mm. long at flowering nodes, to 20 mm. at sterile nodes, about 1–2 mm. broad, deeply vaginate only near the base and with a minute (1 mm.) stipular development present or absent at flowering nodes, sparsely puberulent with hairs 0.2–0.8 (1.5) mm. long; laminae 12–23 cm. long, 4–10 cm. broad, broadly to narrowly ovate or elliptic, tapering gradually to the acuminate apex, narrowed to the obtuse and usually unequal base, sides of the lamina rounded at the very base and 1–4 mm. distant on the petiole, the lamina drying thin- to stiff-chartaceous, smooth and glabrous above, usually lustrous above, minutely (0.2–0.7 mm.) puberulent and somewhat rough to the touch beneath, major venation flat or somewhat elevated beneath, the 3 or 4 (5) pairs of major secondary veins usually arising from the lower two-thirds of the midvein, occasionally with the secondaries gradually diminishing in prominence in the upper third of the lamina, central secondaries arising at angles of 30–60 degrees and ascending near the margin, the upper secondaries usually 3–6 cm. distant on the same side of the midvein. Inflorescence free of the leaf-base of the same node in early stages, often articulate at the base and rarely subtended by scar-tissue, erect, 5–9 cm. long, peduncle 3–12 mm. long, 1–2 mm. thick, glabrous or minutely puberulent, flowering portion 2.5–4 mm. thick at anthesis, 4–6 mm. thick in fruit, the flowers tightly congested; floral bracts 0.5–1 mm. broad and U-shaped or broadly triangular, glabrous centrally and with a dense margin of short (0.1–0.2 mm.) yellowish hairs, not usually forming distinct bands around the spike; anthers 0.2–0.4 mm. long and about 0.4 mm. broad, connective broad at the base and the thecae often divergent, thecae dehiscing laterally or upward; pistil with 3 prominent stigmas about 0.2 mm. long; fruit 1–1.5 mm. long and 1–1.5 mm. thick, round or obpyramidal-trigonous by compression, truncate and densely yellowish puberulent above, the 3 glabrous stigmas often sessile in a slight apical depression (dried).

Plants of lower (0–1,000 m.) altitudes in both the wet Caribbean lowlands and the shade of partially deciduous forests of the Pacific slopes and Nicoya peninsula. The species ranges from southern Mexico to Costa Rica and on the West Indian islands of Puerto Rico and Haiti (as *P. citrifolium* auctores).

This species is recognized by the leaves usually lustrous and always smooth above, slightly scabrous beneath, lack of a well-developed stipule, and unusual fruit with a dense tomentum at the top. Closely related to an alliance of very similar species; see the discussion under *P. hispidum*. The use of the name *P. citrifolium* Lam. by Yuncker and Trelease (1950) is very different from that employed by various authorities in the West Indies and Central America. Plants I have placed in this species are conspecific with material from Puerto Rico and Haiti named as *P. citrifolium* but not with material under that name identified by Yuncker.

Piper lacunosum H.B.K., Nov. Gen. & Sp. 1:51. 1815. *P. pachystachyon* C.DC., Journ. Bot. 4:216, ex char. *P. irazuanum* C.DC., Linnaea 37:340. 1872. *P. luxii* C.DC. in Donn. Smith, Bot. Gaz. 19:5. 1894. *P. pesaresanum* C.DC., Engl. Bot. Jahrb. 40:247. 1908. *P. irazuanum* var. *suborbiculatum* Trel., Contr. U. S. Nat. Herb. 26:137. 1929. *P. tecutlanum* Trel. & Standl., Fieldiana, Bot. 24, pt. 3:328. 1952. Figure 7.

Shrubs or small trees to 7 m. tall, the older nodes somewhat thickened, leafy internodes 2–7 cm. long, 2–4 mm. thick, densely puberulent with brownish hairs 0.2–1 mm. long; shoot-apex emerging from within the prophyll and free of the leaf-base at flowering nodes, the prophyll becoming 2–3 cm. long and often developing before the spikes, with small (0.3 mm.) hairs along the midrib (abaxially) and glabrous edges which dry dark brown. Leaves usually distichous, petioles 6–14 mm. long, to 26 mm. long at lower sterile nodes, 1–3 mm. broad, densely puberulent with yellowish-brown hairs about 0.5 mm. long, vaginate and with scar tissue adaxially for 2–6 mm. above the base at flowering nodes (stipular development absent); laminae 10–19 cm. long, 4–9 (12) cm. wide, narrowly to broadly elliptic or ovate, tapering to the acute or obtuse apex, obtuse or somewhat rounded at the unequal base, sides of the lamina 2–5 mm. distant on the petiole, the lamina drying stiffly chartaceous and usually dark in color (the older leaves paler), upper surface conspicuously rugose-bullate but not scabrous, all the veins deeply impressed above or becoming so, the raised reticulum glabrous but the major veins puberulent above, the bullae about 1–2 mm. broad, lower surface crisp-hairy with hairs to 1 mm. long, the 5 to 10 pairs of major secondary veins arising throughout the length of the midvein, central secondaries arising at angles of 20–50 degrees, all the veins prominent below forming a raised reticulum with small (0.5–3 mm.) lacunae. Inflorescence free of the leaf-base of the same node and apparently articulate at the base, erect or pendant in fruit, 4–14 cm. long, peduncle 8–22 mm. long, 2–3 mm. thick, densely crisp-hairy with brownish hairs 0.2–0.6 mm. long, flowering portion 5–7 mm. thick at anthesis and becoming 1 cm. thick in fruit, occasionally with a slender tip, the flowers crowded; floral bracts 0.3–0.5 mm. broad and liguliform or triangular above, sparsely puberulent, not forming bands around the spike; anthers 0.6–0.9 mm. long, about 0.5 mm. broad, connective broadened near the base and forming a distinct dark tip above the thecae, dehiscence lateral, the filaments prominent, 0.5–1 mm. long; pistil with a distinct (0.5 mm.) style and 3 recurved stigmas but often difficult to distinguish among the bracts and filaments; fruit about 1.3 mm. thick, round in cross-section and with a persistent style, glabrous, apparently fleshy and drying dark.

Plants of wet evergreen montane forest formations between (1,400) 1,800 and 3,000 m. elevation. Probably flowering throughout the year. The species ranges from northern Guatemala (southern Mexico?) to Peru, always at higher altitudes.

The deeply rugose but smooth leaves, thick spikes with stylose pistils and large anthers, and highland habitat distinguish this species from all other Costa Rican pipers. *Piper bredemeyeri* is another highland piper with rugose leaves but these are scabrous and the

spikes are very different. *Piper lacunosum* is quite variable in the number of secondary veins, leaf-shape, and length of spikes but very uniform in leaf-texture and floral characters. While our material differs slightly from Peruvian collections, I have no doubt that these are part of a single species. The species is also distinctive for combining a highly developed apical prophyll with floral morphology that I consider primitive.

Piper lanceaefolium H.B.K., Nov. Gen. & Sp. 1:49. 1815. *P. pseudolanceaefolium* Trel., Contr. U. S. Nat. Herb. 26:170. 1929. *P. liratinerve* Trel. in Woodson & Seibert, Ann. Mo. Bot. Gard. 24: 186. 1937. Figure 11.

Shrubs or occasionally small trees 1.5–4 (6) m. tall, the older nodes somewhat thickened, leafy internodes 2.5–8 (10) cm. long, 1.5–6 mm. thick, densely to sparsely puberulent with pale colored hairs 0.3–0.7 mm. long, often marked with red or purple in living material; shoot-apex emerging from within the prophyll and free of the leaf-base at flowering nodes, the prophyll becoming 2–4 cm. long, acute, whitish puberulent along the midrib abaxially, the usually glabrous margins drying brown. Leaves usually distichous and often uniformly spaced along the stems, petioles 4–12 (18) mm. long, 1.2–3 mm. broad, densely tomentulous with whitish hairs about 0.5 mm. long, deeply vaginate for about half the length and with thin adaxial margins united apically to form a small (1×7 mm.) stipule-like structure at flowering nodes, the stipule often deciduous and leaving a rim of scar tissue on the petiole; laminae 12–23 cm. long, 4–9 cm. broad, very narrowly ovate to elliptic or ovate-lanceolate, tapering very gradually to the long-acuminate apex, usually narrowed below the middle and acute to rounded and cordulate at the unequal base, sides of the lamina 0–3 mm. distant on the petiole, the lower side occasionally forming a small lobe 3–8 mm. long and overlapping the petiole slightly, the lamina drying thin- to stiff-chartaceous, both surfaces smooth to the touch, sparsely and minutely puberulent on the veins above, with short (0.3–0.6 mm.) stiff hairs on the veins beneath, primary and secondary (and occasionally tertiary) veins becoming impressed in age, the primary, secondary, and tertiary veins prominent beneath and forming a conspicuous reticulum on older leaves (upper surface becoming bullate in some), the 5 to 7 pairs of major secondary veins usually arising from the lower half of the midvein, arcuate-ascending, upper secondaries arising at angles of 5–25 degrees, tertiary veins subparallel. Inflorescence free of the leaf-base of the same node in early stages but articulate at the base and subtended by a ridge with longer hairs, peduncle erect but the spike becoming curved, 6–18 cm. long, peduncle 15–38 mm. long, 0.8–1.7 mm. thick, sparsely to densely puberulent with hairs 0.1–0.4 mm. long, flowering portion about 3 mm. thick, at anthesis and 4 mm. thick in fruit, the flowers tightly congested; floral bracts 0.5–1 mm. broad and triangular above, glabrous centrally and with a dense margin of whitish hairs 0.2–0.5 mm. long, forming bands around the spike in later stages; anthers 0.2–0.3 mm. long, about 0.2 mm. broad, dehiscing laterally; pistil with 3 slender stigmas about 0.2 mm. long; fruit about 0.9 mm. long and 0.7 mm. thick, obpyrami-

dal-trigonous or rounded, usually tightly congested, glabrous, truncate apically with the sessile or slightly elevated stigmas breaking off.

Plants of open or partly shaded sites in regions of wet evergreen montane forest formations between 1,200 and 2,800 m. elevation (rarely lower); flowering throughout the year. In Costa Rica the species is known only from the Caribbean side of the Meseta Central and in the Cordillera de Talamanca. The species ranges southward to Colombia and Ecuador.

A piper with unusual leaves that are smooth in texture and have subparallel secondary veins becoming impressed above with prominent tertiary veins beneath. The arched whitish spikes and long peduncles further distinguish the species. *Piper lanceaefolium* is closely related to *P. friedrichsthalii* but the latter has shorter peduncles, lacks a stipule, and is common at lower altitudes. *Piper aduncum* with the leaves scabrous above and less prominent venation is also closely related; these three species form a natural group characterized by the curved spikes. Plants of northern South America placed in this species differ from our material in venation and lobing of the lamina-base. It may be that the populations of Costa Rica and Panama are worthy of subspecific rank.

Piper littorale C.DC., Anal. Inst. Fis.-Geog. Costa Rica 9:165. 1897. *P. maternale* Trel. in Standl., Field Mus. Bot. 18:349. 1937. *P. subcaudatum* var. *maternale* (Trel.) Yuncker, Ann. Mo. Bot. Gard. 37:59. 1950. Figure 10.

Shrubs 1–2 m. tall, the older nodes slightly thickened, leafy internodes 1.5–9 cm. long, 1–5 mm. thick, with short (0.2–0.5 mm.) hairs in longitudinal rows, becoming glabrescent in age; shoot-apex emerging from within the prophyll and free of the leaf-base at flowering nodes, prophyll 5–10 mm. long, acute, densely puberulent along the back of the midrib with the glabrous margins drying dark brown. Leaves usually distichous, petioles 3–7 mm. long, 1–2 mm. broad, vaginate and with scar tissue only at the base at flowering nodes, densely short (0.2–0.5 mm.) puberulent on longitudinal ridges, a minute (0.5–1.2 mm.) stipular development present at flowering nodes but caducous; lamina (5.5) 7–15 cm. long, 2–6 cm. broad, narrowly ovate to elliptic, the apex acuminate, narrowed to the obtuse and unequal base, often cordulate on the longer side with a lobe 0–5 mm. long that may occasionally overlap the petiole, sides of the lamina 0–4 mm. distant on the petiole, the lamina drying thin to stiffly chartaceous, smooth and glabrous above, minutely (0.2–0.5 mm.) puberulent on the veins beneath, venation prominulous above and below, the 3 or 4 pairs of major secondary veins usually arising from the lower two-thirds of the midvein, central secondaries arising at angles of 30–50 degrees and ascending near the margin. Inflorescence free of the leaf-base of the same nodes in early stages but subtended by a ridge of tissue continuous with the leaf-base, erect, 4–8 cm. long, peduncle 6–12 mm. long, 0.8–1.6 mm. thick, glabrous or with

longitudinal rows of minute yellowish hairs, flowering portion 2–3 mm. thick at anthesis, becoming 4–5.5 mm. thick in fruit, the flowers tightly congested; floral bracts 0.5–0.6 mm. broad, triangular from above, glabrous centrally with a dense margin of yellowish hairs 0.1–0.3 mm. long, not forming bands around the spike; anthers about 0.2 mm. long, 0.2–0.3 mm. broad, with a small gland-like apex on the connective, thecae dehiscing laterally; pistil glabrous with 3 small sessile stigmas; fruit becoming 0.7–0.9 mm. thick (dry), obpyramidal-trigonous by compression, truncate apically with a depression around the sessile stigmas, glabrous and dark pellucid verrucose.

Plants of the Caribbean coast; known only from the area between Limon and Bocas del Toro, Panama. The species is apparently limited to areas close to the coast and a number of collections are actually from the sea shore.

This species resembles many other pipers in general form but may be distinguished by the relatively small leaves, smooth and glabrous above and often unequally cordulate at the base, hairs usually in longitudinal rows, short compact spikes, gland-tipped anthers, glabrous truncate fruit, and puberulent prophyll. This is the only species of *Piper* in Costa Rica known to inhabit the sea shore. *Piper panamense* C.DC. and *P. jaquemontianum*, both with puberulent fruit, appear to be closely related to this species.

Piper marginatum Jacq., Icon. Pl. Rar. 2:2, pl. 215. 1786. *P. patulum* Bertol., Fl. Guat. 407, pl. 36. 1840. *P. san-joseanum* C.DC., Linnaea 37:351. 1872. *P. uncatum* Trel., Journ. Wash. Acad. Sci. 13:367. 1923. *P. san-joseanum* var. *minor* Trel., Contr. U. S. Nat. Herb. 26:133. 1929. Figure 3.

Small shrubs to 3 m. tall, the older nodes slightly thickened, leafy internodes 3–14 cm. long, 1–3 (5) mm. thick, glabrous and minutely ridged longitudinally (dry); shoot-apex at first enclosed within the leaf-base of the same node at all nodes, the prophyll small (2 mm.) and glabrous, open and not enclosing the shoot-apex at flowering nodes. Leaves distichous or in a spiral, petioles 3–5 cm. long but longer (10 cm.) at sterile nodes, 2–5 mm. broad, glabrous or minutely puberulent near the lamina, deeply vaginate and with thin winged margins or the margins tearing off to produce scar tissue at all nodes; lamina 8–18 (28) cm. long, 5–13 (24) cm. broad, broadly ovate and tapering gradually to the short-acuminate apex, rounded and truncate to deeply cordate at the base, essentially equal and with the sides of the blade arising together from the apex of the petiole, drying membranaceous to thin-chartaceous, smooth on both surfaces, sparsely and minutely puberulent on the veins above and at the base or glabrous on both surfaces but densely and minutely (0.1–0.3 mm.) ciliolate along the edge, venation palmate with 7 to 13 primary veins, slightly raised above and more prominent below, the 3 central veins united within 2–6 (18) mm. of the petiole and these reaching the apex of the blade. Inflorescence free of the leaf-base of the same node in early stages, erect at first but

becoming arched over or pendulous, slender and whitish in early stages, 10–25 cm. long; peduncle 5–12 (20) mm. long, 0.7–1.8 mm. thick, glabrous, flowering portion becoming 18 cm. long, only 2–3 mm. thick at anthesis and not exceeding 4 mm. in fruit, flowering parts densely crowded and not usually forming bands around the spike; floral bracts triangular or rounded above, about 0.5 mm. broad and with a dense margin of minute (0.1–0.2 mm.) hairs and glabrous center; anthers 0.3–0.4 mm. long, dehiscing laterally; pistil with sessile poorly differentiated stigmas; fruit densely crowded, 0.4–0.7 mm. thick, glabrous, stigmas sessile.

A widespread species confined in Costa Rica to the seasonally dry Pacific slopes from sea level to 1,200 m. elevation. Found only in moist situations in the areas of deciduous dry forest but common in weedy habitats of the moist forest regions; flowering throughout the year. The species ranges from Guatemala to Ecuador, Brazil, and the West Indies.

Recognized by the palmate venation with as many as 13 major veins, shoot-apex from within the leaf-base at flowering nodes, slender whitish spikes, and the dense margin of minute hairs along the edge of the lamina. These hairs together with the nature of the shoot apex, bracts, and flowering parts indicate, I believe, a close relationship with *Piper auritum*. Both species produce a characteristic sasparilla- or anise-like odor when the vegetative parts are crushed. Compare also with *P. multiplinerivum*.

Piper maxonii C.DC., Smiths. Misc. Coll. 71, no. 6:16. 1920. *P. pulchrum* var. *costaricense* C.DC., Bull. Bot. Soc. Belg. 29, pt. 2: 270. 1890. *P. pulchrum* var. *copeyanum* C.DC., Bot. Gaz. 70: 189. 1920. *P. copeyanum* (C.DC.) Trel., Contr. U. S. Nat. Herb. 26: 149. 1929. *P. varium* Trel., Ann. Mo. Bot. Gard. 27:299. 1940. *P. whiteae* Trel., l.c. 1940. *P. maxonii* var. *varium* (Trel.) Yuncker, Ann. Mo. Bot. Gard. 37:71. 1950. Figure 2.

Shrubs or trees to 10 m. tall, the older nodes slightly thickened, leafy internodes 3–15 cm. long, 2–6 mm. thick, glabrous or puberulent with short (0.2–0.6 mm.) yellowish-brown hairs; shoot-apex emerging from within the sheathing leaf-base at all nodes, the prophyll lateral, about 2 mm. long and usually obscured by the leaf-base. Leaves usually distichous and mostly peltate, petioles 3–7 cm. long, 2–6 mm. broad, minutely brownish puberulent or glabrous, deeply vaginate and with thin adaxial margins at all nodes, the stipule-like margins usually becoming torn and clasping the stem at the base; lamina 15–35 cm. long, 8–20 cm. broad, ovate to elliptic in outline, acute or short-acuminate at the apex, usually peltate or subpeltate but occasionally with the sides of the lamina separate at the petiole attachment, unequally retuse or truncate or rarely rounded at the base, the lamina drying chartaceous, smooth and usually glabrous above, minutely (0.1–0.5 mm.) brownish puberulent beneath or occasionally glabrous, the 4 or 5 pairs of major secondary veins usually arising in the lower half of the midvein (lower two-thirds

of the lamina), upper secondaries arising at angles of 20–40 degrees, arcuate ascending. Inflorescence free of the leaf-base of the same node in early stages, pendulous, 8–28 cm. long; peduncles 1.5–3.5 cm. long, 1–3 mm. thick at anthesis, densely puberulent or occasionally glabrous, flowering portion 3.5–7 mm. thick at anthesis, the flowers crowded; floral bracts about 0.5–1 mm. broad and round in outline from above, minutely (0.2–0.5 mm.) puberulent but occasionally glabrous in the center or below (from above); forming bands around the spike in early stages; anthers 0.3–0.4 mm. long and 0.4–0.5 mm. broad, often on conspicuous filaments, the connective broad at the base and the thecae divergent with lateral or upward dehiscence, the edges of the open thecae forming angles of 60–120 degrees, the yellowish apical portion of the stamen about 0.8 mm. long and articulate on the darker basal part of the filament; pistil with 3 slender stigmas; fruit becoming 2 mm. thick, truncate at the apex and glabrous or very minutely (0.05 mm.) puberulent, stigmas sessile, up to 0.8 mm. long (the fruit apparently stylose).

Plants of evergreen montane forests between 1,000 and 2,200 m. altitude but commonest between 1,600 and 1,900 m. Collected around the Central Highlands in Costa Rica and in Chiriqui, Panama.

One of the large-leaved tree-like pipers distinguished by the usually peltate foliage. This species is closely related to *P. fimbriulatum* and is part of a complex of species allied to *P. obliquum*. These pipers exhibit extraordinary morphological variability and the species described here must be considered tentative; see the discussion under *P. obliquum*.

Piper melanocladum C.DC., Bot. Gaz. 70:176. 1920. Figure 6.

Small or slender shrubs to 1.6 m. tall, the older nodes not conspicuously thickened, leafy internodes 2–7 cm. long, 1.5–4 mm. thick, glabrous and longitudinally striate on drying; shoot-apex emerging from the leaf-base and free of the prophyll at flowering nodes, the prophyll small (2.5 mm.) and lateral, often hidden within the leaf-base. Leaves usually distichous, petioles 12–26 mm. long, 2–6 mm. broad, glabrous or sparsely and minutely (0.1 mm.) puberulent, deeply vaginate at all nodes and with broad thin adaxial margins, the stipule-like margins sometimes produced beyond the apex of the petiole to form a ligule-like structure; lamina 14–26 (32) cm. long, 4–9 cm. broad, lanceolate to very narrowly ovate, tapering very gradually to the acute or acuminate apex, tapering abruptly to the obtuse or somewhat rounded and unequal base, sides of the lamina 1–6 mm. distant on the petiole, the lamina drying stiffly chartaceous and grayish in color, upper surface smooth and glabrous, lower surface glabrous or sparsely and very minutely (0.05 mm.) puberulent, the 2 or 3 (4) pairs of major secondary veins arising from the lower two-thirds of the midvein, the upper secondaries arising at angles of 20–40 degrees and arcuate-ascending, often forming a submarginal vein in the upper fourth of the lamina, the major veins usually impressed above, prominent beneath. Inflorescence free or only partly enclosed by the sheathing leaf-base of the same node in early stages, pendulous, 6–14 cm. long; peduncle 11–22 mm. long, about 0.7 mm. thick, glabrous or sparsely and very minutely puberulent, flowering portion 3–4 mm. thick in fruit, the flowers crowded; floral bracts 0.7–1.1 mm. broad

and cupulate or U-shaped from above, sparsely and very minutely (0.05–0.1 mm.) puberulent or glabrous above, not forming conspicuous bands around the spike; anthers about 0.4 mm. long and 0.4 mm. broad, the connective somewhat broadened at the base and the thecae slightly divergent but dehiscing laterally (the stamens not seen in early anthesis); pistil with 3 sessile stigmas, the stigmas about 0.4 mm. long and 0.2 mm. thick; fruit laterally compressed but becoming round in maturity, about 2 mm. thick, truncate at the apex with sessile stigmas, glabrous.

Small plants of the wet forest floor in the Caribbean watershed between sea level and 1,000 m. elevation. The species has only been collected in Nicaragua and Costa Rica: *Englesing 186,* Braggman's Bluff, Nicaragua; *Pittier/Tonduz 9390,* Talamanca valley, and *13148,* Tucurrique; *Standley & Valerio 47139* near Limon, and *48658* near Pejivalle, Cartago; *Burger & Stolze 5915,* near the Rio Puerto Viejo, Heredia.

These small plants are recognized by the semi-succulent lanceolate leaves with only three or four pairs of major secondary veins, lack of an apically developed prophyll, and slender pendulous spikes. *Piper melanocladum* is very closely related to *P. aereum* but the latter differs in larger habit with shorter internodes, petiolar margins that tear off to produce rims of scar tissue, and thicker spikes on thicker peduncles. Together with *P. gibbosum,* these three species (rare in collections) form a group intermediate between two alliances represented by *P. imperiale* and *P. arboreum,* respectively.

Piper multiplinervium C.DC., Journ. Bot. 4:214. 1866. *P. aragonense* Trel., Contr. U. S. Nat. Herb. 26:146. 1929. *P. perpuberulum* Trel., l.c. Figure 3.

Small shrubs or climbers, less than 2 m. tall, stems drying dark with slightly thickened nodes, leafy internodes 2.5–6 cm. long, 1–3.5 mm. thick, glabrous or minutely (0.05–1 mm.) puberulent; shoot-apex emerging from within the sheathing leaf-base at flowering nodes, the prophyll minute (1 mm.) and leaving a small ridge of scar tissue above the leaf-base on one side of the flowering node. Leaves distichous or in a spiral, petioles 1.5–3 cm. long, 1–2 mm. thick, glabrous or minutely puberulent, deeply vaginate and with thin stipule-like margins that tear off to produce 2 long adaxial margins of scar tissue at all nodes; lamina 8–16 cm. long, 5–11 cm. broad, ovate and tapering to the caudate-acuminate or short-acuminate apex, rounded at the truncate to somewhat cordate base, the basal lobes equal or slightly unequal, sides of the blade attached about 1–2 mm. distant on the petiole, the lower leaves often more cordate than those near the apex, drying thin-chartaceous and usually dark in color, smooth on both surfaces, glabrous above, glabrous or very minutely puberulent on the veins beneath, venation palmate but the midvein with a pair of prominent secondary veins and appearing plinerved, the 3 or 5 major primary veins impressed or prominulous above, the secondaries arising at angles of 20–45 degrees from the lower half of the midvein.

Inflorescence free of the leaf-base of the same node in early stages, apparently erect in early stages but becoming arched, 10–18 cm. long; peduncle 1–2 cm. long, 1–1.5 mm. thick, glabrous or sparsely and very minutely (0.05–0.1 mm.) puberulent, flowering portion slender and pale-colored in early stages, less than 4 mm. thick in fruit; floral bracts about 0.5 mm. broad above, round or triangular in outline with a dense margin of minute (0.1 mm.) pale-colored hairs, forming bands around the spike in early stages; anthers 0.1–0.2 mm. long and 0.3–0.4 mm. broad, dehiscing toward their apex; pistil with 3 (4) sessile but clearly differentiated stigmas; fruit laterally compressed in early stages, becoming round or angular by compression in maturity, 1–1.4 mm. thick, glabrous, the stigmas sessile or in a slight depression on the flattened apex of the dry fruit.

Rarely collected plants in Costa Rica and known only from the following locations: Golfito, La Verbena near San Jose, near Turrialba, Tucurrique, and near Siquerres. Apparently restricted to relatively moist situations below 1,200 m. altitude and flowering from September to November. The species is only known from Costa Rica and Colombia.

A very unusual species with palmately veined leaves, the shoot-apex included in the leaf-base at flowering nodes, and semi-scandent habit. Similar to and perhaps related to *P. marginatum* but the latter has many more primary veins and the midvein lacks secondaries and stamens and fruit are quite different. *P. multiplinervium* appears to have no close relationship with any other Costa Rican piper; the leaves look very much like those of *Piper nigrum*.

Piper nemorense C.DC., Bull. Bot. Soc. Belg. 30, pt. 1:222. 1891. *P. corrugatum* O.Ktze., Rev. Gen. 2:565. 1891. *P. tsakianum* C.DC., Anal. Inst. Fis.-Geog. Costa Rica 9:174. 1899. Figure 9.

Slender-stemmed shrubs to 2 (3) m. tall, the older nodes conspicuously thickened, leafy internodes (3) 5–14 cm. long, 2–5 mm. thick, glabrous; shoot-apex emerging from within the prophyll and free of the leaf-base at flowering nodes, the prophyll becoming 5 cm. long, glabrous and usually blunt or asymmetric at the tip. Leaves usually distichous, petioles 2–7 (10) cm. long and 1.5–3 mm. broad, at flowering nodes, glabrous or puberulent with hairs 0.1–0.6 mm. long, grooved adaxially with scar tissue only at the base and a stipule-like development absent at flowering nodes, petioles of the lower sterile nodes longer and deeply vaginate with winged margins in the lower half; lamina 14–35 cm. long, 8–18 (22) cm. broad, narrowly ovate or rarely broadly ovate, tapering very gradually to the acuminate apex, rounded and unequally or subequally cordate or subcordate at the base, sides of the lamina arising together at the petiole and thickened at the base, the lamina drying thin- to thick-chartaceous, smooth and glabrate above, glabrous or more often minutely (0.1–0.6 mm.) puberulent on the veins beneath, the primary and secondary veins usually deeply impressed above and very prominent beneath, the tertiary veins occasionally impressed above and the surface

rugose, the 3 to 6 pairs of major secondary veins usually arising from the lower half of the midvein, upper secondaries arising at angles of 25–50 degrees and arcuate ascending, tertiary veins often subparallel between the secondaries and prominent beneath. Inflorescence free of the leaf-base of the same node and erect in early stages, 9–16 (22) cm. long, peduncle 6–16 (24) mm. long, 1–3 mm. thick, glabrous or sparsely and minutely puberulent, flowering portion 2–4 mm. thick at anthesis, becoming 5–7 mm. thick in fruit, the flowers congested; floral bracts about 0.3 mm. broad, rhombic to triangular and convex above, glabrous in the center and minutely ciliolate beneath, not forming bands around the spikes and often difficult to distinguish from the top of the pistils; anthers 0.1–0.3 mm. long, about 0.2 mm. broad, thecae dehiscing laterally; pistils with 2 or 3 sessile poorly differentiated stigmas; fruit about 0.8 mm. thick and 1.2 mm. long, obpyramidal-trigonous by compression, truncate and often with a cap-like apex, glabrous.

Plants of deep shade in wet forest formations between sea level and 1,200 m. elevation. Endemic to Costa Rica and known only from the Caribbean slopes and the adjacent highlands; flowering from March to August.

These plants are readily recognized by the narrowly ovate leaves unequally cordate at the base with the veins deeply impressed above. The plants placed here may prove to be no more than an unusual form of *P. carrilloanum* but those I have seen in the field (La Hondura below La Palma) were a rather uniform population. *Piper nemorense* together with *P. carilloanum* and *P. grande* make up a closely related trio; see the discussions under those species and compare *P. riparense*.

Piper nudifolium C.DC., Bull. Soc. Bot. Belg. 30, pt. 1:205. 1891. *P. labeculatum* Trel., Contr. U. S. Nat. Herb. 26:139. 1929. *P. esquivelanum* Trel., l.c. 161. *P. sandaloense* Trel. in Standl., Field Mus. Bot. 18:359. 1937. *P. sesquimetrale* Trel. in Standl., l.c. 360. *P. silencioi* Trel. in Standl., l.c. 360. *P. terronesense* Trel. in Standl., l.c. 365. *P. macropunctatum* Yuncker, Ann. Mo. Bot. Gard. 38:10. 1950. Figure 8.

Herbs or subshrubs to 1.5 m. tall, the older nodes somewhat thickened, leafy internodes 3–7 (12) cm. long, 2–4 mm. thick, glabrous and with conspicuous pellucid dots; shoot-apex emerging from within the prophyll and free of the leaf-base at flowering nodes, the prophyll 8–20 (40) mm. long, glabrous or minutely (0.1 mm.) puberulent on the abaxial surface, usually with conspicuous pellucid dots. Leaves usually in a spiral, petiole 8–25 mm. long but becoming 55 mm. long at lower sterile nodes, about 2 mm. broad and deeply grooved adaxially (vaginate only at the base) at flowering nodes, glabrous or sparsely and minutely puberulent, punctate, the petioles deeply vaginate with thin stipule-like margins continuous with the lamina at sterile nodes; lamina 12–23 cm. long, 6–15 cm. broad, broadly

ovate to elliptic, tapering gradually to the acute or subacuminate apex, rounded at the obtuse to truncate equal or subequal base, semi-succulent but drying thin-chartaceous, smooth and glabrous above and below or rarely sparsely and minutely (0.1 mm.) puberulent on the veins beneath, pellucid dots present and especially conspicuous (0.05–0.1 mm.) on younger parts, the 3 or 4 pairs of major secondary veins usually arising from the lower half of the midvein, upper secondaries arising at angles of 20–40 degrees, arcuate ascending. Inflorescence free of the leaf-base of the same node in early stages, erect, 2–9 cm. long, peduncles 5–12 mm. long, 0.8–2 mm. thick, glabrous or minutely puberulent, flowering portion 1.8–3 mm. thick at anthesis, becoming 4–6 mm. thick in fruit, the flowers loosely crowded; floral bracts 0.3–0.5 mm. broad and usually triangular from above, glabrous, not forming bands around the spike; anthers 0.2–0.3 mm. long and about 0.2 mm. broad, the connective pellucid glandular at the apex, thecae dehiscing laterally; pistil conical at the apex with a short (0.2–0.3 mm.) style and usually 3 stigmas, glabrous; fruit round or trigonous by compression, conical and short stylose at the apex, often with conspicuous (0.05–0.1 mm.) orange pellucid dots.

Small plants growing in the deep shade of wet evergreen forests from sea level to 1,200 m. elevation on both Caribbean and Pacific slopes in Costa Rica. The species ranges from eastern Nicaragua to Darien, Panama and probably adjacent Colombia.

A very unusual species distinguished by its small stature, pellucid dots that are very conspicuous on dried younger parts, conical pistil, glandular connective, and by the usual absence of hairs. The form of pistil and anthers indicates a relationship with *P. phytolaccaefolium*. Despite the form of the leaves and their venation (very similar to many other species), *P. nudifolium* is not readily confused with any other Costa Rican piper.

Piper oblanceolatum Trel., Contr. U. S. Nat. Herb. 26:175. 1929. Figure 14.

Shrubs or small trees with multiple trunks and diffuse branching 3–10 m. tall, older nodes conspicuously thickened, leafy internodes 1–5 cm. long, 1–3 mm. thick, with yellowish hairs 0.5–1 mm. long at the young nodes, internodes usually glabrous; shoot-apex emerging from within the prophyll and free of the leaf-base at flowering nodes, prophyll 10–22 mm. long, acute, puberulent along the back of the midrib, drying dark brown. Leaves usually distichous, petiole 2–8 mm. long, 0.8–1.4 mm. thick, glabrous or with slender hairs 0.5–1.5 mm. long, vaginate only at the base and a very small (0.5 mm.) ciliate ligule-like development present or absent at flowering nodes; laminae 10–18 cm. long, 3–6 cm. broad, very narrowly elliptic to oblanceolate, tapering gradually to the long-acuminate apex, narrowed below to the unequally cuneate or obtuse base, sides of the lamina 1–5 mm. distant on the petiole, the lamina drying thin-chartaceous and dark in color, smooth or very slightly scabrous on either surface, minutely (0.1–0.3 mm.) puberulent above with the hairs evenly spaced, longer (0.2–0.4 mm.) whitish appressed hairs on the veins beneath, the venation flat above, the 3 to 5 pairs of major secondary veins arising from the lower half of the midvein, the upper secondaries arising at angles

of 10–25 degrees, arcuate ascending. Inflorescence free of the leaf-base of the same node in early stages, erect, 5–10 cm. long, peduncles 14–24 mm. long, 0.8–2 mm. thick, sparsely hirsutulous or glabrescent, flowering portion about 3 mm. thick at anthesis and 4 mm. thick in fruit, the flowers congested; floral bracts 0.4–0.6 mm. broad and narrowly triangular above, glabrous above with proximal cilia 0.1–0.3 mm. long, forming bands (together with the anthers) around the spike; anthers about 0.2 mm. long and 0.4 mm. broad, connective broadened basally and the divergent anthers dehiscing partly upward; pistils obscured by anthers and bracts, stigmas 0.1–0.3 mm. long; fruit about 0.5×0.3 mm. thick above, laterally compressed and tetragonous, truncate above with a slight depression around the sessile stigmas (dry), glabrous.

Plants of the shade of wet forests between 600 and 2,000 m. elevation, mostly in areas subject to the moist winds from the Caribbean. The species is only known from the area between Tilaran, Guanacaste and Orosi, Cartago.

This species is recognized by the tall habit, thin oblanceolate leaves with minute hairs above, floral bracts with obscure cilia, thecae divergent at an angle of about 90 degrees, large stigmas, and glabrous fruit. *Piper oblanceolatum* is closely related to *P. colonenese* with thicker leaves, pubescent floral bracts, and unusual petioles. Both species can be confused with smooth-leaved members of the *P. hispidum* complex.

Piper obliquum Ruiz & Pavon, Fl. Peruv. & Chil. 1:37, pl. 63. 1798. *P. subfuscum* C.DC., Journ. Bot. 4:217. 1866, photo. *P. ceibense* C.DC., Anal. Inst. Fis.-Geog. Costa Rica 9:163. 1897. *P. glabrifolium* C.DC., l.c., photo. *P. pseudo-glabrifolium* Trel., Contr. U. S. Nat. Herb. 26:150. 1929. *P. formicitolerans* Trel. in Standl., Field Mus. Bot. 18:343. 1937. *P. nemori-marginis* Trel. in Standl., l.c. 350. *P. tardans* Trel. in Woodson & Schery, Ann. Mo. Bot. Gard. 27:298. 1940. Figure 5.

Shrubs or slender few-branched trees to 8 m. tall, the older nodes somewhat thickened, leafy internodes 4–12 cm. long, 3–9 mm. thick, usually puberulent with short (0.3–1 mm.) yellowish-brown hairs, rarely with very short (0.3 mm.) tubercles at the nodes; shoot-apex emerging from within the sheathing leaf-base at all nodes, the prophyll lateral, about 2 mm. long and 4 mm. broad and glabrous on the upper part, usually obscured by the leaf-base. Leaves usually distichous, petioles 4–9 cm. long, 3–10 mm. broad, densely brownish puberulent, deeply vaginate and with thin adaxial margins at all nodes, clasping the stem at the base; lamina 20–45 cm. long, 12–26 cm. broad, narrowly ovate to oblong, usually short-acuminate at the apex, unequally cordate, the lower lobe 4–10 cm. long (measured from the petiole attachment) and occasionally overlapping the petiole, the sides of the lamina 4–16 mm. distant on the petiole, the lamina drying thin- to stiff-chartaceous and often grayish above, smooth and glabrous on the upper surface,

usually densely puberulent on the veins beneath with scattered hairs between the veins, the brownish hairs 0.3–1 mm. long, the major veins flat or slightly impressed above and prominent beneath, the 4 to 6 pairs of major secondary veins usually arising from the lower half of the midvein (lower two-thirds of the lamina), the upper secondaries arising at angles of 20–40 degrees and arcuate ascending. Inflorescence free of the leaf-base of the same node in early stages, pendulous, 20–60 cm. long; peduncles 1–3 cm. long, 2–4 mm. thick, sparsely puberulent or glabrous, flowering portion 4–7 mm. thick at anthesis and becoming 14 mm. thick in fruit, the flowers crowded; floral bracts 0.7–1.5 mm. broad and triangular to rounded or somewhat cupulate from above, puberulent with conspicuous (0.1–0.5 mm.) brownish hairs, forming bands around the spike in early stages; anthers 0.2–0.3 mm. long and 0.3–0.5 mm. broad, on relatively short filaments and apparently articulate at the very base of the anther, the connective broad at the base with the thecae greatly divergent or almost borne in a single plane and opening upward; pistil apparently without a style but the 3 stigmas becoming 0.8 mm. long; fruit round or angular by compression, laterally compressed in early stages, truncate at the apex with 3 sessile stigmas, becoming 1–2 mm. thick and puberulent or glabrate.

Plants of moist evergreen forest formations between 500 and 2,000 m. elevation on the Pacific slope in Costa Rica and western Panama. Fertile collections have been made in January, Feburary, and March. The species, as here circumscribed, ranges from Guatemala to Peru and the Guianas.

One of the large-leaved tree-like pipers of forest shade distinguished by the brownish puberulence on bracts and leaves and the unusual stamens. The plants placed here are part of a complex of taxa which include *P. imperiale, P. fimbriulatum, P. euryphyllum, P. biseriatum, P. maxonii, P. cenocladum,* and *P. gibbosum* among our pipers. These plants vary greatly and it may be that these entities referred to as species are only plants with certain combinations of morphological characters. On the other hand, the great variation may mask more species than I have recognized. In the only area where I have seen several growing together ("La Selva," Rio Puerto Viejo, Heredia) the taxa appeared to be distinct. I have deliberately used the early name of Ruiz and Pavon for one of the taxa in this alliance though I have not seen the type and the name may be misapplied here. I have referred to *P. obliquum* under the other species and find it useful in referring to this complex of species. The extraordinary variation in this complex can be seen in the specimens figured by Trelease and Yuncker in *Piperaceae of Northern South America* (1950), figures: 1, 5, 6, 7, 15, 16, 17, 26, 76–78, 80–100, 104, 105, 107, 110, 111, 114–124, 126–140, 376, 378. The plants of this complex, as I interpret it, have the following characters in common:

tall habit with large asymmetric leaves, prophyll small and lateral, inflorescence free of the leaf-base and usually long-pendulous; stamen with the connective often modified to cause the thecae to dehisce apically and occasionally prolonged below to give the appearance of a jointed filament, the pistil sometimes with a short style and the stigmas often quite long. *Piper auritum* with much the same leaf-shape has very different flowers and is not closely related.

Piper otophorum C.DC., Bull. Soc. Bot. Belg. 30, pt. 1:220. 1891. *P. sperdinum* C.DC., Smiths. Misc. Coll. 71, pt. 6:1. 1920. Figure 14.

Small shrubs to 1.5 m. tall, leafy internodes 2–8 cm. long, 2–3 mm. thick, usually densely appressed puberulent with hairs about 0.1–0.2 mm. long (in ours) but occasionally with crooked hairs 2–3 mm. long in addition; shoot-apex emerging from within the prophyll at flowering nodes but usually obscured by the base of the lamina, prophyll puberulent along the midrib. Leaves usually distichous, petioles 3–12 mm. long, 1.3–2.2 mm. thick, densely puberulent, with scar-tissue near the base at flowering nodes, usually covered by the base of the lamina on one side; lamina 14–24 cm. long, 6–10 cm. broad, inequilaterally elliptic or ovate, tapering to the long-acuminate apex, narrowed at the very unequal base, acute to obtuse and slightly rounded on one side but auriculate on the other side, the basal lobe extending laterally across the petiole 1–2 cm. and about as long as the petiole, sides of the lamina 2–7 mm. distant on the petiole, the lamina drying thin-chartaceous, smooth and glabrous above, minutely appressed puberulent on the veins beneath (in ours), major veins flat above, the 3 to 5 pairs of major secondary veins arising from the lower half of the midvein, the upper secondaries arising at angles of 15–40 degrees and arcuate ascending. Inflorescence apparently free of the leaf-base of the same node in early stages but subtended by a rim of thin scar-tissue, erect, 6–12 cm. long, peduncle 10–25 mm. long, 1–1.8 mm. thick, densely puberulent with short (0.1 mm.) stiff yellowish hairs, flowering portion about 2–3 mm. thick, becoming 3–4 mm. thick in fruit, the flowers congested; floral bracts 0.3–0.8 mm. broad and triangular from above, with a margin of minute hairs and occasionally with 1 to 4 long (0.2–0.5 mm.) whitish hairs, not forming conspicuous bands around the spike; anthers 0.2–0.3 mm. long, about 0.2 mm. broad, thecae dehiscing laterally; pistil with a short (0.2–0.5 mm.) slender style and 2 or 3 stigmas; fruit 0.5–0.7 mm. thick, becoming 1 mm. long, obpyramidal-trigonous by compression, truncate and with an apical depression when dried, glabrous and very minutely pellucid punctate, the slender style usually breaking off in fruit.

Small plants of the shade of wet forest formations between sea level and 1,000 m. elevation on both the Caribbean and Pacific slopes of Costa Rica. The species is endemic to Costa Rica and Panama.

A piper with very unusual leaves auriculate on one side in which the basal lobe is usually two or three times broader than long. Very closely related to *P. terrabanum* with which it shares the moderately large long-acuminate leaves smooth and glabrous above, fruit with depressed apex (dry), and slender fruiting spikes with obscure bracts.

Piper otophorum differs from *P. terrabanum* in the unusual leaf-base, puberulent peduncle, and fewer secondary veins. I include *P. sperdinum* (*Pittier 3438*, San Blas, Panama) since it shares the unusual leaf-shape and flowering characters; it differs in possessing unusually long hairs on stems and leaves.

Piper papantlense C.DC. in DC., Prodr. 16, pt. 1:338. 1869. *P. venulosum* Trel., Contr. U. S. Nat. Herb. 26:132. 1929. *P. dissimulans* Trel., l.c. 133. *P. heterophlebium* Trel. in Standl., Field Mus. Bot. 18:345. 1937. Figure 3.

Shrubs or slender trees to 5 m. tall, the stems usually drying brown and with the older nodes conspicuously thickened, leafy internodes 3–9 (15) cm. long, 1–3 (5) mm. thick, glabrous; shoot-apex emerging from within the prophyll and free of the leaf-base at flowering nodes, the prophyll 5–20 mm. long, 0.5–1.5 mm. broad at the base (unopened), glabrous and usually drying dark brown. Leaves often distichous, petioles 1–2 cm. long at flowering nodes, 1–3 mm. thick, with a shallow groove adaxially and a small (0.5 mm.) stipule-like structure at the base at flowering nodes, glabrous, the petiole often longer and deeply vaginate with thin margins at sterile nodes; lamina 10–18 cm. long, 4–11 cm. broad, elliptic to broadly ovate, usually tapering gradually to the acuminate apex, obtuse to rounded and truncate at the base, the larger leaves of sterile nodes often cordate, equal or subequal at the base with the sides arising together from the petiole, margin of the lamina thickened at the petiole, drying thin- to stiff-chartaceous and usually pale grayish-green, venation palmate with 3 to 7 primary veins, the 3 central veins united for less than 8 mm. above the base, the midvein occasionally with prominent secondaries in the distal half of the lamina, the primaries prominulous above and prominent beneath, the tertiary veins often subparallel but not especially prominent beneath. Inflorescence free of the leaf-base of the same node in early stages, pendulous, 7–22 cm. long; peduncle 14–26 mm. long, about 1 mm. thick, the flowering portion usually over 8 cm. long, becoming 4 mm. thick in fruit, the flowers numerous and congested; floral bracts about 0.3 mm. broad (from above), rounded or triangular in outline, glabrous in the center (above) and sparsely puberulent around the edges, forming bands (together with the anthers) around the spike in early stages; stamens apparently 2 per pistil, anthers with divergent thecae on a broad filament, the thecae 0.1–0.2 mm. long and 0.2–0.3 mm. broad, dehiscing upward; pistils with 3 or 4 sessile stigmas; fruit crowded but round in outline (from above), obconic, becoming 1 mm. long and 1 mm. thick, the surface glabrous and smooth, stigmas small and sessile.

A species of wet forest edges and somewhat open habitats from sea level on the Caribbean side to 1,000 m. altitude; absent below 500 m. on the Pacific slope. The species ranges from southern Mexico to central Costa Rica.

Distinctive plants with glabrous palmately veined leaves, that dry pale in color, a developed prophyll, long spikes, and larger leaves that may be cordate. Very similar in general appearance to *P. reticulatum* but without the disc-like apex on the glabrous fruit, less

prominent tertiary venation, and longer spikes. Probably related to *Piper grande* and its allies. I have not seen the original material of *P. papantlense* but I have seen specimens determined by C. De Candolle. *Piper diandrum* C.DC. sensu Standley and Steyermark (Fieldiana, Bot. 24, pt. 3:295. 1952) is this species.

Piper peracuminatum C.DC., Smiths. Misc. Coll. 71, pt. 6:9. 1920. *P. fusco-granulatum* Trel., Contr. U. S. Nat. Herb. 26:180. 1929. Figure 14.

Shrubs or small trees 2–3 m. tall, the older nodes slightly thickened, leafy internodes 2–7 cm. long, 2–4 mm. thick, hirsute with yellowish hairs of various (0.2–1.5 mm.) lengths; shoot-apex emerging from within the prophyll and free of the leaf-base at flowering nodes, prophyll about 12 mm. long (?immature), acute, densely hirsutulous abaxially with the glabrous margins drying dark brown. Leaves usually distichous, petioles 7–16 mm. long, 1.2–2.5 mm. thick, densely hirsutulous, vaginate in the lower half and without a ligule-like development at flowering nodes, scar-tissue present on the lower half or third adaxially at flowering nodes; laminae 15–27 cm. long, 8–13 cm. broad, elliptic to somewhat obovate or ovate, broadest at or about the middle, long-acuminate at the apex, narrowed below the middle and obtuse or cordulate at the unequal base, the longer side 2–14 mm. longer than the shorter, sides 1–4 mm. distant on the petiole, the lamina drying chartaceous and dark in color, slightly scabrous and very short papillate-puberulent above with longer (0.1–0.5 mm.) hairs on the veins, more generally hirsutulous beneath with crooked hairs 0.3–0.8 mm. long, primary and secondary veins becoming impressed above, the 4 or 5 pairs of major secondary veins arising from the lower half of the midvein, upper secondaries arising at angles of 20–35 degrees. Inflorescence free of the leaf-base of the same node in early stages, erect, 10–16 cm. long, peduncles 10–22 mm. long, 1.4–2.4 mm. thick, minutely (0.2 mm.) puberulent, flowering portion about 3 mm. thick at anthesis, and 5 mm. thick in fruit, the flowers congested; floral bracts 0.4–0.7 mm. broad and usually triangular above, glabrous centrally with a margin of yellowish hairs 0.1–0.2 mm. long, forming bands round the spike in certain stages; anthers 0.3–0.4 mm. long and 0.3–0.4 mm. broad, connective slightly expanded at the base but the thecae not divergent and dehiscing laterally (thecae forming an angle of 30–45 degrees), connective with a gland-like tip; pistil narrowed above with distinct (0.2 mm.) stigmas; fruit laterally compressed and 4-angled or rounded, 0.6–0.8 mm. thick, very minutely (0.05 mm.) puberulent, conical or rounded above with 3 recurved stigmas.

Plants of the lowland Caribbean coastal plain; fruiting (in Panama) in August. Known from only a single collection (*United Fruit Co. 269*, Hacienda de Zent, type of *P. fusco-granulatum*) in Costa Rica and from three collections in Panama (fide Yuncker).

Piper peracuminatum is distinguished by the large slightly scabrous leaves with pubescence of various lengths, long-acuminate apex and often cordulate base, petioles with scar-tissue, anthers dehiscing

laterally, prominent stigmas, and puberulent fruit. This species is closely related to *P. zacatense* with thinner leaves, slender spikes, and range restricted to the Pacific lowlands. Both species are related to *P. hispidum* and its allies but differ in form of the anthers and lack of a ligular development. Compare this species also with *P. colonense* which shares characters of the petiole and pistil.

Piper perbrevicaule Yuncker, Ann. Mo. Bot. Gard. 37:51. 1950. Figure 10.

Herbaceous subshrubs 15–35 cm. tall, older leafless nodes usually absent, leafy internodes 1–4 cm. long, 1–3 mm. thick, densely villous or hirsute with yellowish hairs 1–2 mm. long; shoot-apex emerging from within the prophyll and free of the leaf-base at flowering nodes, prophyll 5–12 mm. long, acute, with long (1 mm.) crooked hairs along the midrib abaxially and the outer glabrous margin drying brown, often persisting. Leaves usually distichous, petioles 8–22 mm. long, 1–2 mm. thick, densely villous or hirsute, vaginate only at the base and a stipular development absent or obscure at flowering nodes; laminae 5–12 cm. long, 2–5 cm. broad, asymmetrically elliptic to obovate or somewhat rhombic, sides of the lamina very unequal in area, abruptly short-acuminate or acute at the apex, oblique and cordulate at the very unequal base with the longer side forming a lobe 4–15 mm. long and often overlapping the petiole, sides of the lamina 1–4 mm. distant on the petiole, the lamina drying thin-chartaceous and pale greenish, smooth or slightly rough to the touch above, with scattered crooked hairs 0.7–2 mm. long on the upper surface and straight hairs on the veins beneath, venation becoming slightly impressed above and somewhat rugose, with 2 to 4 major secondary veins on each side arising from the lower half of the midvein, upper secondaries arising at angles of 20–40 degrees, arcuate ascending, the secondaries fewer and arising at a narrower angle on the smaller side of the leaf. Inflorescence free of the leaf-base of the same node in early stages, probably pendulous, 4–6 cm. long, peduncle 3–5 cm. long, about 0.7 mm. thick, sparsely puberulent, flowering portion 1.5–2 mm. thick at anthesis, the flowers crowded; floral bracts 0.3–0.4 mm. broad and triangular or rhombic above, glabrous above and not forming bands around the spike; anthers about 0.3 mm. long and 0.2 mm. broad, thecae parallel and dehiscing laterally; pistil short-stylose with 3 small (0.1–0.2 mm.) stigmas; fruit ovoid-subglobose with pointed apex, glabrous, stigmas sessile (fide Yuncker).

Small plants of the lowland Caribbean forest known only from Bocas del Toro, Panama.

This is the smallest species of *Piper* known to me and is apparently a plant of the deep shade of the forest floor. The auriculate leaves, very long peduncles, glabrous bracts, and stylose ovaries further distinguish this species. While it has not been reported for Costa Rica, it may be present in the Talamanca Valley. There are no close relatives among Costa Rica's pipers but compare *P. sinugaudens*.

Piper perhispidum C.DC., Bot. Gaz. 70:183. 1920. *P. pileatum* Trel., Contr. U. S. Nat. Herb. 26:184. 1929. *P. pileatum* var. *obliquum* Trel., l.c. *P. rugosifolium* Trel., l.c. 185. Figure 12.

Shrubs 1–3 m. tall or semi-scandent and growing over other plants, older nodes slightly thickened, leafy internodes 1–10 cm. long, 1.3–4 mm. thick, hirsute with yellowish-brown usually retrorse hairs 0.3–2.5 mm. long; shoot-apex emerging from the prophyll and free of the leaf-base at flowering nodes, prophyll 10–20 mm. long, acute, puberulent abaxially on the midrib with the glabrous margins drying dark brown. Leaves usually distichous, petioles 3–10 (20) mm. long, 1–2.5 mm. thick, densely hirsute or crisp-puberulent, vaginate only at the base and with a stipular development absent or minute (1 mm.) at flowering nodes; laminae 10–24 cm. long, 2.5–8.5 cm. broad, lanceolate to narrowly ovate or elliptic, tapering very gradually to the acuminate apex, obtuse or rounded on one side at the unequal base, sides of the lamina often quite unequal in width, arising 2–5 mm. distant on the petiole, the lamina drying thin to stiffly chartaceous and dark in color above, scabrous and pubescent above with slender hairs about 1.5 mm. long, densely puberulent on the veins beneath, venation soon becoming impressed above and prominent beneath forming a rugose upper surface and prominent reticulum beneath, the 3 to 5 pairs of major secondary veins arising from the lower half or the midvein, often with fewer veins on the narrower half, upper secondaries arising at angles of 10–30 degrees and arcuate-ascending. Inflorescence free of the leaf-base of the same node in early stages, erect, 6–11 cm. long, peduncle 8–14 mm. long, 0.7–1.6 mm. thick, densely to very sparsely crisp-puberulent, flowering portion 2.5–3.5 mm. thick at anthesis, about 4 mm. thick in fruit, the flowers congested; floral bracts 0.4–0.6 mm. broad and rounded or triangular above, glabrous centrally with a conspicuous margin of whitish hairs 0.1–0.2 mm. long, forming bands around the spike in early stages; anthers 0.2–0.3 mm. long, 0.4–0.5 mm. broad, connective very broad basally with the divergent thecae dehiscing upward; pistil with 3 small sessile stigmas; fruit becoming laterally compressed, about 0.5×1 mm. thick and truncate above, often with a slight depression around the sessile stigmas (dry), minutely brownish puberulent above and pellucid-muricate on the sides.

Plants of moist montane forest between 1,000 and 1,800 m. elevation on the Caribbean slopes, on the Meseta Central, and in the western part of the Cordillera de Talamanca. Probably flowering throughout the year but as yet not collected from June to October.

Piper perhispidum is characterized by the scabrous leaves hairy and usually rugose above, occasionally scandent habit, and montane forest habitat. It is very closely related to *P. villiramulum* and differs only in the larger anthers and fruit, habitat, and narrow more rugose leaves. It differs from rugose specimens of *P. hispidum* in the smaller or absent stipular development. *Piper bredemeyeri* has rugose leaves with a smaller reticulum and very different anthers and fruit.

Piper phytolaccaefolium Opiz in Presl, Reliq. Haenk. 151. 1830. *P. brevispicatum* Opiz in Presl, l.c. 151. pl. 28. *Artanthe brevi-*

spicata Miq., Syst. Piper. 508. 1844. *A. phthinotricha* Miq., l.c. 527. tab. 90. *A. phytolaccaefolia* Miq., l.c. 534. *Piper phthinotrichon* C.DC. in DC., Prodr. 16, pt. 1: 298. 1869. *P. globosum* C.DC., Linnaea 37:340. 1872. *P. candelarianum* C.DC., l.c. 357. *P. psilocladum* C.DC., Bull. Soc. Bot. Belg. 30, pt. 1:211. 1891. *P. candelarianum* var. *latifolium* C.DC., Anal. Inst. Fis.-Geog. Costa Rica 9: 167. 1897. *P. sepium* C.DC., l.c. 168, ex char. *P. amphoricarpum* Trel., Contr. U. S. Nat. Herb. 26:29. 1927. *P. cordulatum* var. *granulatum* Trel., l.c. 25. *P. cyanophyllum* Trel., l.c. 136. 1929. *P. candelarianum* var. *sepium* (C.DC.) Trel., l.c. 137. *P. candelarium* var. *pedroanum* Trel. in Standl., Field Mus. Bot. 18:334. 1937. *P. papillicarpum* Trel. in Standl., l.c. 352. *P. simulans* Trel. in Standl., l.c. 361. Figure 8.

Small shrubs 1–2 (3) m. tall, the older nodes slightly thickened, leafy internodes 2–7 (10) cm. long, 1.5–4 mm. thick, glabrous or very rarely very minutely (0.05–0.1 mm.) puberulent; shoot-apex emerging from within the prophyll and free of the leaf-base at flowering nodes, the prophyll to 2 cm. long, glabrous and usually drying very dark. Leaves usually distichous, petioles 4–12 (22) mm. long, 1–2 mm. broad and grooved adaxially, vaginate and with scar tissue only at the base at flowering nodes, with loose stipule-like margins that tear off to produce scar tissue at sterile nodes, usually glabrous; lamina 7–16 cm. long, 2–5 (8) cm. broad, very narrowly elliptic or lanceolate to ovate or oblong, tapering gradually to the acute or acuminate apex, acute or obtuse at the base (occasionally subtruncate in broader leaves), equal or subequal at the base with the sides arising 0–2 mm. distant on the petiole; the lamina drying membranaceous to chartaceous, smooth and glabrous on both surfaces, small (0.05 mm.) pellucid or dark gland-dots usually conspicuous beneath, major veins flat or slightly raised above, the 5 to 10 pairs of major secondary veins arising throughout the length of the midvein, the central secondaries arising at angles of 30–60 degrees, ascending near the margin and forming an arcuate marginal vein in the distal third of the lamina. Inflorescence free of the leaf-base of the same node in early stages, apparently pendulous in early and later stages, 2–4.5 cm. long, peduncle 8–24 mm. long, 0.5–0.8 mm. thick, glabrous and punctate, flowering portion 3–4 mm. thick at anthesis and becoming 10 mm. thick in fruit, often with a short (2 mm.) slender flowerless tip, the flowers loosely crowded; floral bracts 0.5–1 mm. broad and triangular or rounded from above, glabrous above but minutely (0.1 mm.) fimbriate around the edge, not forming distinct bands around the spike; anthers about 0.5 mm. long and 0.5 mm. thick, the connective thick and forming a distinct disc-like structure 0.2–0.3 mm. broad at the apex of the anther, thecae dehiscing laterally; pistil conical at the apex with 3 stigmas on a short (0.2 mm.) style; fruit conic, about 2 mm. thick, glabrous, somewhat rugose and usually black when dry, usually tapering to the apex and short-stylose, bracts obscured by the fruit in later stages.

Plants of wet forest formations of both Caribbean and Pacific slopes in Costa Rica between sea level and 1,800 m. altitude. Apparently growing in forest-shade and flowering and fruiting throughout

the year. The species ranges from Guatemala to Venezuela and Ecuador.

A very distinctive piper with pinnately veined glabrous leaves, very short spikes pendulous on slender peduncles, large anthers with unusual connective, stylose or substylose pistils, apparently soft-fleshy fruit, and glabrous prophyll. The leaves are quite variable in width (in different plants) but less so in length; they are often conspicuously punctate. The unusual anthers, gland-dots, and conic fruit, indicate a close relationship with *P. deductum, P. garagaranum,* and *P. nudifolium.* Specimens without spikes may be very difficult to separate from *P. arieianum.* I am using the name *P. phytolaccaefolium* in the sense of Yuncker and Trelease (1950); I have not seen type material of those names described before 1872.

Piper pittieri C.DC., Bull. Soc. Bot. Belg. 29, pt. 2:69. 1890. *P. trimetrale* C.DC., Anal. Inst. Fis.-Geog. Costa Rica 9:159. 1897. Figure 7.

Shrubs or slender short-lived trees to 4 m. tall, the older nodes only slightly thickened, leafy internodes 3–14 cm. long, 2–6 mm. thick, densely to sparsely puberulent, the hairs short or crooked, 0.2–0.9 mm. long and drying brownish; shoot-apex enclosed within the leaf-base of the same node in early stages, the prophyll short (3–5 mm.) and glabrous. Leaves usually distichous, petioles 5–10 cm. long, 3–8 mm. broad, deeply vaginate and with winged margins or margins of scar tissue at all nodes, sparsely puberulent and often conspicuously pellucid punctate; laminae 16–28 cm. long, 12–20 cm. broad, broadly ovate, tapering to the obtuse or short-acute apex, usually rounded and truncate at the base, equal or subequal at the base, sides 0–8 mm. separate on the petiole, the lamina drying membranaceous to thin chartaceous with the lower surface usually much paler in color and often with conspicuous pellucid dots, smooth above and below, puberulent on the veins of both surfaces and glabrous or sparsely puberulent between the veins, the hairs 0.2–0.5 (1) mm. long, the 4 to 7 pairs of major secondary veins arising from the lower two-thirds of the midvein, the central secondaries arising at angles of 30–50 degrees. Inflorescence at first included in the leaf-base of the same node and subtended by scar tissue continuous with the petiole in later stages, slender and whitish in early stages, 10–20 (30) cm. long; peduncle 1–5 cm. long, 2–5 mm. thick, sparsely to densely crisp-puberulent, flowering portion becoming 14 mm. thick (dry), the flowers and fruit very numerous and densely crowded; floral bracts 0.8–1.4 mm. broad and triangular above with a dense margin of whitish or brownish cilia and usually with a glabrous central area; anthers 0.3–0.5 mm. long, the connective with a gland-like tip, dehiscence lateral; pistil with a short (0.5 mm.) style and 3 spreading stigmatic lobes; fruit glabrous and apparently fleshy, becoming obpyramidal and angular by compression, 2–3 mm. long and about 2 mm. thick, truncate at the apex in late stages and with a very short style or the stigmas becoming sessile.

Distinctive plants of wet montane forests, commonly found between 2,000 and 2,600 m. elevation but recorded from 600 to 3,000 m. The species is confined to Costa Rica and western Panama.

A very distinctive piper easily recognized by the large subcordate leaves that include both shoot and inflorescence in their base (in early stages), thick fruiting spikes that are stylose in certain stages, and the high-altitude habitat. *P. tristemon* C.DC. and *P. villarealii* Yuncker of northern South America are very closely related to *P. pittieri*. This group of species is quite isolated among the pipers I have seen but the flowers and fruit suggest a relationship with *P. augustum*.

Piper poasanum C.DC., Bull. Soc. Bot. Belg. 30, pt. 1:206. 1891. *P. palmasanum* C.DC., Smiths. Misc. Coll. 71, pt. 6:3. 1920. *P. pexum* Trel., Contr. U. S. Nat. Herb. 26:140. 1929. *P. silvanorum* Trel., l.c. 169. *P. crispatimargine* Trel. in Standl., Field Mus. Bot. 18:339. 1937. Figure 4.

Shrubs or occasionally small trees to 4 m. tall, the older nodes conspicuously thickened, leafy internodes 2–6 (12) cm. long, (1.5) 2–5 mm. thick, glabrous or more often puberulent with short (0.2–1 mm.) yellowish hairs; shoot-apex emerging from within the stipular leaf-base and the longer prophyll, the prophyll becoming 15–30 mm. long, puberulent along the midrib (abaxially) and glabrous on the pale brown margins. Leaves usually distichous, petioles 10–20 mm. long at flowering nodes, with a stipule-like development 10–15 mm. long and 2–4 mm. broad that is soon torn off to produce a vaginate area surrounded with scar-tissue on the basal third of the petiole (adaxially) at flowering nodes, upper third of the petiole grooved adaxially and about 1–2 mm. thick, glabrous to densely puberulent; laminae 8–18 cm. long, 4–7 (9) cm. broad, elliptic to ovate, tapering gradually to the acuminate apex, usually narrowed to the acute or somewhat rounded unequal or subequal base, abruptly acuminate and subcordate in broad-leaved specimens, sides of the lamina 1–4 mm. distant on the petiole, the lamina drying chartaceous and usually much darker above than below, smooth and usually glabrous above, densely short (0.2–1 mm.) puberulent on the veins beneath, major veins flat or impressed above, prominent beneath, the 3 or 4 pairs of major secondary veins usually arising from the lower half of the midvein, arcuate ascending, the upper secondaries arising at angles of 20–40 degrees. Inflorescence at first enclosed within the stipular development of the leaf-base and later subtended by a rim of scar-tissue, erect, 3–12 cm. long, peduncle 6–18 (22) mm. long, 1–2 mm. thick, glabrous or puberulent, flowering portion 3–4 mm. thick at anthesis, about 6 mm. thick in fruit, the flowers closely congested; floral bracts 0.5–1 mm. broad and triangular or rounded above, glabrous centrally with a margin of short (0.2–0.4 mm.) yellowish-white hairs, not usually forming bands around the spike; anthers 0.3–0.4 mm. long, 0.4–0.5 mm. broad, connective broadened below the thecae and the thecae often divergent, dehiscing laterally, filament prominent and with an articulation 0.2–0.3 mm. below the anther; pistil with 3 slender stigmas about 0.3 mm. long;

fruit about 1.3 mm. long and 1 mm. thick, congested but round in cross-section, truncate above and glabrous or very minutely and sparsely puberulent, apparently fleshy, stigmas sessile.

Plants of wet montane forest formations between 1,500 and 2,600 m. elevation. The species is known from the Caribbean side of the Meseta Central and the Cordillera de Talamanca and from Chiriqui, Panama. An unusual collection (*Davidson 368,* F) from Chiriqui may represent a related species.

Piper poasanum exhibits an unusual development of the leaf-base forming a ligule-like stipule very similar to the cap-like prophyll of many other species. This stipule can be distinguished from the prophyll in that it arises directly from the leaf-base, opens away from the petiole (adaxially), and lacks the distinct midrib. In addition, the stipule may be present at all nodes while the prophyll is usually confined to flowering nodes. This species is related to *P. crassinervium* and shares the same variability in pubescence. The latter species has a smaller stipular development, truncate leaves, and longer spikes with stylose pistils.

Piper polytrichum C.DC. ex Schroeder, Candollea 3:138. 1926. Figure 12.

Small shrubs 1–2 (3) m. tall, the older nodes slightly thickened, leafy internodes 1–6 cm. long, 0.8–3 mm. thick, hirsute with thin yellowish crooked hairs 0.5–2 mm. long; shoot-apex emerging from the prophyll and free of the leaf-base at flowering nodes, prophyll 10–20 mm. long, hirsute along the midrib abaxially, glabrous and drying dark brown on the sides, acute. Leaves usually distichous, petioles 4–7 mm. long, about 1 mm. thick, densely hirsute, vaginate only at the base and without a ligule-like development at flowering nodes; laminae (6) 8–17 cm. long, (2) 3–7 cm. broad, narrowly elliptic to ovate or ovate-lanceolate, sides of the blade often quite unequal in width, tapering gradually to the acuminate apex, obtuse or rounded on the longer side basally, sides of the lamina 1–3 mm. distant on the petiole; the lamina drying thin to stiffly chartaceous and dark above, slightly scabrous above with whitish crooked hairs 1–2 mm. long, densely puberulent on the veins beneath, venation usually flat above, the 3 to 5 pairs of major secondary veins arising from the lower half of the midvein, the upper secondaries arising at angles of 15–30 degrees. Inflorescence free of the leaf-base of the same node in early stages, erect, 5–9 cm. long, peduncle about 6 mm. long and 1 mm. thick, densely hirsute, flowering portion 2–3 mm. thick at anthesis, about 4 mm. thick in fruit, the flowers congested; floral bracts 0.2–0.4 mm. broad, round or triangular and glabrous above with a few minute hairs beneath, inconspicuous and not forming bands around the spike, anthers about 0.2 mm. long and 0.3 mm. broad, connective broad below with the divergent anthers deshiscing upward; pistil with 3 small sessile stigmas; fruit 4-angled by lateral compression, about 0.5×1 mm. thick, truncate above with a depression around the stigmas (dry) glabrous or sparsely and very minutely puberulent.

Plants of the shade of moist forests in south-western Costa Rica from San Isidro del General to San Vito at altitudes of 600 to 1,200 m. Collected with mature spikes from January to March and in August and November. Endemic to Costa Rica but to be expected in adjacent Panama.

This species is recognized by the long crooked hairs on the dark upper leaf-surfaces, slender spikes with inconspicuous bracts, and mostly glabrous fruit compressed laterally. *Piper polytrichum* is related to *P. biauritum* of the Caribbean slopes and higher elevations with usually broader leaves and puberulent fruit. Both species are allied to the very difficult complex of taxa related to *P. hispidum*. There appears to be some intergradation between this species and *P. villiramulum*. Both of these taxa may prove to be no more than subspecific elements of *P. hispidum* (in a very wide sense)

Piper pseudo-fuligineum C.DC., Linnaea 37:355. 1872 (photo). *P. salinasanum* C.DC., Bull. Soc. Bot. Belg. 30, pt. 1:214. 1891. *P. domingense* C.DC., Anal. Inst. Fis.-Geog. Costa Rica 9:161. 1897. *P. salinasanum* var. *subscabrifolium* C.DC., l.c. 164. *P. dumeticola* C.DC., l.c. 164. *P. pseudo-dilatatum* C.DC., l.c. 165. *P. verbenanum* C.DC., l.c. 165. *P. taboganum* C.DC., Smiths. Misc. Coll. 71, pt. 6: 4. 1920. *P. breve* C.DC. in Trel., Contr. U. S. Nat. Herb. 26:38. 1927. *P. atlantidanum* Trel., Journ. Wash. Acad. Sci. 19:329. 1929. *P. nigricaule* Trel., Contr. U. S. Nat. Herb. 26:158. 1929. *P. griseo-pubens* Trel., l.c. 176. *P. griseo-pubens* var. *revocabile* Trel., l.c. *P. squali-pelliculum* Trel., l.c. 178. *P. clavulispicum* Trel. in Standl., Field Mus. Bot. 18:337. 1937. *P. ponendum* Trel. in Standl., l.c. 355. *P. salutatrix* Trel. in Standl., l.c. 359. *P. vitabile* Trel. in Standl., l.c. 369. Figure 12.

Shrubs 1–2 (3) m. tall, older nodes somewhat thickened, leafy internodes 1.5–8 cm. long, 1.2–3 (4) mm. thick, densely hirsutulous and occasionally becoming glabrescent in age, the yellowish hairs 0.4–1.6 mm. long; shoot-apex emerging from within the prophyll and free of the leaf-base at flowering nodes, prophyll 8–16 mm. long, acute, puberulent along the midrib abaxially, the glabrous margins drying brown. Leaves usually distichous, petioles 4–10 mm. long, 0.8–1.8 mm. thick, densely hirsutulous, vaginate near the base and with a small stipular development often tearing loose to form scar-tissue on the lower third of the petiole at flowering nodes; lamina (7) 10–20 cm. long, (2.5) 4–11 cm. broad, rhombic to elliptic, ovate or obovate, tapering gradually or abruptly to the acuminate apex, often conspicuously narrowed below the middle and somewhat cuneate, the base unequal with the longer side rounded or sometimes cordulate, the sides of the lamina 1–5 mm. distant on the petiole, the lamina drying thin to stiffly chartaceous and darker above than beneath, scabrous or smooth above, densely hirsutulous above with appressed

hairs 0.2–1 mm. long, densely pale hirsutulous beneath, venation becoming impressed above in late stages, prominent beneath, the 4 or 5 pairs of major secondary veins usually arising from the lower half of the midvein, upper secondaries arising at angles of 15–30 degrees, arcuate ascending. Inflorescence free of the leaf-base of the same node in early stages, erect, 4–11 cm. long, peduncles 6–11 mm. long, 1–2 mm. thick, densely hirsutulous, flowering portion 2–3 mm. thick at anthesis, 3–4 mm. thick in fruit, the flowers congested; floral bracts 0.2–0.5 mm. broad and triangular above with a margin of hairs 0.1–0.2 mm. long, not forming bands around the spike, usually inconspicuous in fruit; anthers 0.2–0.3 mm. long, 0.2–0.3 mm. broad, connective only slightly broadened beneath and the thecae dehiscing laterally or slightly upward; pistil with 3 small (0.1–0.3 mm.) recurved stigmas; fruit about 0.7 mm. thick, obpyramidal-trigonous by compression, rounded or truncate above with the stigmas usually breaking off, glabrous and often brownish in color (dry).

Plants of partly open sites between sea level and 1,200 m. throughout Costa Rica but more common in the seasonally dry evergreen (premontane moist) forest formations of the Pacific slope; flowering throughout the year. The species ranges from Mexico to northern South America (under a host of names).

Piper pseudo-fuligineum is recognized by its weedy habitat, the very variable but often narrowly rhombic leaves densely puberulent above, slender spikes with small anthers, and glabrous trigonous fruit. This species is very closely related to *P. dilatatum* and may be no more than a very puberulent form of that species. I consider them distinct primarily because of the difference in the habitats they occupy in Costa Rica. *Piper pseudo-fuligineum* is commonly found on the drier Pacific watershed and is virtually absent in areas subject to the wet Caribbean weather while the reverse is true of *P. dilatatum*. These two taxa are very similar in general appearance to *P. hispidum* and its allies but they differ in important characters of the anthers and fruit. *Piper karwinskianum* (Kunth) C.DC. of Mexico may be an earlier name for this species.

Piper pseudo-lindenii C.DC., Linnaea 37:335. 1872. *P. virillanum* C.DC., Anal. Inst. Fis.-Geog. Costa Rica 9:158. 1897. *P. pertractatum* Trel., Contr. U. S. Nat. Herb. 26:130. 1929. Figure 3.

Shrubs to 4 m. tall, stems slender but the nodes conspicuously thickened in age, leafy internodes 0.8–4 (7) cm. long, 0.7–1.2 (2) mm. thick, glabrous or very minutely puberulent; shoot-apex emerging from the prophyll and free of the leaf-base of the same node, the prophyll 3–6 mm. long, less than 1 mm. broad at the base (unopened), glabrous and drying dark brown. Leaves usually distichous, petioles 2–6 mm. long at flowering nodes, 0.6–1.2 mm. thick, glabrous or very minutely (0.05–0.1 mm.) puberulent, grooved adaxially but vaginate only at the base at flowering nodes, a stipule-like structure absent; lamina 6–16 cm. long,

(1.5) 2–4.5 (8) cm. broad, lanceolate or narrowly elliptic, gradually tapering to the acuminate apex, acute to obtuse or rounded at the base, the sides of the lamina unequal and 1–2 mm. distant on the petiole, the larger leaves sometimes cordulate on the larger side, drying chartaceous and often grayish green, smooth on both surfaces, glabrous or sparsely and very minutely (0.05–0.1 mm.) puberulent on both surfaces, venation palmate with the 3 (4) primary veins slightly raised above, the primary veins united for 2–5 mm. near the base and reaching the apex, the midvein without major secondary veins, the upper epidermal cells quite irregular in outline. Inflorescence free of the leaf-base of the same node in early stages, 4–10 cm. long; peduncle 4–10 mm. long, about 0.7 mm. thick, glabrous or very minutely puberulent, flowering portion 16–48 mm. long and about 2 mm. thick at anthesis, becoming 9 cm. long and 4 mm. thick in fruit, the flowers and fruit crowded; floral bracts about 0.3 mm. broad, round or triangular (from above) and glabrous in the center with a fringe of hairs around the edge, not forming conspicuous bands around the spike; anthers 0.3–0.4 mm. long and equally broad or broader, connective wider beneath and the thecae divergent with upward dehiscence; pistil broad at the base and gradually narrowed at the apex with 3 or 4 sessile stigmas; fruit compressed laterally at the broad base, about 1.5×0.7 mm. at the base and 1 mm. tall, narrowed to the rounded apex, glabrous and drying dark in color, the fruit apparently minutely puberulent at the base by emersion in the puberulent rachis.

Ranging from sea level to 2,200 m. elevation on the Atlantic slopes and around the Meseta Central and Sierra de Tilaran. Endemic to Costa Rica and western Panama but see the discussion below.

The narrow lanceolate leaves with only three major veins, puberulent rachis, narrowed fruit rounded at the apex, and shoot-apex protected by the prophyll are distinguishing features of this species. It is differentiated from the closely related *P. amalago* by the consistently narrow or asymmetric leaf-form, fruit laterally narrowed at the base and rounded above, and possibly by habitat. *Piper pseudo-lindenii* is very closely related to *P. oblique-ovatum* of Nicaragua and *P. gracillimum* (sensu auctores) of Honduras. Until these relationships can be clarified it seems best to consider the Costa Rica plants distinct.

Piper reptabundum C.DC., Bot. Gaz. 70:169. 1920. Figure 10.

Habit unknown, older nodes conspicuously thickened and usually with adventitious roots, leafy internodes 1–2.5 cm. long, 0.7–1.7 mm. thick, glabrous; shoot-apex emerging from within the prophyll and free of the leaf-base at flowering nodes, prophyll about 10 mm. long, very narrow (0.5 mm.) and apparently blunt at the tip, glabrous. Leaves usually distichous, petioles 0.5–3 mm. long, 1.2–2 mm. thick, glabrous, vaginate only at the base and lacking a stipular development at flowering nodes; laminae 11–18 cm. long, 3–5 cm. broad, asymmetrically narrowly oblong or oblanceolate, sides of the lamina very unequal in area with the broader side more curved, narrowly long-acuminate at the apex, oblique at the

base with the longer side rounded and slightly cordulate, sides of the lamina 1–2 mm. distant on the petiole, the lamina drying thin-chartaceous and usually grayish, smooth or slightly rough to the touch, glabrous above and beneath, midvein becoming impressed above, with 2 to 5 major secondary veins on each side, arising from throughout the length of the midvein, central secondaries arising at angles of 20–45 degrees, the narrower side of the lamina with fewer veins arising at narrower angles. Inflorescence free of the leaf-base of the same node in early stages, apparently long-pendant, 6–12 cm. long, peduncle 4.5–7.5 cm. long, about 0.8 mm. thick, glabrous, flowering portion about 2 mm. thick in fruit, the flowers closely crowded; floral bracts 0.4–0.5 mm. broad and triangular above, glabrous and lustrous above, not forming bands around the spike; anthers about 0.3 mm. long, apparently dehiscing laterally, borne on a distinct filament above the level of the bracts; pistil short-stylose with 3 distinct (0.1–0.2 mm.) stigmas; fruit becoming obpyramidal trigonous and rounded above, about 0.5 mm. thick, glabrous and with a very minutely pellucid-papillate surface above.

Known only from the single collection by Pittier (*9277*) from the forests of Shirores, Talamanca, Limon, at an elevation of about 100 m.

A very unusual piper with distinctly asymmetric glabrous leaves and long-pedunculate spikes. The species is either a very small herb or a small climber. The adventitious roots at most nodes suggests a climbing habit. This species appears to have no close relatives among Costa Rica's other pipers but the glabrous parts and form of the bracts indicate some relationship with *P. aequale* and its allies.

Piper reticulatum L., Sp. Pl. 1:29. 1753. *P. discophorum* C.DC., Bull. Soc. Bot. Belg. 30, pt. 1:201. 1891. Figure 3.

Shrubs or slender-stemmed trees to 6 m. tall, stems usually drying yellowish-green, the older nodes conspicuously thickened, leafy internodes 5–12 cm. long, 1.5–3 (5) mm. thick, glabrous or sparsely and very minutely (0.05–0.1 mm.) puberulent; shoot-apex emerging from the prophyll and free of the leaf-base at flowering nodes, the prophyll 4–10 mm. long, drying greenish or grayish in color, glabrous or very minutely (0.05 mm.) puberulent. Leaves in a spiral, petioles 8–20 cm. long (longer at sterile nodes), 1.5–3 mm. thick, glabrous or very sparsely and minutely puberulent, often yellowish on drying, grooved adaxially but vaginate only at the base and with a minute (–0.5 mm.) stipule-like development at the base at flowering nodes; lamina 16–30 cm. long, 9–15 cm. broad, usually larger at the lower sterile nodes, ovate and tapering gradually to the short-acuminate or caudate-acuminate apex, obtuse to rounded or truncate at the base, the larger laminae occasionally subcordate, equal or subequal at the base with the sides of the lamina arising together on the petiole, drying stiffly chartaceous and usually pale grayish-green, smooth and glabrous on both surfaces, venation palmate with the 5 to 7 (9) primary veins united for less than 6 mm. at the base, the midvein without major secondaries but many secondary veins subparallel and interconnecting the primaries, both primary and secondary veins prominent beneath. Inflorescence free of the leaf-base in early stages, erect at anthesis, 6–11 cm. long; peduncle 10–25 mm. long, about 1 mm. thick, glabrous or very minutely puberulent, the flowering portion 4.5–8.5 cm. long, becoming 6 mm. thick in fruit, the flowers crowded

on the minutely puberulent rachis and the rachis usually not readily visible; floral bracts about 0.3 mm. broad, usually round (viewed from above), glabrous or with minute hairs at the base, not forming bands around the spike nor easily distinguished; stamens with thick filaments broadened at the apex, anthers about 0.2–0.3 mm. long and 0.3–0.5 mm. broad, the connective very broad at the base and the thecae divergent with upward dehiscence; pistil with 3 or 4 thick sessile stigmas; fruit becoming 2 mm. thick and angled by compression, with a small (0.7 mm.) round glabrous disc-like area around the stigmas, surfaces drying yellowish and minutely granular.

Understory plants of the deep shade in wet forest formations between sea level and 700 m. elevation (in Costa Rica) on both Caribbean and Pacific slopes. The species ranges from Nicaragua to northern South America and the West Indies.

A very distinctive species of *Piper* with palmately veined leaves and prominent secondary venation drying grayish and stiffly chartaceous. No other piper in our Flora possesses the disc-like area around the stigmas. Probably related to *P. pinoganense* of Panama and *P. grande* and its allies; these share the form of the prophyll, texture of the leaves, and have characteristically large epidermal cells.

Piper riparense C.DC., Anal. Inst. Fis.-Geog. Costa Rica 9:173. 1897. Figure 9.

Shrubs to 3 m. tall, older nodes conspicuously thickened, leafy internodes 3–20 cm. long, 3–6 mm. thick, conspicuously crisp-hairy but becoming glabrous with age; shoot-apex emerging from within the prophyll and free of the leaf-base at flowering nodes, the prophyll becoming 3 (5) cm. long, usually with a rounded tip, crisp-puberulent with hairs about 1 mm. long. Leaves usually distichous, petioles 2.5–5.5 cm. long and about 2 mm. broad with scar tissue only at the base and without a stipule-like development at flowering nodes, grooved adaxially but deeply vaginate and with loose adaxial margins at the longer (13 cm.) petioles of the lower sterile nodes, sparsely to densely crisp-hairy, the yellowish hairs 0.5–1.5 mm. long; lamina 15–40 cm. long, 8–26 cm. broad, ovate and gradually tapering to the acuminate apex, deeply cordate to subcordate or occasionally obliquely truncate at the equal or unequal base, the lower lobe rarely more than 1 cm. longer than the shorter lobe, sides of the blade attached together or 1–6 mm. distant on the petiole, the basal lobes never overlapping and the basal sinus usually wide, the lamina drying thin- to stiffly-chartaceous and usually grayish, the upper surface smooth or slightly scabrous with scattered hairs to 1 mm. long, the lower surfaces densely crisp-hairy, the edge of the blade with crooked hairs to 1 mm. long and often revolute on drying, major veins often impressed above on the older leaves and becoming slightly bullate, the 4–7 pairs of major secondary veins usually arising from the lower two-thirds of the midvein, the central secondaries arising at angles of 30–50 degrees and arcuate ascending, the lowest secondaries forming part of the lamina-margin near the petiole. Inflorescence free of the leaf-base of the same node in early stages and erect, 10–22 cm. long, peduncle 8–20 mm. long, about

1.5–2.5 mm. thick, densely to sparsely crisp-hairy (rarely glabrous), flowering portion 2–3 mm. thick at anthesis, becoming 4–6 mm. thick in fruit, the flowers densely congested; floral bracts 0.2–0.4 mm. long and oblong to rhombic or triangular from above, usually convex with a raised proximal portion on the upper glabrous surface, densely puberulent beneath, not forming bands around the spike; anthers 0.2–0.4 mm. long, about 0.2 mm. broad, thecae dehiscing laterally and across the top, pistil with 3 short (0.2 mm.) stigmas but these usually breaking off in fruit; fruit 0.8–1.1 mm. long, 0.6–1 mm. thick, obpyramidal-trigonous by compression, upper surface of paler tissue forming a cap-like truncate apex, glabrous, stigmas deciduous.

Plants of open or partly shaded sites in wet evergreen forest formations between sea level and 1,500 m. elevation. The species is known only from Costa Rica and eastern Nicaragua.

A very distinct species recognized by the large cordate leaves slightly unequal at the base, long crooked hairs on stems and leaves, and slender erect (in early stages) spikes. This species is easily confused with *P. obliquum* and its allies but those lack a developed prophyll and have deeply vaginate petioles at flowering nodes. *Piper riparense* is closely related to *P. nemorense* and shares the unusual bracts and form of the fruit with that species but the latter lacks the large hairs and short stigmas.

Piper sagittifolium C.DC., Anal. Inst. Fis.-Geog. Costa Rica 9:171. 1897. Figure 6.

Erect herbs with few branches to about 1 m. tall, stems retrorse tomentulous on the longitudinal ribs but becoming glabrous on older parts and above the leaf-axils, leafy internodes 3–9 cm. long, 2–6 mm. thick, usually hollow and often with an aperture (made by ants?) on the stem in the leaf-axil within the sheathing leaf-base; shoot apex emerging from within the sheathing leaf-base of the same node at all nodes, a prophyll not apparent and represented only by a ridge of hairs at the flowering node. Leaves in a spiral; petioles 1–3.5 (5) cm. long, 2–6 mm. broad, vaginate and with winged margins at all nodes, with rows of small (0.3–0.7 mm.) retrorse hairs; lamina 15–25 (32) cm. long, 5–12 cm. broad, narrowly elliptic to narrowly obovate or oblong, gradually tapering to the acuminate apex, widened near the base above the unequal lobes, sagittate, subhastate or occasionally cordulate at the base, the lobes acute or sometimes rounded at the tip, rarely with secondary lobes, one lobe often overlapping the stem, drying chartaceous and often gray-green, smooth on both surfaces, glabrous above but minutely (0.1–0.2 mm.) puberulent on the veins beneath, the midvein often slightly impressed above, the 3 to 5 pairs of major secondary veins arising from the lower two-thirds of the midvein or gradually diminishing in size and arising throughout the length of the midvein, the central secondaries arising at angles of 30–60 degrees, arcuate ascending. Inflorescence free of the leaf-base of the same node, often terminal, erect, 3–6 cm. long; peduncle about 1 cm. long and 1.7 mm. thick, densely brownish tomentulous with the hairs often in longitudinal rows, flowering spike 2–5.5 cm. long, about 1 cm. thick in fruit, often with a slender flowerless portion at the apex, the flowers and bracts rather loosely aggregated; floral bracts somewhat cupulate

(viewed from above) or U-shaped, sparsely puberulent and not forming bands around the spike; anthers about 1 mm. long and dehiscing laterally, the connective prolonged beyond the thecae; pistil stylose from early stages, style 1–2 mm. long with 2 style branches or stigmas, style and stigma white at anthesis (alive); fruit round and not tightly compressed, 2–3 mm. thick, glabrous, 3 mm. long (below the style) and abruptly narrowed below the persistent style.

Endemic to the Pacific slopes of Costa Rica from the western part of the General Valley to the Osa Peninsula and the highlands bordering Panama near San Vito and Agua Buena. Confined to the deep shade of wet forests.

This species is unique among pipers as regards leaf-shape and I believe that it bears no close relationship to other Costa Rican pipers (with the possible exception of *P. hebetifolium*). The lack of a developed prophyll, stylose pistil, and form of the bracts indicate a relationship with the *Piper obliquum* alliance. I believe that the unusual anthers and long styles with divergent stigmas are primitive characters in the genus. *Trianaeopiper garciae* Trel. & Yuncker of Colombia possesses leaves very similar to *P. sagittifolium* and it may be that the genera are related most closely by these two species. The hollow stems often harbor ants.

Piper sancti-felicis Trel., Contr. U. S. Nat. Herb. 26:35. 1927. *P. scabrum* Sw., Fl. Ind. Occ. 1:59. 1797, (!) not Lam. 1791. *P. reventazonis* Trel., l.c. 172. 1929. *P. tsuritkubense* Trel., l.c. 174. *P. spicilongum* Trel., l.c. 177. *P. scintillans* Trel., l.c. 179. *P. subhirsutum* Trel., l.c. 179. *P. subhirsutum* var. *tomentosicaule* Trel., l.c. 179. *P. rectamentum* Trel., l.c. 180. *P. fraguanum* Trel., Journ. Wash. Acad. Sci. 19:332. 1929. *P. tentatum* Trel. in Standl., Field Mus. Bot. 18:365. 1937. *P. konkintoense* Trel., Ann. Mo. Bot. Gard. 27: 293. 1940. *P. pseudoviridicaule* var. *nievicitanum* Trel., l.c. 296. 1940. Figure 13.

Shrubs 1.5–3 m. tall, the older nodes slightly thickened, leafy internodes 2.5–10 cm. long, 1.5–3 (4) mm. thick, densely hispidulous; shoot-apex emerging from within the prophyll and a stipule-like structure at flowering nodes, the prophyll usually puberulent along the back of the midrib with the glabrous margins drying dark brown. Leaves usually distichous, petioles 6–12 mm. long, 1–2 mm. thick, hispidulous with appressed ascending hairs about 0.3 mm. long, vaginate only at the base at flowering nodes, a ligule-like stipular development present, 6–16 mm. long, at first enclosing the shoot-apex and opening away from the petiole (adaxially); lamina 12–20 cm. long, 6–10 cm. broad, narrowly ovate to elliptic or oblong, tapering gradually to the acuminate apex, narrowed to the unequal base, often rounded on the longer side, sides of the lamina 2–6 mm. distant on the petiole, the lamina drying thin-chartaceous and usually dark in color, scabrous on both surfaces, sparsely and very minutely puberulent above, more densely puberulent be-

neath with hairs 0.1–0.5 mm. long, veins prominulous or impressed above, the 4 to 6 pairs of major secondary veins arising from the lower two-thirds of the midvein, upper secondaries arising at angles of 15–35 degrees, tertiary veins often subparallel. Inflorescence partly included in the stipular development of the leaf-base in early stages and later subtended by scar-tissue on one side, erect and straight, 8–15 cm. long, peduncle 4–10 (14) mm. long, 1–2 mm. thick, hispidulous with minute (0.1–0.4 mm.) yellowish hairs, flowering portion 2–3 mm. thick at anthesis, becoming 3–4 mm. thick in fruit, the flowers densely crowded; floral bracts 0.2–0.5 mm. broad, glabrous centrally with a dense border of minute yellowish hairs, forming indistinct bands around the spike; anthers 0.1–0.2 mm. long, 0.2–0.4 mm. broad, connective broadened at the base with the divergent thecae dehiscing upward; pistil puberulent with sessile stigmas; fruit 0.5–0.8 mm. thick, obpyramidal by compression, truncate above with a depression around the stigmas (dry), puberulent above and reddish pellucid punctate on the sides.

Plants of moist evergreen forest formations from sea level to 1,000 m. altitude on both the Caribbean and Pacific watersheds, growing in open and shaded sites; flowering throughout the year. I have seen material ranging from Honduras to Venezuela and the West Indies.

Piper sancti-felicis is recognized by the large ligulate stipular development which, together with the prophyll, dries very dark brown or black. The thin broad scabrous leaves also drying dark, slender erect spikes, and moist lowland habitat further distinguish the species. The anthers dehiscing upward and laterally compressed fruit truncate and puberulent above ally this species to the closely related *P. hispidum*. Most authors have not distinguished this species from *P. hispidum* but the very different morphology at the apex of flowering shoots serves to separate them. Intermediates between the two species have not been collected in Costa Rica but separating the two may be very difficult at higher elevations (as in collections from Chiriqui, Panama). *Piper bisasperatum* of our wet highland forests possesses some characters of both *P. hispidum* and *P. sancti-felicis*. The rigidity of botanical nomenclature does not permit the use of Swartz's *P. scabrum*; I am sure that there must be another name earlier than that of Trelease.

Piper scleromyelum C.DC., Anal. Inst. Fis.-Geog. Costa Rica 9:167. 1897. Figure 7.

Habit unknown, older nodes conspicuously thickened, leafy internodes 4–8 cm. ong, 1.7–3.5 mm. thick, glabrous; shoot-apex emerging from within the prophyll and free of the leaf-base at flowering nodes, prophyll about 12 mm. long, narrow and blunt apically, glabrous. Leaves usually distichous, petioles usually obscured by the lamina-base, 1–5 mm. long, about 1.7 mm. thick, glabrous or very minutely

(0.03 mm.) puberulent, vaginate only at the base and without a stipular development at flowering nodes; laminae 12–20 cm. long, 7–11 cm. broad, ovate to broadly elliptic-oblong, often with one side considerably broader than the other; tapering abruptly to the short-acuminate apex, rounded at the subequal or unequal and somewhat asymmetric base, cordulate at the very base with the broader lobe 0–3 mm. longer than the shorter, sides of the lamina arising close together on the petiole, the lamina drying stiffly chartaceous to subcoriaceous, smooth and lustrous above, glabrous on both surfaces, venation becoming impressed above and prominent beneath, with 2 or 3 major secondary veins on each side arising from the lower third or lower fourth of the midvein, upper secondaries arising at angles of 20–45 degrees, arcuate-ascending, tertiary veins subparallel and usually perpendicular to the midvein. Inflorescence free of the leaf-base of the same node in early stages, subtended by a raised ridge of tissue, probably erect, 5–10 cm. long, peduncle 8–14 mm. long, about 1.7 mm. thick, glabrous, flowering portion about 3 mm. thick at anthesis, the flowers densely congested; floral bracts about 0.5 mm. broad and triangular above, glabrous centrally with a margin of dense yellowish hairs 0.1–0.2 mm. long, not forming conspicuous bands around the spike in early stages or anthesis; anthers about 0.2 mm. long and 0.3 mm. broad, connective narrow and the thecae not greatly divergent but dehiscing apically; pistil obscured by the bracts but with a short (0.1–0.2 mm.) style and 3 short recurved stigmas; fruit said to be obpyramidal-trigonous and glabrous with sessile stigmas.

This species is known from only a single collection: *Tonduz 8675* forest of Tsuritkub, Talamanca, 100 m. altitude, March, 1894.

A very striking essentially glabrous plant with broad lustrous subsessile leaves, unusual venation, and anthers with the thecae flaring open apically. These plants are probably scandent, climbing by means of adventitious roots. *Piper scleromyelum* is very closely related to *P. ottoniaefolium* C.DC. (sensu Trelease & Yuncker, 1950) of northwestern South America and differs only in the much broader and thicker lustrous leaves. Additional material may show that these are only unusual characteristics of the type collection and that our material is a peripheral population of *P. ottoniaefolium* which has recently been found in Panama (*Dressler 3862*). *Piper novogranatensis* C.DC. (sensu Trelease & Yuncker, 1950) does not appear to be distinct from *P. ottoniaefolium*. The most closely related Costa Rican species is *P. xanthostachyum*, also a climber.

Piper silvivagum C.DC., Anal. Inst. Fis.-Geog. Costa Rica 9: 162. 1897. *Piper vitabundum* Trel., Contr. U. S. Nat. Herb. 26:38. 1927. *P. pseudo-albuginiferum* Trel., l.c. 165. *P. conscendens* Trel. in Standl., Field Mus. Bot. 18:338. 1937. Figure 10.

Scandent or clambering shrubs, the older nodes somewhat thickened, leafy internodes 2–12 cm. long, 1–3 mm. thick, puberulent with appressed retrorse whitish hairs 0.1–0.5 mm. long and becoming glabrous in age; shoot-apex emerging from

within the prophyll and free of the leaf-base at flowering nodes, prophyll 5–15 mm. long, very minutely (0.03–0.1 mm.) puberulent along the back of the midrib with the glabrous sides drying dark brown. Leaves usually distichous, petioles 4–8 (12) mm. long, 0.5–0.9 mm. thick, sparsely to densely puberulent, vaginate only at the base and with a small (1–2 mm.) ciliate stipular development at flowering nodes; laminae 8–13 cm. long, 2–5 cm. wide, narrowly elliptic to ovate-lanceolate, tapering very gradually to the acuminate apex, narrowed to the obtuse and unequal base, sides of the lamina 1–4 mm. distant on the petiole, the lamina drying chartaceous and often dark in color, glabrous and smooth or very slightly scabrous above, minutely (0.1–0.5 mm.) puberulent on the veins beneath with appressed ascending hairs, venation flat above, the 3 or 4 pairs of major secondary veins arising from the lower half of the midvein, the upper secondaries arising at angles of 10–30 degrees, arcuate ascending. Inflorescence free of the leaf-base of the same node in early stages, apparently erect, 8–14 cm. long at maturity, peduncle 8–14 mm. long, 0.7–1.5 mm. thick, glabrous, flowering portion 1.5–2.5 mm. thick at anthesis, 2.5–3.5 mm. thick in fruit, the flowers congested; floral bracts 0.3–0.4 mm. broad and triangular or rounded above, glabrous centrally with a conspicuous or inconspicuous margin of hairs 0.05–0.2 mm. long, together with the anthers forming bands around the spike in certain stages; anthers 0.1–0.2 mm. long, 0.2–0.3 mm. broad, connective very broad basally with the divergent thecae dehiscing upward; pistil inconspicuous with small sessile stigmas; fruit becoming laterally compressed, about 0.5 mm. thick, truncate above with a slight depression around the 3 small stigmas (dry), very minutely puberulent above.

A species of the Caribbean slopes and lowlands, ranging from central Costa Rica to Bocas del Toro, Panama. Collected in only two areas of Costa Rica: Talamanca lowlands (*Tonduz 8595* and *9272*) and the Reventazon valley between 600 and 1,400 m. elevation (*Lent 861, Tonduz 11518, Valerio 1219*).

A distinctive piper because of its habit of growing over other shrubs, long internodes, thin narrow leaves glabrous above and appressed puberulent beneath, and long slender spikes. The stipular development, anthers opening upward, and puberulent fruit ally this species with the scabrous *P. hispidum*. *Piper silvivagum* may be difficult to separate from the smooth-leaved members of the *P. hispidum* alliance such as *P. chrysostachyun* and *P. dotanum* of the Pacific watershed.

Piper sinugaudens C.DC., Bot. Gaz. 70:188. 1920. Figure 10.

Shrubs 1–3 m. tall, older nodes conspicuously thickened, leafy internodes 1.5–8 cm. long, 0.6–2 (3) mm. thick, sparsely to densely hirsutulous with small (0.3–1 mm.) whitish usually retrorse hairs; shoot-apex emerging from within the prophyll and free of the leaf-base at flowering nodes, prophyll 6–14 mm. long, acute, puberulent along the midrib abaxially with the glabrous margins drying brown. Leaves usually distichous, petioles 2–6 mm. long, about 1 mm. thick, densely hirsutulous,

vaginate only at the base and with a minute (–1 mm.) stipular development at flowering nodes; laminae 7–15 cm. long, 2–5.5 cm. broad, very narrowly elliptic or ovate to oblanceolate, usually widest at or above the middle, tapering abruptly to the acuminate apex, rounded and cordulate on both sides of the unequal base, basal lobes 3–10 mm. long (from the petiole attachment), the longer lobe often overlapping the petiole, sides of the petiole 0–2 mm. distant on the petiole, the lamina drying chartaceous and often grayish in color, smooth and glabrous or with a very few hairs on the veins above, puberulent on the veins beneath with minute (0.1–0.4 mm.) ascending whitish hairs, venation flat above, the 3 or 4 pairs of major secondary veins arising from the lower two-thirds of the midvein, upper secondaries arising at angles of 25–45 degrees, arcuate-ascending. Inflorescence free of the leaf-base of the same node in early stages, erect in early stages, 2.5–6 cm. long, peduncles 5–12 mm. long, 0.4–0.8 mm. thick, minutely (0.2 mm.) puberulent, flowering portion 1.2–1.7 mm. thick, about 2 mm. thick in fruit, the flowers crowded; floral bracts 0.4–0.7 mm. broad and triangular or cupulate from above, glabrous centrally with a margin of minute (0.05–0.2 mm.) hairs, not forming bands around the spike; anthers 0.2–0.3 mm. long, 0.2–0.3 mm. broad, connective slightly expanded at the base and the thecae slightly divergent (forming a 60 degree angle) and dehiscing laterally; pistil narrowed apically into a short (0.1–0.2 mm.) style with 3 very short (0.1 mm.) stigmas; fruit angular by compression but becoming separate on drying, obpyramidal-trigonous, 0.5–0.7 mm. thick above, truncate above and the stigmas essentially sessile, glabrous.

Plants of deep shade in lowland (0–800 m.) wet forest formations of the Caribbean watershed and in southwestern Costa Rica; known only from Nicaragua and Costa Rica.

This species is characterized by the thick nodes, usually narrow lamina very unequal and often cordulate at the base, slender spikes, stylose pistils, and deep forest habitat. The form of the pistil, fruit, and floral bracts indicate a relationship with *P. glabrescens* and its allies but these differ in the origin of the inflorescence and function of the prophyll. *Piper enganyanum* Trel. & Yuncker and *P. raizudoanum* Trel. & Yuncker of Colombia are very closely related but differ in the sessile stigmas. Among our pipers, *P. ejuncidum* with different floral bracts appears closely related. I have placed specimens of rather different appearance under this name; collections from the Caribbean slope have consistently narrower leaves than those of the Pacific.

Piper subsessilifolium C.DC., Bull. Soc. Bot. 30, pt. 1:216. 1891, ex char. *P. flaviramum* C.DC., Bot. Gaz. 70:181. 1920. *P. pendens* Trel., Contr. U. S. Nat. Herb. 26:160. 1929. *P. arundinetorum* Trel., l.c. 159. *P. sulcinervosum* Trel., l.c. 159. *P. pendens* var. *infaustum* Trel., l.c. 160. *P. flavirameum* var. *obscurum* Trel. in Standley, Field Mus. Bot. 18:343. 1937. Figure 11.

Small shrubs to 2 (rarely 3) m. tall or somewhat scandent and occasionally epiphytic, the older nodes conspicuously thickened and the stem often much angled (zigzag), leafy internodes 2–8 cm. long, 1–3 mm. thick, glabrous or minutely (0.1–0.4 mm.) puberulent; shoot-apex emerging from within the prophyll and free of the leaf-base at flowering nodes, the prophyll becoming 3–6 cm. long, glabrous or minutely puberulent over the entire abaxial surface. Leaves distichous, petioles 2–10 mm. long, about 1–2 mm. thick, sparsely to densely puberulent (at least at the base), vaginate only at the base and without a stipule-like development at flowering nodes; lamina (9) 12–24 cm. long, 3–9 (11) cm. broad, narrowly ovate to elliptic-oblong, tapering gradually to the long-acuminate apex, obtuse to subtruncate at the base (rounded in broader laminae), somewhat unequal with the sides of the laminae 0–4 mm. distant on the petiole, the lamina drying thin-chartaceous, smooth on both surfaces, usually minutely puberulent on the veins above (often only near the petiole), sparsely and minutely puberulent on the veins beneath (rarely glabrous), the 3 to 5 pairs of major secondary veins usually arising from the lower third of the midvein, upper secondaries arising at angles of 10–30 degrees and strongly ascending, major veins often deeply impressed above, tertiary veins prominent beneath and often subparallel. Inflorescence free of the leaf-base of the same node in early stages, erect, 4–8 cm. long, often purple or dark reddish in color, peduncle 5–12 mm. long, 0.6–1 mm. thick, sparsely to densely puberulent with short (0.2 mm.) hairs or occasionally glabrous, flowering portion about 3 mm. thick at anthesis and 4 mm. thick in fruit, the flowers congested; floral bracts 0.3–0.6 mm. broad and triangular or slightly cupulate from above, glabrous centrally but with a dense border of short (0.1–0.2 mm.) often purple hairs, not usually forming distinct bands on the spike; anthers 0.2–0.3 mm. long, about 0.2 mm. broad, thecae dehiscing laterally; pistil with 3 distinct (0.1 mm.) stigmas; fruit obpyramidal-trigonous by compression, about 0.7 mm. thick, truncate at the apex and slightly depressed in the center (dry), glabrous.

Plants of the wet montane forests subject to the moist Caribbean winds, between 1,000 and 2,200 m. elevation. The species is endemic to Costa Rica and has only been collected along the edge of the Meseta Central between Los Angeles de San Ramon and Tapanti, southeast of Cartago.

An unusual piper distinguished by its striking venation, short petioles, long-acuminate often narrow laminae, and purplish young spikes. The wet montane habitat and usually puberulent leaves distinguish this species from the closely allied *P. xanthostachyum* and *P. concepcionis*. The latter species are often climbers, as is *P. subsessilifolium*. The strongly ascending secondary veins and prominent tertiary veins are usually dark on a pale background on the lower surface. Flowering and fruiting spikes are rare in collections.

Piper tenuimucronatum C.DC., Smiths. Misc. Coll. 71, no. 6:12. 1920. *P. tractifolium* Trel., Contr. U. S. Nat. Herb. 26:166. 1929. *P. perfugii* Trel. in Woodson & Schery, Ann. Mo. Bot. Gard. 27:295. 1940. Figure 10.

Small shrubs 1–3 m. tall, older nodes conspicuously thickened, leafy internodes 1–7 cm. long, 1–4 mm. thick, glabrous; shoot-apex emerging from within the prophyll and partly enclosed by the stipule at flowering nodes, the prophyll becoming 25 mm. long, glabrous and drying pale brown. Leaves usually distichous, petioles 5–11 mm. long, 0.6–1.4 mm. thick, glabrous, a stipular development present and deciduous, the stipule forming a ligule-like structure 2–10 mm. long (above the petiole base) and about 2 mm. broad, opening away from the petiole (adaxially) and similar in color and texture to the prophyll, the deciduous stipule leaving a vaginate area and marginal scar-tissue only at the base at flowering nodes; laminae 6–12 cm. long, 2–5 cm. broad, narrowly ovate or elliptic, acuminate at the apex with the tip often narrowed to a bristle-like extension 0.5–2 mm. long and about 0.2 mm. thick, obtuse to acute at the unequal or subequal base, sides of the lamina 0–3 mm. distant and decurrent on the petiole, lamina drying chartaceous and much paler beneath than above, smooth and glabrous on both surfaces, major veins flat above, the 2 or 3 pairs of major secondary veins arising from the lower half of the midvein, upper secondaries arising at angles of 20–45 degrees, arcuate ascending. Inflorescence free or partly enclosed in the stipular development of the leaf-base in early stages, usually subtended by scar-tissue on the sides adjacent to the leaf-bases in later stages, apparently erect, 2.5–8 cm. long, peduncles 10–20 mm. long, 0.5–1 mm. thick, glabrous, flowering portion 2–3 mm. thick at anthesis, becoming 3–4 mm. thick in fruit, the flowers congested, occasionally with a short (2–3 mm.) flowerless tip; floral bracts 0.6–0.8 mm. broad and crescent-shaped or broadly triangular from above, glabrous centrally with a margin of short (0.1–0.3 mm.) hairs, forming bands around the spike in fruiting stages; anthers 0.4–0.5 mm. long, about 0.4 mm. broad, often with a gland-like apex, dehiscing laterally; pistil with 3 short (0.2 mm.) sessile stigmas; fruit laterally compressed during development, mature fruit not seen, glabrous and apparently truncate at the apex with sessile stigmas, fleshy.

Plants of the wet montane forest formations between 1,200 and 2,000 m. elevation. Known only from near San Isidro, Heredia, and Tapanti, Cartago, in Costa Rica and from the highlands of Chiriqui, Panama.

A small piper of shaded sites distinguished by the smaller leaves, unusual stipular development, and lack of pubescence on vegetative parts. This species is very closely related to *P. carpinteranum* with puberulent leaves often lobed at the base. *Piper decurrens* differs in venation, leaf-form, and lack of the stipular development and unusual leaf-tip. These three montane pipers are a natural group probably related to *P. sinugaudens*.

Piper terrabanum C.DC., Bull. Soc. Bot. Belg. 30, pt. 1:217. 1891. *P. dilatatum* var. *acutifolium* C.DC., l.c. 217. *P. cyphophyllum* C.DC., Anal. Inst. Fis.-Geog. Costa Rica 9:167. 1897. *P. laevifolium* C.DC., l.c. 169, non Blume. *P. falcigerum* Trel., Contr. U. S. Nat. Herb. 26:147. 1929. *P. sinuatifolium* Trel., l.c. 147. *P. sublaevifolium* Trel. ex C.DC., l.c. 147. *P. auriculiferum* Trel., l.c. 156.

P. celatipetiolum Trel., l.c. 156. *P. disparifolium* Trel., l.c. 156. *P. anisophyllum* Trel., l.c. 157. *P. celatipetiolum* var. *brenesi* Trel. in Cufod., Archivo Bot. Sist. Fitogeog. & Genet. 10:26. 1934. *P. anisophyllum* var. *granulatum* Trel. in Standl., Field Mus. Bot. 18:331. 1937. *P. verruculaepetiolum* Trel. in Standl., l.c. 368. 1937. *P. wedelii* Yuncker, Ann. Mo. Bot. Gard. 37:56. 1950. Figure 14.

Shrubs to 2 (rarely 3) m. tall, older nodes conspicuously thickened, leafy internodes 2–7 cm. long, 1–3.5 mm. thick, glabrous or rarely very minutely (0.05 mm.) puberulent; shoot-apex emerging from within the prophyll and free of the leaf-base at flowering nodes, the prophyll becoming 20–35 mm. long, glabrous or minutely puberulent along the midrib, 2 mm. broad at the base (unopened), drying brown. Leaves usually distichous, petioles 3–12 (20) mm. long, 1–2.2 mm. broad, with a small ridge of scar-tissue on a minute (0.5 mm.) stipule-like structure at the base, glabrous or minutely puberulent; lamina (12) 15–28 (32) cm. long, 5–11 (14) cm. broad, usually broadly elliptic and widest near the center but occasionally ovate or obovate, tapering gradually to the narrowly acuminate apex, the narrowed tip often over 2 cm. long, narrowed to the unequal base, often acute on one side and cordulate or rounded on the other, sides of the lamina 2–8 mm. distant on the petiole, the lamina drying thin-chartaceous and somewhat paler beneath than above, smooth or very slightly scabrous on either surface, glabrous above and minutely (0.1 mm.) puberulent on the veins beneath, less densely puberulent near the base of the lamina, major veins usually flat above, the 3 to 6 pairs of major secondary veins usually arising in the lower two-thirds of the midvein, upper secondaries arising at angles of 20–40 degrees, arcuate-ascending and 3–7 cm. distant along the same side of the midvein. Inflorescence free of the leaf-base of the same node in early stages, erect, 7–15 cm. long, peduncle 7–14 mm. long, 0.8–1.8 mm. thick, glabrous or sparsely and very minutely puberulent, flowering portion 1.4–2.5 mm. thick at anthesis, 2.2–3.5 mm. thick in fruit, the flowers congested; floral bracts 0.3–0.7 mm. broad and triangular above, glabrous in the center with a densely ciliolate margin of whitish hairs about 0.1 mm. long, not usually forming conspicuous bands around the spike and usually obscure in fruit; anthers 0.2–0.3 mm. long, 0.2–0.3 mm. broad, thecae dehiscing laterally; ovary with distinct stigmas about 0.2 mm. long; fruit conic or obpyramidal-trigonous by compression, 0.6–1 mm. thick, truncate apically and with a depression around the sessile stigmas on drying, glabrous and minutely pellucid-muricate.

Plants of shaded sites in wet forest formations between sea level and 1,000 m. elevation on both the Caribbean and Pacific slopes. The species ranges from Costa Rica southward to Panama and undoubtedly into northern South America (under a host of names).

The species is distinguished by the moderately large, thin leaves, unequal at the base and long-acuminate apically, the slender spikes, small trigonous fruit with a depression at the apex, and generally glabrous parts. *Piper terrabanum* is very closely related to *P. otophorum* with auriculate leaf-base and densely puberulent peduncles. Together, these species are related to *P. dilatatum* and its allies; a group of species with very similar floral morphology.

Piper tonduzii C.DC., Anal. Inst. Fis.-Geog. Costa Rica 9:170. 1897. *P. ripense* C.DC., l.c. 169. 1897. *P. pallidifolium* C.DC., Bot. Gaz. 70:176. 1920. *P. nanum* C.DC., l.c. 180. *P. tonduzii* var. *semiherbaceum* Trel., Contr. U. S. Nat. Herb. 26:143. 1929. *P. rhodostachyum* Trel., l.c. 158. Figure 4.

Small shrubs 0.3–2 m. tall, the older nodes not conspicuously thickened, leafy internodes 1.5–7 cm. long, 1–3 mm. thick, densely puberulent with slender crooked hairs 0.5–1.8 mm. long; shoot-apex emerging from within the prophyll and from within a stipule-like development at flowering nodes, the prophyll becoming 10–16 mm. long, puberulent along the midrib and drying brown. Leaves usually distichous, petioles 3–10 mm. long, about 1 mm. broad, densely crisp-hairy, vaginate and with scar-tissue basally at all nodes, a short (2–3 mm.) stipular development present at flowering nodes and tearing off to produce a rim of scar tissue subtending the inflorescence; lamina 8–16 cm. long, 2.5–5 (6.5) cm. broad, lanceolate to narrowly ovate or narrowly elliptic, gradually tapering to the acute or acuminate apex, narrowed to the unequally cordulate base, the longer basal lobe about 5 mm. long and often obscuring the petiole, sides of the lamina 0–3 mm. distant on the petiole, the lamina drying chartaceous and often grayish-green on both surfaces, smooth and glabrous or sparsely puberulent above, conspicuously crisp-hairy beneath with slender crooked hairs 0.5–1.5 mm. long, venation flat or becoming deeply impressed above producing a bullate surface, prominent beneath, the 4–9 pairs of major secondary veins arising throughout the length of the midvein, central secondaries arising at angles of 25–65 degrees, ascending near the margin. Inflorescence at first included in the stipule-like development of the leaf-base of the same node and later subtended by a rim of scar-tissue continuous with the petiole, apparently erect in early stages, 2–6 cm. long, often with a short (2–4 mm.) slender flowerless tip, the flowers congested, peduncle 4–10 mm. long, less than 1 mm. thick but densely crisp-hairy, flowering portion 2–3 mm. thick at anthesis, becoming 5 mm. thick in fruit; floral bracts 0.5–1 mm. broad and U- or Y-shaped from above, sparsely puberulent proximally (above), not forming distinct bands around the spike; anthers 0.3–0.4 mm. long about 0.3 mm. broad, connective with a gland-like apex, thecae dehiscing laterally; pistil with a short (0.2–0.4 mm.) style with 2 (3) recurved stigmas; fruit usually rhombic by compression, becoming about 2 mm. thick, truncate and short-stylose apically, glabrous and smooth.

Plants of the wet Caribbean slopes and adjacent highlands, from sea level to 1,200 m. elevation. The species is known only from Costa Rica and eastern Nicaragua; probably flowering throughout the year.

A distinctive piper with lanceolate hirsute often bullate leaves pinnately veined, small spikes subtended by scar-tissue, and stylose ovary. The form of the bracts and fruit indicates a close relationship with *P. glabrescens*. *Piper tonduzii* may be confused with *P. deductum* but they do not share the same geographical range and differ in floral bracts and fruit.

Piper trigonum C.DC., Journ. Bot. 4:212. 1866. *P. trichopus* Trel., Contr. U. S. Nat. Herb. 26:25. 1927. *P. generalense* Trel. in

Standl., Field Mus. Bot. 18:344. 1937. *P. marginatibaccum* Trel. in Standl., l.c. 349. *P. acutissimum* var. *trichopus* Yuncker, Ann. Mo. Bot. Gard. 37:66. 1950. Figure 8.

Small shrubs 0.5–1.5 (2) m. tall, the older nodes slightly thickened, leafy internodes 1.2–5 cm. long, 1–2.2 mm. thick, minutely (0.1–0.4 mm.) puberulent with curved yellowish usually retrorse hairs appressed against the stem; shoot-apex emerging from within the prophyll and free of the leaf-base at flowering nodes, prophyll 6–16 (20) mm. long, blunt at the tip, minutely puberulent over the entire abaxial surface, brownish. Leaves usually distichous, petiole 3–6 (10) mm. long, 0.7–1.4 (1.8) mm. thick, densely puberulent, vaginate only at the base and without a stipular development at flowering nodes (but the base of the caducous prophyll may form a collar-like ridge on the stem above the leaf-base); laminae 9–16 cm. long, 2.5–4 (5.5) cm. broad, very narrowly elliptic-oblong (in ours) to oblong or lanceolate, short-acuminate at the apex, acute to obtuse at the slightly unequal base, sides of the lamina 0–3 mm. distant on the petiole, the lamina drying thin-chartaceous, smooth and glabrous above but ciliolate along the upper edge, densely puberulent on the veins beneath with appressed ascending yellowish hairs about 0.2 mm. long, venation flat above, the (3) 4–6 pairs of major secondary veins arising from the lower three-fourths of the midvein or gradually diminishing in size to the apex, occasionally forming connections near the margin, upper secondaries arising at angles of 20–40 (60) degrees and arcuate-ascending. Inflorescence free of the leaf-base of the same node in early stages, pendulous in fruit, 4–8.5 cm. long, peduncle 5–14 (17) mm. long, 0.5–1 mm. thick, puberulent, flowering portion about 2 mm. thick, becoming 3–4 mm. thick in fruit, the flowers congested; floral bracts 0.3–0.5 mm. broad and triangular or rounded above, glabrous with an inconspicuous (0.1 mm.) margin of hairs, not forming bands around the spike; anthers 0.2–0.3 mm. long, 0.3–0.4 mm. broad, connective forming a conspicuous (0.1 mm.) pellucid tip, thecae dehiscing laterally; pistil conical at the apex with 3 stigmas 0.1–0.2 mm. long; fruit obpyramidal-trigonous, about 1.5 mm. thick, truncate above with a depression (dry) around the sessile stigmas, glabrous and pellucid punctate above (in ours).

Plants of shaded sites known in Costa Rica only from the General Valley between 1,000 and 1,200 m. elevation. Two fruiting collections were made by Alexander Skutch in August (*2846*) and December (*2183*). The species ranges to southern Colombia.

Piper trigonum is recognized by the pinnate venation, small curved hairs, anthers with gland-like disc, trigonous fruit with deep central depression above when dry, and restricted habitat. Costa Rican specimens differ from Colombian material in the narrower leaves with secondary veins arising at a more narrow angle, but these characters are quite variable on an individual plant. I prefer to place these plants under the older name until these very closely related taxa are better known. Among Costa Rican species, *P. arieianum* is the closest relative differing in pubescence, fruit less depressed apically (dry), leaf-venation, and range.

Piper tuberculatum Jacq., Collect. 2:2, pl. 211. 1788. Figure 8.

Small shrubs to 2 or 3 m. tall or occasionally becoming trees 6 m. tall with trunks 18 cm. in diameter at the base, the older nodes conspicuously thickened, leafy internodes 1–4 (6) cm. long, 1–3 (4) mm. thick, minutely (0.1 mm.) puberulent or glabrescent, the younger stems often with small (1–3 mm.) tubercles that become very brittle dried; shoot-apex emerging from within the sheathing leaf-base at flowering nodes and free of the prophyll, the prophyll minute (–1 mm.) and lateral but larger at the base of new axillary branches. Leaves distichous, petioles 1–7 mm. long, 1–2 mm. thick, glabrous or densely and very minutely (0.05 mm.) puberulent, often with conspicuous warty tubercles to 2 mm. long, these usually pink but drying brown and brittle, deeply vaginate with the adaxial petiole margins extending 1–2 mm. beyond the base of the lamina to form a ligule-like structure, scar tissue not usually evident on the petiole; lamina 4–12 cm. long, 2–6 cm. broad, oblong or somewhat ovate, tapering abruptly to the obtuse and often blunt apex, tapering abruptly to the unequal base, the shorter side acute to rounded, the longer side usually rounded and cordulate at the very base and sometimes overlapping the petiole, sides of the lamina 2–8 mm. distant on the petiole, the lamina drying chartaceous and usually grayish in color, smooth and glabrous or glabrescent above, minutely puberulent on the veins beneath, the 4 to 10 pairs of major secondary veins arising from throughout the length of the midvein, central secondaries arising at angles of 50–80 degrees and joining near the margin but not forming a definite marginal vein. Inflorescence free of the leaf-base of the same node in early stages, erect, 4–14 cm. long; peduncle 6–12 (18) mm. long, about 1–2 mm. thick, minutely (0.05–0.2 mm.) puberulent, flowering portion 2–5 mm. thick, the flowers densely crowded; floral bracts 0.5–0.7 mm. broad above, triangular from above but U-shaped near the base, with a ciliolate margin of whitish hairs and glabrous center, occasionally forming conspicuous bands around the spike; anthers 0.3–0.4 mm. long, 0.3–0.5 mm. broad, the thecae usually divergent at the base and dehiscing laterally or upward, connective forming a minute (0.05 mm.) tip above the thecae; pistil with 3 or 4 short sessile stigmas; fruit at first laterally compressed but becoming rounded at maturity, about 1–1.5 mm. thick, glabrous and broadest at the truncated apex, the stigmas often borne in a depression at the top of the dried fruit.

A species of the seasonally very dry areas of the Pacific slopes in deciduous and semi-deciduous forest formations from sea level to 1,000 m. elevation. Probably flowering throughout the year and confined to shaded sites or moist soils in the dry lowlands of Guanacaste. The species ranges from southern Mexico to South America and the West Indies.

A very distinctive piper characterized by the blunt oblong leaves with tuberculate petioles and pinnate venation to the top of the lamina, small prophyll that does not enclose the shoot-apex, and seasonally dry habitat. *Piper tuberculatum* is related to *P. arboreum* and *P. cordulatum* C.DC. of Panama.

Piper umbricola C.DC., Bull. Soc. Bot. Belg. 30, pt. 1:215. 1891. *P. brachistopodium* C.DC., Bot. Gaz. 70:182. 1920. *P. nodosum* C.DC., l.c. 185. *P. disparipes* Trel., Contr. U. S. Nat. Herb. 26:162. 1929. *P. imparipes* Trel., l.c. 163. 1929. *P. papulatum* Trel., l.c. 163. *P. injucundum* Trel., l.c. 181. *P. captum* Trel. in Standl., Field Mus. Bot. 18:335. 1937. *P. pustulicaule* Trel. in Standl., l.c. 357. 1937. Figure 13.

Shrubs 1–3 m. tall, older nodes conspicuously thickened, leafy internodes 1.5–7 cm. long, 1.5–4 mm. thick, glabrous or sparsely and very minutely (0.05–0.1 mm.) puberulent; shoot-apex emerging from within the prophyll and free of the leaf-base at flowering nodes, prophyll 10–22 mm. long, acute, glabrous and drying dark brown. Leaves usually distichous, petioles 4–12 mm. long, 1–2 mm. thick, glabrous or very minutely papillate-puberulent, vaginate only at the base and with a very short (0.3–1 mm.) ciliate ligule-like development at flowering nodes; laminae 12–24 cm. long, 4–9 cm. broad, elliptic to ovate or somewhat rhombic, the two sides often unequal in width, usually tapering gradually to the acuminate apex, narrowed below the middle to the obtuse and unequal base or rounded in broader laminae, sides of the lamina 2–8 mm. distant on the petiole, the lamina drying chartaceous and usually dark in color, smooth glabrous and somewhat lustrous above, very minutely (0.03–0.1 mm.) puberulent on the veins beneath, venation only rarely becoming impressed in age above, the 3 or 4 pairs of secondary veins usually arising at angles of 20–40 degrees. Inflorescence free of the leaf-base of the same node in early stages, erect, 5–11 cm. long, peduncles 2–8 (12) mm. long, 1.3–2.2 mm. thick, glabrous, flowering portion 2–3.5 mm. thick at anthesis, becoming 4–5 mm. thick in fruit, the flowers congested; floral bracts 0.4–0.5 mm. broad, triangular and glabrous centrally above with a margin of minute (0.1 mm.) hairs, the bracts and anthers forming distinct bands around the spike; anthers 0.1–0.2 mm. long, 0.2–0.3 mm. broad, connective very broad with the divergent thecae dehiscing upward; pistil obscured by bracts and anthers; fruit 0.7–0.9 mm. thick, rounded or laterally compressed, truncate above with a central depression around the 3 small sessile stigmas, glabrous.

Plants of the evergreen forest formations between 500 and 1,300 m. elevations on the Meseta Central and Pacific watershed. Flowering material has been collected between November and March. The species is known from the highlands of Guanacaste to the Panamanian border and is to be expected in Chiriqui.

Piper umbricola is characterized by the smooth leaves glabrous above, relatively thick banded spikes, anthers dehiscing upward, glabrous fruit, and restricted habitat. This species is very closely related to *P. chrysostachyum* and these taxa may prove to be conspecific. Together they are related to the scabrous-leaved *P. hispidum* and its allies. All the "species" of this alliance must be considered first approximations and no more.

Piper urophyllum C.DC., Anal. Inst. Fis.-Geog. Costa Rica 9:170. 1897. *P. sarapiquinum* C.DC., l.c. 166. 1897. Figure 9.

Slender stemmed shrubs to 3 (occasionally 5) m. tall, the older nodes conspicuously thickened, leafy internodes 1.2–5 cm. long, 0.7–1.8 mm. thick, glabrous and often drying with longitudinal ridges; shoot-apex emerging from the prophyll and free of the leaf-base at flowering nodes, the prophyll 4–8 (15) mm. long and drying grayish- or yellowish-green, blunt at the tip, glabrous. Leaves usually distichous, petiole 4–10 mm. long, 0.5–1.5 mm. thick, glabrous, deeply grooved adaxially, without scar-tissue or stipule-like structures at flowering nodes; lamina 7–13 cm. long, 2.5–5.5 cm. broad, usually broadly elliptic in outline and tapering abruptly to the caudate or caudate-acuminate apex, the tip 1–2 cm. long and about 2–3 mm. broad, acute to obtuse at the base, sides of the lamina arising together or 1–2 mm. distant on the petiole, the basal margins thickened at the petiole, the lamina drying stiffly chartaceous and grayish-green, smooth and glabrous on both surfaces, the midvein flat or prominulous above, more prominent beneath, the (3) 5–7 pairs of major secondary veins arising throughout the length of the midvein, central secondaries arising at angles of 30–60 degrees, the margin often curled under on drying; stomates surrounded by what appear to be concentric circles of cells (100×) on the lower epidermis. Inflorescence free of the leaf-base of the same nodes in early stages, apparently vertical-erect in early stages and very slender (2 mm.), becoming 8 cm. long and 3–4 (abnormally 7) mm. thick in fruit; peduncle 6–12 mm. long, 0.5–1 mm. thick, glabrous, the flowers loosely or densely crowded; floral bracts about 0.5 mm. broad and triangular or somewhat Y-shaped from above, glabrous on the upper part, not forming bands around the spike; anthers about 0.3 mm. long and 0.2 mm. broad, dehiscing laterally; pistil conical at the apex with 2 or 3 poorly differentiated stigmas; fruit becoming 2 mm. broad and transversely flattened (broadest perpendicular to the axis of the spike), glabrous, probably congested and becoming separate on drying, thickest near the apex and truncate or slightly conical above, the stigmas subtended by a minute (0.2 mm.) disc-like projection.

Plants of wet evergreen forest formations of the Caribbean slope and collected only near Tilaran and Golfo Dulce on the Pacific slope; from sea level to 1,000 m. elevation. The species is known only from Costa Rica and the Department of Zelaya, Nicaragua. Probably flowering throughout the year.

A very distinctive species easily recognized by the pinnately veined caudate-acuminate leaves with gland-like enlargement of the base of the lamina, slender spikes with unusual fruit, and lack of pubescence. This species is probably related to *P. darienense*, *P. reticulatum*, and perhaps to *P. grande* and its allies.

Piper urostachyum Hemsley, Biologia Cent. Amer. 3:57, tab. 72. 1882. *P. lanuginosum* C.DC., Anal. Inst. Fis.-Geog. Costa Rica 9:159. 1897. *P. arcte-acuminatum* Trel., Contr. U. S. Nat. Herb. 26:139. 1929. *P. cuasianum* Standl., Field Mus. Bot. 22:136. 1940.

P. dimorphotrichum Yuncker, Ann. Mo. Bot. Gard. 37:52. 1950. Figure 7.

Slender shrubs to 2.5 m. tall, leafy internodes 1.5–6 (13) cm. long, 1.5–3.5 mm. thick, usually densely hirsute with brownish hairs of varying (0.5–4 mm.) length; shoot-apex emerging from within the prophyll and free of the leaf-base at flowering nodes, the prophyll about 10–15 mm. long, puberulent abaxially. Leaves usually distichous, petioles usually less than 9 mm. long at flowering nodes (to 25 mm. at sterile nodes), about 2–3 mm. thick, densely hirsute, a stipular-like development absent at flowering nodes or obscured by the vestiture; laminae 12–22 (26) cm. long, 5–10 (14) cm. broad, narrowly rhombic-ovate to ovate, elliptic or occasionally obovate, tapering gradually to the acuminate apex, the apex often quite narrow, narrowed to the rounded and subcordate or cordulate base, the basal lobes subequal or unequal, the lower lobe becoming 5–15 mm. long and often overlapping the petiole, sides of the lamina 1–5 mm. distant on the petiole, the lamina drying thin-chartaceous and usually dark in color, upper surface smooth or slightly roughened with the hairs confined to the veins or throughout, lower surfaces usually conspicuously puberulent with smaller (0.4 mm.) and longer (2–4 mm.) crooked hairs, the major veins usually impressed above, the 3 or 4 pairs of major secondary veins arising from the lower half of the midvein, upper secondaries arising at angles of 20–35 degrees, tertiary veins prominent beneath. Inflorescence free of the leaf-base of the same node in early stages, pendulous from early stages, 5–12 cm. long; peduncles 2–6 cm. long, about 1 mm. thick, densely hirsute or villous, flowering portion 2–4 mm. thick at anthesis, becoming 5 mm. thick in fruit, often with a slender flowerless apex 5–12 mm. long; flowers loosely crowded; floral bracts 0.8–1.3 mm. broad and triangular or U-shaped from above, glabrous in the center and fringed with conspicuous (0.1–0.6 mm.) yellowish-brown hairs, occasionally forming bands around the young spike; anthers 0.4–0.6 mm. long, 0.3–0.4 mm. broad, with a conspicuous (0.1–0.2 mm.) gland-like disc at the apex, thecae dehiscing laterally and apparently unilocular; pistils with slender styles about 0.5 mm. long with conspicuous recurved stigmas; fruit round in cross-section or rarely laterally compressed, 1–2 mm. thick, truncate and stylose apically, glabrous and somewhat muricate.

Plants of the shade of wet forest formations between sea level and 1,000 m. elevation on the Caribbean slope and southwestern Pacific slope in Costa Rica. The species ranges from Nicaragua to Darien, Panama; flowering throughout the year.

A distinctive species with relatively short (2–6 cm.) spikes on long-pendulous peduncles, unusual vestiture, gland-tipped anthers, and stylose pistils. *Piper fallens* of Honduras is very similar but with much shorter peduncles. *Piper setosum* Trel. & Yuncker is very closely related but possesses shorter spikes and very different prophylls. These species with apiculate anthers and distinctly stylose pistils are an isolated group probably related to *P. phytolaccaefolium* and its allies.

Piper veraguense C.DC. in DC., Prodr. 16:294. 1869. *P. peltaphyllum* C.DC., Bull. Soc. Bot. Belg. 30, pt. 1:220. 1891. *P. peltaphyllum* var. *lasvueltasanum* C.DC., Bot. Gaz. 70:172. 1920. Figure 2.

Slender few-branched herbs to about 1 m. tall, stems drying pale green and with longitudinal grooves, leafy internodes 6–16 cm. long, 2.5–4.5 mm. thick; shoot-apex emerging from the prophyll and free of the leaf-base at flowering nodes, the prophyll becoming 4 cm. long, glabrous and with a blunt apex. Leaves in a spiral, peltate with the petiole attached 3–7 cm. from the basal edge; petiole 10–20 cm. long, about 2–3 mm. thick, vaginate only at the base at flowering nodes but with winged stipule-like margins at sterile nodes, glabrous; lamina 20–32 cm. long, 11–19 cm. broad, gradually tapering to the long-acuminate apex, round or emarginate at the base, drying chartaceous and gray-green, smooth and glabrous on both surfaces, the venation prominulous above and below, with 1 major midvein and 4 to 6 primary veins radiating outward from the petiole-attachment, with 2 to 4 pairs of major secondary veins arising from the lower half of the midvein, the upper secondaries arising at angles of 30–45 degrees and arcuate ascending, the tertiary veins forming concentric circles around the petiole attachment, margin of the blade often curled under on drying. Inflorescence free of the leaf-base of the same node in early stages, slender and erect, 10–16 cm. long; peduncle 12–20 mm. long, 0.8–1.6 mm. thick, glabrous, flowering portion 8–14 cm. long, becoming about 4 mm. thick in fruit, the flowers and bracts numerous and densely crowded; floral bracts 0.6–1 mm. broad above and triangular in outline, with minute inconspicuous hairs around the margin, not forming conspicuous bands around the spike; anthers 0.2–0.3 mm. long, often with orange pellucid dots, the filaments sometimes visible; pistil with sessile poorly differentiated stigmas; fruit densely crowded and usually 3-angled by compression, obpyramidal, about 1 mm. thick, glabrous with sessile stigmas.

Known in Costa Rica only from the wet forest formations of the Caribbean slopes between 200 and 800 m. elevation. The collections seen are: *Pittier 2522*, near Carillo; *Skutch 4676*, near Turrialba; *Tonduz 13189*, near Tucurrique; and *Burger & Ramirez 3988*, near the Rio Pacuare. The species also occurs in Panama and probably Colombia (see below).

An extraordinary species because of the peltate leaves with tertiary veins forming a circular pattern near the petiole. The plants that I have seen had the lamina loosely attached on the petiole and therefore hanging vertically with the flat "upper" surface oriented toward the light on a steep slope. The nature of the prophyll and fruit indicate a relationship with *Piper grande* and its allies. *Piper albert-smithii* Trel. & Yuncker and *P. mutisii* Trel. & Yuncker of Colombia share these unusual leaves and are probably synonymous with *P. veraguense*.

Piper verruculosum C.DC., Seem. Journ. Bot. 4:215. 1866 (Photo!). *P. nudicaule* C.DC., Anal. Inst. Fis.-Geog. Costa Rica 9: 162. 1897 (Photo). *P. carnosicaule* Trel., Contr. U. S. Nat. Herb. 26:168. 1929. *P. zingiberinum* Trel. in Standl., Field Mus. Bot. 18: 370. 1937. Figure 10.

Small shrubs 1–2 (3) m. tall and often with spreading branches, older nodes conspicuously thickened, leafy internodes 1.2–7 cm. long, 1–2.5 mm. thick, glabrous; shoot-apex emerging from within the prophyll and free of the leaf-base at flowering nodes, prophyll 8–16 mm. long, narrow and usually blunt apically, glabrous or with very minute (0.03 mm.) hairs along the midrib abaxially, drying dark. Leaves usually distichous, petioles 2–10 mm. long, 0.7–2 mm. thick, glabrous, vaginate only at the base and lacking a stipular development at flowering nodes; laminae 7–14 cm. long, 2.5–5.5 cm. broad, narrowly ovate to elliptic or oblong, often asymmetric with the sides of the blade very unequal in area, tapering gradually to the acuminate or long-acuminate apex, obtuse at the unequal and often oblique base, sides of the lamina 1–4 mm. distant on the petiole, the lamina drying thin-chartaceous, grayish brown above and pale gray beneath, smooth and glabrous on both surfaces, venation flat or slightly raised above, the 2 or 3 pairs of major veins arising from the lower half of the midvein, upper secondaries arising at angles of 20–45 degrees, arcuate-ascending. Inflorescence free of the leaf-base of the same node in early stages, probably erect, 4–8 cm. long, peduncles 4–9 mm. long, 0.5–1 mm. thick, glabrous, strongly ridged on drying, flowering portion about 1.3 mm. thick at anthesis and 2 mm. thick in fruit, the flowers congested; floral bracts 0.3–0.4 mm. broad and triangular or somewhat U-shaped above, glabrous above with a margin of minute (0.1 mm.) hairs beneath, not forming bands around the spike; anthers 0.2–0.3 mm. long, about 0.2 mm. broad, connective narrow and expanded at the apex to form a small (0.05 mm.) pellucid tip, thecae dehiscing laterally; pistil with a short (0.1 mm.) style and 2 or 3 small (0.1 mm.) stigmas; fruit obpyramidal-trigonous, about 0.5 mm. thick and slightly rounded above stigmas sessile, very minutely (0.03 mm.) granular-puberulent above.

A species of the shade of cloud forest on the Caribbean watershed from above the San Carlos plain and near Zarcero in Alajuela to Muñeco, Cartago, between 1,200 and 1,800 m. elevation. Flowering collections have been made in January and August and a single fruiting collection in March.

Piper verruculosum is distinguished by the generally glabrous parts, thin asymmetric leaves and very slender spikes with narrow anthers and short-styled pistils. This species looks very similar to *P. virgultorum* but differences in prophyll and floral parts indicate that there is no close relationship. *Piper scansum* Trel. & Yuncker of northwestern Colombia is very similar. Among Costa Rican species the very variable *P. aequale* appears to be the most closely related.

Piper villiramulum C.DC., Smiths. Misc. Coll. 71, pt. 6:11. 1920. *P. hirsutum* var. *laevius* C.DC., Bull. Soc. Bot. Belg. 30, pt. 1: 204. 1891. *P. hirsutum* var. *parvifolium* C.DC., l.c. 203. 1891. *P. hirsutum* var. *longepilosum* C.DC., Anal. Inst. Fis.-Geog. Costa Rica 9:160. 1897. *P. talamancanum* Trel., Contr. U. S. Nat. Herb. 26:173. 1929. *P. laevius* (C.DC.) Trel., l.c. 174. *P. comatum* Trel., l.c. 175. *P. granulatum* Trel., l.c. 175. *P. leucophlebium* Trel., l.c. 176. *P. bocasense* Trel. in Standl., Field Mus. Bot. 18:333. 1937. Figure 12.

Shrubs or small trees, 1–3 (4) m. tall, older nodes slightly thickened, leafy internodes 1–10 cm. long, 1.2–4 mm. thick, hirsutulous with yellowish often retrorse hairs 0.3–2.5 mm. long; shoot-apex emerging from within the prophyll and free of the leaf-base at flowering nodes, prophyll 8–20 mm. long, acute, puberulent along the midrib abaxially with the glabrous margins drying dark brown. Leaves usually distichous, petioles 3–10 (20) mm. long, 1–2 mm. thick, densely crisp-puberulent or hirsutulous, vaginate only at the base and a stipular development absent or small (0.5–1.5 mm.) at flowering nodes; laminae 9–20 (24) cm. long, 2.5–9 cm. wide, narrowly to broadly ovate or ovate-lanceolate, usually tapering gradually to the acuminate apex, obtuse or rounded at the unequal base, sides of the lamina 1–5 mm. distant on the petiole, the lamina drying thin to stiffly-chartaceous, scabrous above with slender hairs 0.5–1.5 mm. long, densely hirsutulous beneath, venation often becoming impressed and the laminae rugose in age, the 3 to 5 pairs of major secondary veins arising from the lower half of the midvein, prominent beneath, upper secondaries arising at angles of 10–30 degrees and arcuate-ascending. Inflorescence free of the leaf-base of the same node in early stages, erect, 6–11 cm. long, peduncle 4–8 (14) mm. long, 0.7–1.8 mm. thick, densely to very sparsely crisp-puberulent, flowering portion 2–3.5 mm. thick at anthesis, about 4 mm. thick in fruit, the flowers congested; floral bracts 0.3–0.6 mm. broad, rounded or triangular from above and glabrous centrally with a margin of whitish hairs 0.1–0.2 mm. long, forming bands around the spike in early stages; anthers 0.1–0.2 mm. long, 0.2–0.4 mm. broad, connective broad basally with the divergent thecae dehiscing upward; pistil obscured by bracts and anthers; fruit becoming laterally compressed, 0.3×0.6 mm. thick, truncate above with a slight depression around the small sessile stigmas, minutely puberulent above, pellucid muricate on the sides.

Plants of lower elevations (0–1,000 m.) in open and shaded sites throughout Costa Rica except for the deciduous (tropical dry) forest formations of Guanacaste; probably flowering throughout the year. The species ranges from Nicaragua to Panama.

Piper villiramulium is characterized by the scabrous leaves pubescent above and usually widest below the middle, usually open habitat at lower elevations, anthers opening upward, and fruit puberulent above. This species is closely related to *P. hispidum* and differs primarily in the stipular development and pubescence on the upper leaf-surface. Two taxa which may prove to be conspecific

with *P. villiramulum* are *P. perhispidum* and *P. capacibracteum*. Both of the latter have larger anthers and fruit and are found only above 1,000 m. elevation. *Piper villiramulum* is closely related to *Piper eriopodon* (Miq.) C.DC. of northern South America. Together these species form a group parallel with and very difficult to separate from *P. hispidum* and its allies. There may be intergradation between this species and *P. polytrichum* in the General Valley.

Piper virgultorum C.DC., Bot. Gaz. 70:173. 1920. *P. subquadratum* Trel., Contr. U. S. Nat. Herb. 26:174. 1929. Figure 10.

Probably small shrubs, older nodes somewhat thickened, leafy internodes 1.5–6 cm. long, 1–3 mm. thick, glabrous or very minutely (0.02–0.1 mm.) puberulent; shoot-apex emerging from within the prophyll and free of the leaf-base at flowering nodes, prophyll 3–6 mm. long, acute, minutely (0.1–0.3 mm.) puberulent abaxially, drying pale brown. Leaves usually distichous, petioles 3–6 mm. long, 0.8–1.5 mm. thick, glabrous, vaginate only at the base and with a small (0.2–1 mm.) ligule-like development at flowering nodes; lamina 6–17 cm. long, 3–7 cm. broad, subrhombic to elliptic or ovate with the two sides of the lamina often quite unequal in width, acuminate or caudate-acuminate at the apex, narrowed to the unequally obtuse base or rounded on the longer side, sides of the lamina 1–5 mm. distant on the petiole, the lamina drying thin chartaceous and grayish in color, glabrous and smooth or very slightly scabrous on both surfaces, venation flat above and below, the 3 or 4 pairs of major secondary veins usually arising in the lower half of the midvein, upper secondaries arising at angles of 20–40 degrees. Inflorescence free of the leaf-base of the same node in early stages, erect, 4–9 cm. long, peduncle 3–8 (12) mm. long, 0.6–1.4 mm. thick, flowering portion about 2 mm. thick at anthesis and 2.8 mm. thick in fruit, the flowers congested; floral bracts about 0.3–0.4 mm. broad and triangular or rounded above, glabrous above or very minutely (0.1 mm.) puberulent proximally, occasionally forming bands around the spike together with the stamens; anthers 0.1–0.2 mm. long, 0.2–0.3 mm. broad, connective broad with the diverging thecae dehiscing upward; pistil with 3 minute stigmas; fruit round or laterally compressed, 0.4–0.7 mm. thick, truncate above with a depression around the sessile stigmas (dry), very minutely (0.03 mm.) puberulent.

The species has only been collected from the lowland Caribbean area of southern Costa Rica; it ranges into Panama. Collections of flower and fruit have been made from February to August.

Piper virgultorum is characterized by the smaller almost glabrous asymmetric leaves, slender pinkish spikes, small apically dehiscing anthers, and slightly puberulent fruit. This species is very closely related to the scabrous and puberulent *P. erubescentispicum* of Panama. Both are unusual members of a difficult species-group comprising *P. hispidum* and its allies. *Piper terrabanum* is also related to this species, and *Tonduz 8570*, a paratype of *P. subaspericaule* (*P. terrabanum* in part) is this species.

Piper xanthostachyum C.DC., Anal. Inst. Fis.-Geog. Costa Rica 9:169. 1897. *P. pseudo-aduncum* C.DC., l.c. 166, photo. *P. matinanum* C.DC., l.c. 170. *P. bryogetum* C.DC., Bot. Gaz. 70:175. 1920. *P. opacibracteum* Trel., Contr. U. S. Nat. Herb. 26:148. 1929. *P. unguiculiferum* Trel., l.c. 149. *P. unauriculatum* Trel. in Standl., Field Mus. Bot. 18:367. 1937. Figure 11.

Climbing plants or shrubs with scandent branches, usually with conspicuously thickened older nodes, occasionally rooting from the older nodes, leafy internodes 2–6 cm. long, 1–2.5 mm. thick, glabrous or very minutely (0.05 mm.) papillate-puberulent; shoot-apex emerging from within the prophyll and free of the leaf-base at flowering nodes, the prophyll becoming 10 mm. long, glabrous and drying dark, about 1 mm. broad unopened. Leaves usually distichous, petioles 2–10 mm. long, 1–2 mm. thick, glabrous, grooved adaxially and a stipule-like structure absent at flowering nodes; lamina 10–18 cm. long, 3–8 cm broad, narrowly elliptic-oblong to narrowly obovate or ovate, acuminate at the apex, narrowed at the acute or obtuse subequal base, sides of the blade 0–3 mm. distant on the petiole and thickened (often to form a small lobe 1–2 mm. long) at the base, the lamina drying chartaceous and often grayish, smooth and glabrous on both surfaces, the major veins becoming impressed above, the 3 or 4 pairs of major secondary veins usually arising from the lower half of the midvein, upper secondaries arising at angles of 15–35 degrees and ascending, tertiary veins prominent beneath and subparallel, venation yellowish or pale-colored beneath (dry). Inflorescence free of the leaf-base of the same node in early stages, erect, 5–12 cm. long, peduncle 5–12 mm. long, 1–1.5 mm. thick, glabrous, flowering portion 2–3 mm. thick at anthesis, 3–4 mm. thick in fruit, the flowers congested; floral bracts 0.3–0.5 mm. broad and crescent- or U-shaped from above, glabrous centrally and with a dense margin of short (0.1–0.2 mm.) yellowish hairs; anthers 0.2–0.3 mm. long and equally broad, the thecae parallel and opening near the top, yellowish; pistil with 3 distinct (0.1 mm.) sessile stigmas; fruit obpyramidal-trigonous by compression, about 0.6–0.7 mm. thick and 1 mm. long, glabrous but densely pellucid-punctate, truncate at the apex.

Plants of the wet evergreen forest formations of both the Caribbean and Pacific slopes between sea level and 1,000 m. elevation. Endemic to Costa Rica but to be expected in western Panama; flowering throughout the year.

One of the few species of pipers possessing the scandent habit or rarely found as an epiphyte. The generally slender short-petiolate leaves with strongly ascending secondary veins, unusual thickening at the base of the lamina, crescent-shaped bracts, and apically dehiscing anthers further distinguish this species. (These anthers are unlike those of *P. hispidum* and its allies where the thecae are divergent.) Compare this species with *P. concepcionis* which may prove to be a large-leaved form of *P. xanthostachyum*. Also closely related are *P. subsessilifolium* of higher altitudes and *P. scleromyelum* with very different venation.

The name *P. xanthostachyum* has been used by Standley for very similar plants ranging from Guatemala to Honduras at elevations from 1,000 to 2,800 m. These plants have laterally dehiscing anthers and possess characteristics of both *P. xanthostachyum* and *P. subsessilifolium*. These more northerly pipers could be considered a third species or their somewhat intermediate character may indicate that all three entities are best placed in a single species. We have very few specimens in anthesis from Costa Rica; more definite conclusions will have to await better data.

Piper yucatanense C.DC., Linnaea 37:334. 1872. *P. thiemeanum* Trel., Amer. Jour. Bot. 8:214, pl. 5, f.2. 1921. *Arctotonnia pittieri* Trel., Proc. Amer. Phil. Soc. 73:328. 1934. *Ottonia thiemeana* (Trel.) Yuncker, Ann. Mo. Bot. Gard. 37:71. 1950. Figure 3.

Small sometimes scandent shrubs to 2 (4) m. tall or rarely slender trees, stems with the older nodes somewhat thickened, leafy internodes 1.2–6 (10) cm. long, 0.7–1.5 (2) mm. thick, glabrous or very minutely (0.1 mm.) puberulent; shoot-apex emerging from the prophyll and free of the leaf-base at flowering nodes, the prophyll 3–6 mm. long, glabrous and usually drying dark. Leaves usually distichous, petiole 2–5 mm. long and about 0.7 mm. thick at flowering nodes, glabrous or very minutely puberulent, vaginate only near the base and a stipule-like structure absent at flowering nodes; lamina 7–15 cm. long, 2.5–7 cm. broad, narrowly ovate to lanceolate, gradually tapering to the long-acuminate apex, obtuse to rounded and subcordate at the base, the basal sides very unequal but arising close (0–2 mm.) together on the petiole, the leaf-margin slightly thickened at the base and somewhat gland-like at the juncture with the petiole, drying thin-chartaceous, smooth and essentially glabrous on both surfaces, occasionally becoming slightly bullate above, venation palmate with 3 to 6 (7) primary veins, the 3 central veins united for 0–4 mm. from the base and reaching the apex of the blade, the midvein without major secondaries, epidermal cells of the lower leaf-surface with an undulate margin. Inflorescence free of the leaf-base of the same node in early stages, 1.5–5 cm. long and apparently pendulous; peduncle 6–15 mm. long, about 0.7 mm. thick, glabrous, flowers pedicellate and quite separate on the glabrous rachis, said to be fragrant; floral bracts cupulate or U-shaped and 0.3–0.4 mm. broad above, glabrous or sparsely and very minutely puberulent; pedicel 2–3 mm. long and 0.2–0.3 mm. thick, stamens borne on the base of the pistil above the pedicel and usually 5 (3 to 6) in number, anthers 0.3–0.4 mm. long, with a conspicuous connective and lateral dehiscence; body of the fruit ellipsoid and glabrous, becoming 3 mm. long and 2 mm. thick, the 3 or 4 well differentiated stigmas sessile or on the conical apex of the fruit.

Plants of low altitude (0–300 m.) wet or moist forest formations of the Caribbean coast. Ranging from southern Mexico to central Panama but not as yet recorded from Costa Rica.

Differing from all other pipers in our area by the pedicellate flowers and fruit. The species was placed in the genus *Arctottonia*

by Trelease and *Ottonia* by Yuncker. I do not believe that the development of pedicels warrants generic rank; *Piper nigrum*, the type species, is slightly pedicellate in fruit. Among our Costa Rican species there may be a relationship between *P. yucatanensis* and *P. urophyllum*; these share the unsual thickening at the base of the lamina, form of the epidermal cells, prophyll, and stigmas.

Piper zacatense C.DC., Anal. Inst. Fis.-Geog. Costa Rica 9:161. 1897. *P. zacatense* var. *percaudatum* C.DC., l.c. Figure 14.

Probably shrubs or slender tree-like plants, older nodes not conspicuously thickened, leafy internodes 2–8 cm. long, 1–3.5 mm. thick, densely hirsutulous with yellow-brown hairs of varying (0.5–2 mm.) length, shoot-apex emerging from within the prophyll and free of the leaf-base at flowering nodes, prophyll about 15 mm. long, densely puberulent, acute. Leaves usually distichous, petioles 6–12 (20) mm. long, 1.5–2 mm. thick, densely hispidulous, vaginate near the base and a ligule-like development absent or minute (0.5 mm.) at flowering nodes, scar-tissue usually present on the lower third of the petiole at flowering nodes; laminae 16–28 cm. long, 7–12 cm. broad, broadly elliptic or somewhat rhombic with the sides often unequal in width, broadest near the middle, tapering gradually to the long-acuminate apex or caudate-acuminate, the slender (5 mm.) tip 2–4 cm. long, obtuse or rounded on the longer side at the unequal base, sides of the lamina 1–4 mm. distant on the petiole, the lamina drying thin-chartaceous and dark in color, smooth or very slightly scabrous above, minutely puberulent on the veins above, hirsutulous beneath with grayish hairs 0.2–1.5 mm. long, venation becoming impressed above only on the old leaves, the 4 or 5 pairs of major secondary veins arising from the lower half of the midvein, upper secondaries arising at angles of 15–35 degrees, arcuate-ascending. Inflorescence free of the leaf-base of the same node in early stages, erect, 3.5–9 cm. long, peduncle 8–14 mm. long, 1–1.6 mm. thick, minutely (0.1–0.4 mm.) hirsutulous, flowering portion 1.8–2.5 mm. thick at anthesis, about 3.5 mm. thick in fruit, the flowers congested; floral bracts 0.3–0.5 mm. broad and triangular above, glabrous centrally with a margin of yellowish hairs 0.1–0.3 mm. long, not usually forming distinct bands around the spike) anthers 0.2–0.3 mm. long and 0.2–0.3 mm. broad, the connective narrow and the thecae only slightly divergent with lateral dehiscence, a minute gland-like tip sometimes present on the connective; pistil with 3 small sessile stigmas; fruit laterally compressed and tetragonous, about 0.7×0.9 mm. thick, truncate above with a depression around the stigmas (dry), sparsely and very minutely (0.05 mm.) puberulent above.

Plants of the lowland (0–500 m.) moist evergreen forest formations of the Pacific slope of southwestern Costa Rica. The species has only been collected in March and April by Pittier and Tonduz (*6828* the type, *9914, 9991, 10002*).

Piper zacatense is recognized by the large long-acuminate leaves, petioles with scar-tissue, slender spikes, small anthers, laterally compressed slightly puberulent fruit, and restricted range. This species resembles *P. dilatatum* but differs in the fruit which indicates a close

relationship with *P. hispidum* and its allies. This species has not been recollected in this century and I believe that it is a plant of the deep forest. Compare this species with *P. peracuminatum* of the Caribbean lowlands.

NAMES NOT TREATED IN THIS FLORA

The following are names in *Piper* based on collections from Costa Rica that have not been seen and are not treated in this Flora. Since this work treats only a small area and many species require monographic study over their entire range, loans from European herbaria were not requested.

P. curvipium Trel., Contr. U. S. Nat. Herb. 26:172. 1929, based on *P. hirsutum* var. *pallescens* C.DC.

P. geniculatum var. *longe-petiolatum* C.DC., Bull. Soc. Bot. Belg. 30, pt. 1:201. 1891.

P. gibbifolium C.DC., Bot. Gaz. 70:181. 1920.

P. guacimonum (C.DC.) Trel., Contr. U. S. Nat. Herb. 26:169. 1929.

P. hirsutum var. *pallescens* C.DC., Bull. Soc. Bot. Belg. 30, pt. 1: 204. 1891.

P. mombachanum C.DC., Bot. Gaz. 70:180. 1920.

P. nobile var. *minus* C.DC., Bull. Soc. Bot. Belg. 30, pt. 1:208. 1891.

P. san-marcosanum C.DC., Anal. Inst. Fis.-Geog. Costa Rica 9:158. 1897.

P. san-marcosanum var. *gracillimum* C.DC., l.c.

P. sepium var. *glabrum* C.DC., Bot. Gaz. 70:179. 1920.

P. sepium var. *guacimonum* C.DC., l.c.

P. subsessilifolium var. *palmanum* C.DC., Bot. Gaz. 70:183. 1920.

P. tablazosense C.DC., Engl. Bot. Jahrb. 10:288. 1888.

P. tractifolium var. *pubescens* Trel., Contr. U. S. Nat. Herb. 26:166. 1929.

P. tuisanum C.DC., Anal. Inst. Fis.-Geog. Costa Rica 9:163. 1897.

P. turrialvanum var. *magnifolium* C.DC., Anal. Inst. Fis.-Geog. Costa Rica 9:160. 1897.

P. umbellatum var. *tomentellum* C.DC. ex Schroeder, Candollea 3: 140. 1926.

P. zentanum C.DC., Bot. Gaz. 70:170. 1920.

POTHOMORPHE Miquel

Herbs or shrubs, stems with thickened nodes, not usually branching at flowering nodes; shoot-apex at first enclosed within the sheathing leaf-base at all nodes. Leaves alternate and in a spiral or distichous, petioles sheathing the stem at all nodes, lamina thin and entire, usually symmetrical. Inflorescence solitary or paired at a node, compound with simple spikes borne in an umbellate cluster on an axillary stalk (compound peduncle), the spikes at first subtended by caducous bracts (prophylls?); flowers bisexual and subtended by puberulent peltate bracts, densely congested, stamens two, pistil sessile with 3 minute and sessile stigmas, glabrous, fruit becoming angular by compression, pericarp dry.

Two species of *Pothomorphe* are found in Costa Rica, a third (*Piper heydei* C.DC.) is endemic to the Guatemalan highlands. Our two species are widespread, often in open or disturbed sites, and also occur in the Old World.

Pothomorphe differs from *Piper* only in the arrangement of spikes on a short axillary stalk (common peduncle). This inflorescence is probably a leafless axillary branch with the spikes borne on a greatly reduced axis. The species of *Pothomorphe* are very closely related and undoubtedly have a common origin. However, there are some species of *Piper* more closely related to *Pothomorphe* species than to certain other species of *Piper*. Thus, *Pothomorphe* appears to be a very natural taxon derived from *Piper* and only its rank, as genus or subgenus, is in question. I believe that the lack of a functional classification within *Piper* and these very unusual inflorescences make it advisable to maintain the genus *Pothomorphe*. The most closely related Costa Rican piper is probably *Piper marginatum* with very similar floral bracts and fruit.

1a. Leaves peltate, stems essentially glabrous; areas of higher rainfall from 0 to 700 m. elevation ..... *P. peltata.*

1b. Leaves deeply cordate, young stems usually puberulent; (0) 600 to 2,000 m. elevation ..... *P. umbellata.*

Pothomorphe peltata (L.) Miq., Comm. Phyt. 37. 1840. *Piper peltatum* L., Sp. Pl. 30. 1753, as *pelatum*. *Pothomorphe almirantensis* Trel. in Woodson & Schery, Ann. Mo. Bot. Gard. 27:306. 1940. Figure 2.

Herbaceous or few-branched subshrubs, 0.5–1.5 (2) m. tall, leafy internodes (2) 4–20 cm. long, 2–10 mm. thick, glabrous or sparsely and very minutely (0.05 mm.) puberulent, pellucid-punctate and often marked with dark lenticels. Leaves peltate with the petiole attached in the lower third of the lamina, petiole 10–26 cm. long, 2–9 mm. broad, glabrous, vaginate and with thin sheathing margins in the lower third at flowering nodes; lamina 20–30 (42) cm. long, 15–26 (40) cm. broad, broadly ovate to suborbicular, narrowed abruptly at the acute or short-acuminate apex, subcordate to round at the base, drying thin-chartaceous and pale greenish

beneath, somewhat darker above, smooth and essentially glabrous on both surfaces but with very minute (0.05 mm.) hairs on the veins above, minutely (0.05 mm.) pellucid-punctate on both surfaces, venation becoming prominent above and flat beneath, with 11 to 14 major veins arising from the petiole attachment, midvein with 1 or 2 pairs of arcuate-ascending secondary veins. Inflorescence umbellate, erect, the 3 to 20 spikes borne on a common peduncle 3–8 cm. long and about 2 mm. thick, glabrous, each spike at first subtended by a narrowly triangular glabrous bract (prophyll?) about 2 cm. long, spikes 4–10 cm. long, erect, peduncles of the spikes 3–20 mm. long, about 1 mm. thick, flowering portion of the spike white to pale green, 2–3 mm. thick at anthesis, 3–4 mm. thick in fruit, the flowers densely congested; floral bracts 0.3–0.5 mm. broad and triangular above, glabrous centrally with dense margin of short (0.1–0.2 mm.) whitish hairs, not forming bands around the spike; anthers about 0.1 mm. long and 0.2 mm. broad, thecae parallel and dehiscing apically; pistil obscured by the bracts, with 3 minute sessile stigmas; fruit becoming obpyramidal-trigonous by compression, about 0.5 mm. thick, truncate above, glabrous.

Plants of open or partly shaded sites in areas of evergreen forest formations on both the Caribbean and Pacific slopes below 1,000 m. elevation. This species is found in much of the range of the family in the neotropics, and flowers throughout the year in Costa Rica.

Pothomorphe peltata is easily recognized by the thin broad peltate leaves, mostly glabrous parts, umbellate spikes, and low altitude habitat.

Pothomorphe umbellata (L.) Miq., Comm. Phyt. 36. 1840. *Piper umbellatum* L., Sp. Pl. 1:30. 1753. Figure 2.

Shrubs or subshrubs, 1–3 m. tall, usually with few lateral branches on the upper stems, leafy internodes 1.5–10 (20) cm. long, (3) 4–12 mm. thick, variable in pubescence with hairs 0.5–2 mm. long or occasionally glabrous, pellucid punctate and with dark lenticels on older parts. Leaves cordate, petioles 12–30 cm. long, 3–6 mm. broad, densely puberulent to glabrous, vaginate and with thin deciduous sheathing margins on the lower half at flowering notes; laminae 20–40 cm. long, 20–42 cm. broad, very broadly ovate, narrowed abruptly to the short obtuse or acute apex, deeply cordate, cleft to about one-fourth of the lamina's length, with broad rounded symmetrical lobes, drying thin-chartaceous and pale greenish beneath, slightly darker above, smooth above and below, minutely puberulent or glabrous on both surfaces, venation prominent on both surfaces, with 7 to 15 major veins from the petiole attachment, midvein with 1 to 5 secondary veins, conspicuous (0.05 mm.) pellucid dots visible on both surfaces and translucent. Inflorescence umbellate and erect, with 2 to 6 spikes on a common peduncle 5–40 mm. long and about 2 mm. thick, umbels solitary or paired at a node; spikes 4–10 cm. long, at first subtended by very narrowly triangular bracts (prophylls?) about 2 cm. long, peduncles of the spikes 2–20 mm. long, about 1 mm. thick, glabrous or minutely puberulent, flowering portion 1.5–2.5 mm. thick at anthesis, about 3 mm. thick in fruit, whitish to pale green, the flowers densely congested; floral bracts 0.3–0.5 mm. broad and triangular or somewhat V-shaped above, glabrous centrally with a dense margin of short (0.1–0.2 mm.) whitish hairs, not forming bands around the spike;

anthers about 0.2 mm. long and 0.3 mm. broad, thecae somewhat divergent on the broad connective and dehiscing apically; pistil obscured by the bracts, with 3 minute sessile stigmas; fruit obpyramidal-trigonous by compression, 0.5–0.8 mm. thick, truncate above, glabrous.

Common weedy plants of open or partly shaded sites between 600 and 2,000 m. elevation (rarely at lower elevations) on both the Caribbean and Pacific slopes. This species ranges from Mexico to Peru, Brazil, and the West Indies; probably flowering throughout the year in Costa Rica.

Pothomorphe umbellata is easily recognized by the thin, broad, deeply cordate leaves, often puberulent stems, umbellate spikes, and altitudinal range. In sterile condition this species may resemble *Piper marginatum* with smaller leaves.

SARCORHACHIS Trelease

Climbers or shrubs with trailing branches, stems glabrous and somewhat succulent; shoot-apex at first enclosed in the sheathing leaf-base, a small prophyll often present at the base of the inflorescence. Leaves alternate and somewhat succulent, petiole with sheathing base which tears open as the shoot-apex and inflorescence emerge producing two adaxial margins of scar-tissue extending up into the lamina; lamina entire and glabrous, venation palmate. Inflorescence at first enclosed within the leaf-base of the same node, simple and axillary or terminal, solitary or when two the outer (leaf-opposed) nodose below the peduncle, peduncle usually with an encircling ridge of scar-tissue at the base; floral bracts peltate; anthers 2-thecous; pistil partly immersed in the rachis, stigmas 4 (3 or 5) and sessile; fruit becoming laterally compressed.

A genus of the neotropics ranging from Costa Rica to Ecuador and Brazil with probably fewer than four species. Very closely related to *Piper* but differing in the axillary or apparently terminal spikes and pistils immersed in the semi-succulent rachis. Growth at the flowering nodes is very different from *Piper* and rather similar to some species of *Peperomia*. I believe that the axillary spike of *Sarcorhachis* is a reduced axillary branch with further growth leaf-opposed at flowering nodes. It may be argued that *Sarcorhachis* represents no more than an unusual development within *Piper*. However, until an effective classification of *Piper* is available, I prefer to maintain the genus *Sarcorhachis* for these very unusual plants.

Sarcorhachis naranjoana (C.DC.) Trel., Contr. U. S. Nat. Herb. 26:17. 1927. *Piper naranjoanum* C.DC., Linnaea 37:363. 1872. *Sarcorhachis anomala* Trel., Contrib. U. S. Nat. Herb. 26:118. 1929. *Piper terminalispicum* Standl., Field Mus. Bot. 18:365. 1937. Figure 3.

Climbers or (?) shrubs with pendant branches, climbing to over 10 m. high and with long-pendulous branches to 2 m. long, leafy internodes 2–6 cm. long, (1) 2–6 mm. thick, semi-succulent and glabrous. Leaves usually distichous, petioles 3–4 (5) cm. long, 1–3 mm. thick, glabrous, vaginate throughout and with adaxial ridges of scar-tissue at all nodes; lamina 8–16 cm. long, 5–11 cm. broad, broadly ovate, acute to short-acuminate at the apex, rounded to the truncate or subcordate equal or subequal base, sides of the lamina 0–2 mm. distant on the petiole; lamina semi-succulent, drying subcoriaceous and grayish-green in color smooth and glabrous on both surfaces, major veins 5 to 11, the innermost united for 1 cm. or less to the midvein. Inflorescence at first enclosed within the leaf-base of the same node and subtended by a rim of scar-tissue continuous with the petiole margins in later stages, pendulous (together with the flowering stems), 4–16 cm. long; peduncles 1–3 cm. long, 1–3 mm. thick, glabrous near the base but often puberulent distally, flowering rachis usually minutely (0.1 mm.) puberulent, 2–3 mm. thick at anthesis, 3–5 mm. thick in fruit; floral bracts 0.4–0.6 mm. broad, triangular or round, glabrous centrally with a dense margin of short (0.1–0.3 mm.) yellowish hairs, rather inconspicuous and not forming bands around the spike; anthers 0.2–0.4 mm. long and equally broad, borne on short (0.2 mm.) filaments above the level of the pistils, connective thick and often produced beyond the thecae, thecae with thick walls and dehiscing laterally; pistil with only the upper part free of the rachis, stigmas 0.2–0.4 mm. long and 0.1–0.2 mm. thick; fruit becoming laterally compressed and very narrowly rhombic from above (4×2 mm.), fleshy, rounded and glabrous above.

Plants of wet forest formations from sea level to 1,600 m. on the Caribbean slopes and above 1,000 m. on the Pacific slopes near San Vito in southern Costa Rica. The species ranges from Costa Rica to Darien, Panama. Collections in flower and fruit have been made throughout the year with the exception of February, March, and April.

A very unusual climber with long-pendant stems and glabrous vegetative parts. The succulent spikes with immersed fruit, small peltate bracts, and semi-succulent leaves and stems make it possible to confuse this species with some of our large peperomias, such as *P. vinasiana*. In the absence of spikes these plants resemble aroids or, to a lesser extent, some pipers (such as *P. papantlense*). The species is more common than herbarium material would indicate; the plants appear to flower infrequently.

ILLUSTRATIONS

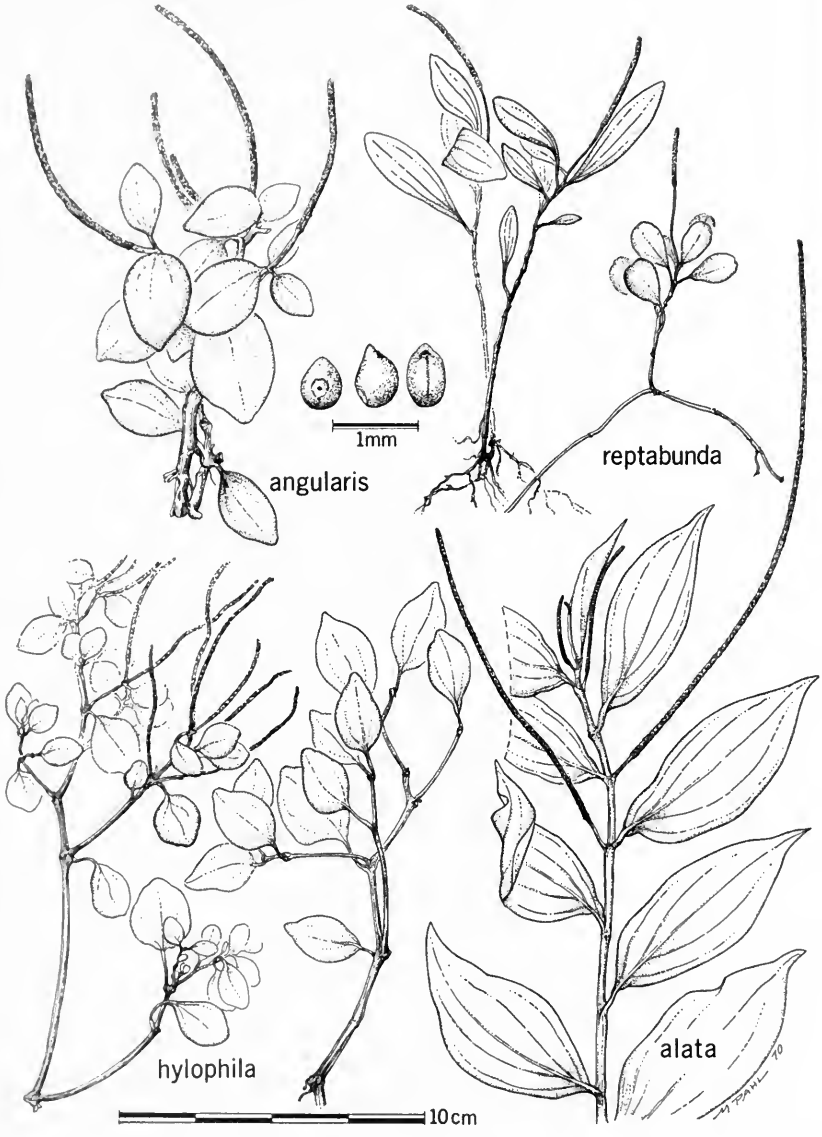

FIG. 1. *Peperomia alata* and three closely related species; the fruit without a developed beak and sub-laterally attached to the rachis. Well-developed mature plants are illustrated; juvenile and depauperate specimens may all resemble *P. reptabunda*.

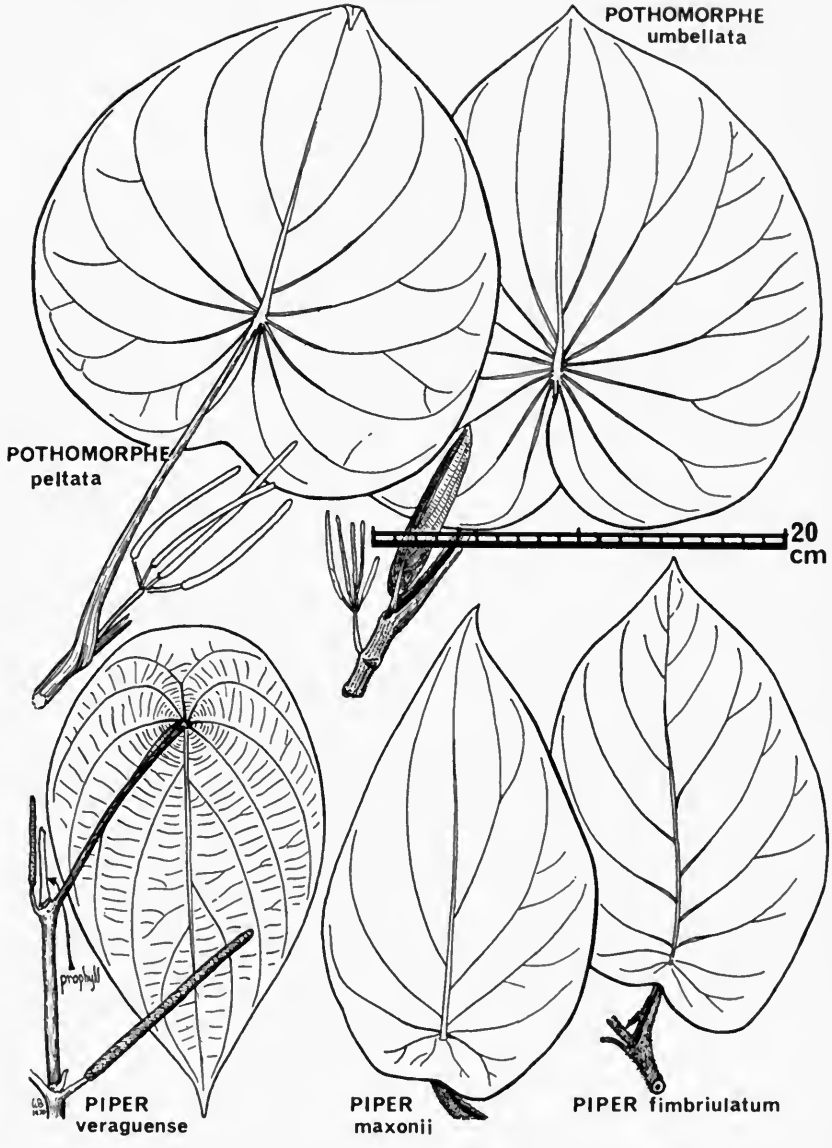

FIG. 2. Two species of *Pothomorphe* and three species of *Piper* with peltate leaves.

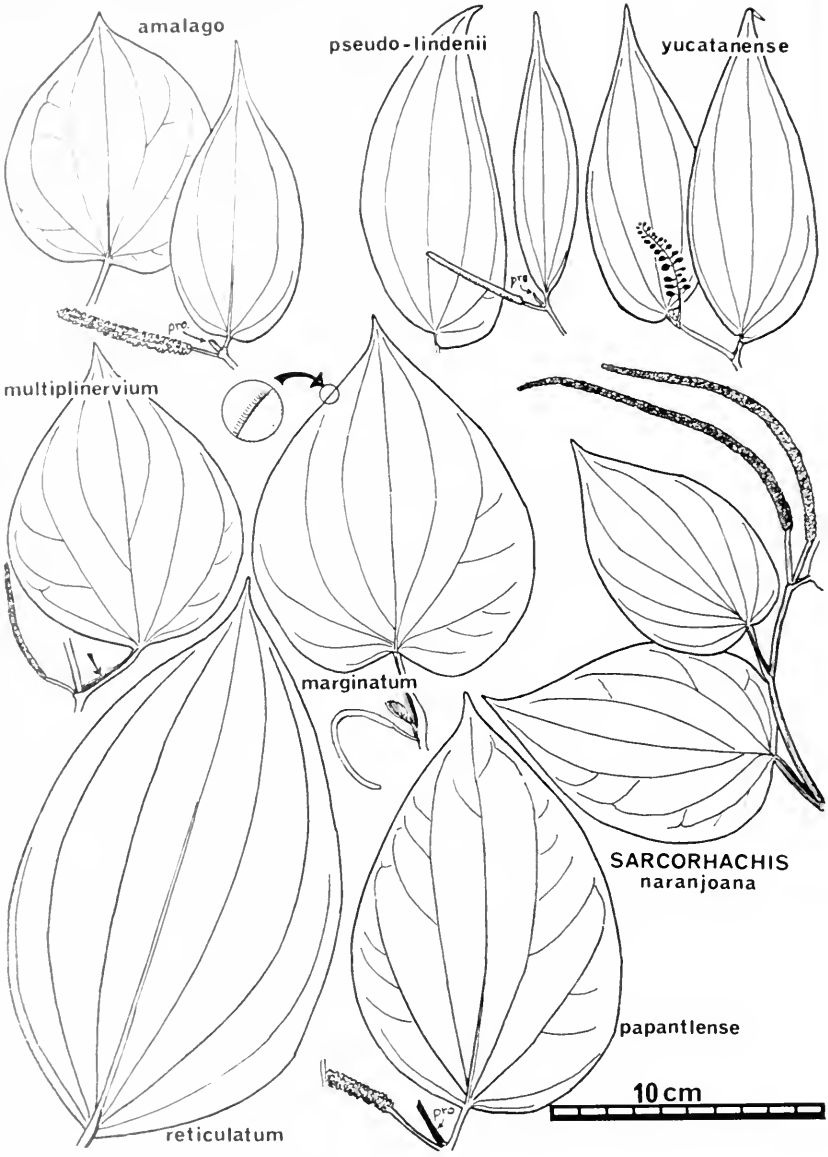

FIG. 3. A species of *Sarcorhachis* and seven species of *Piper* with palmately veined leaves.

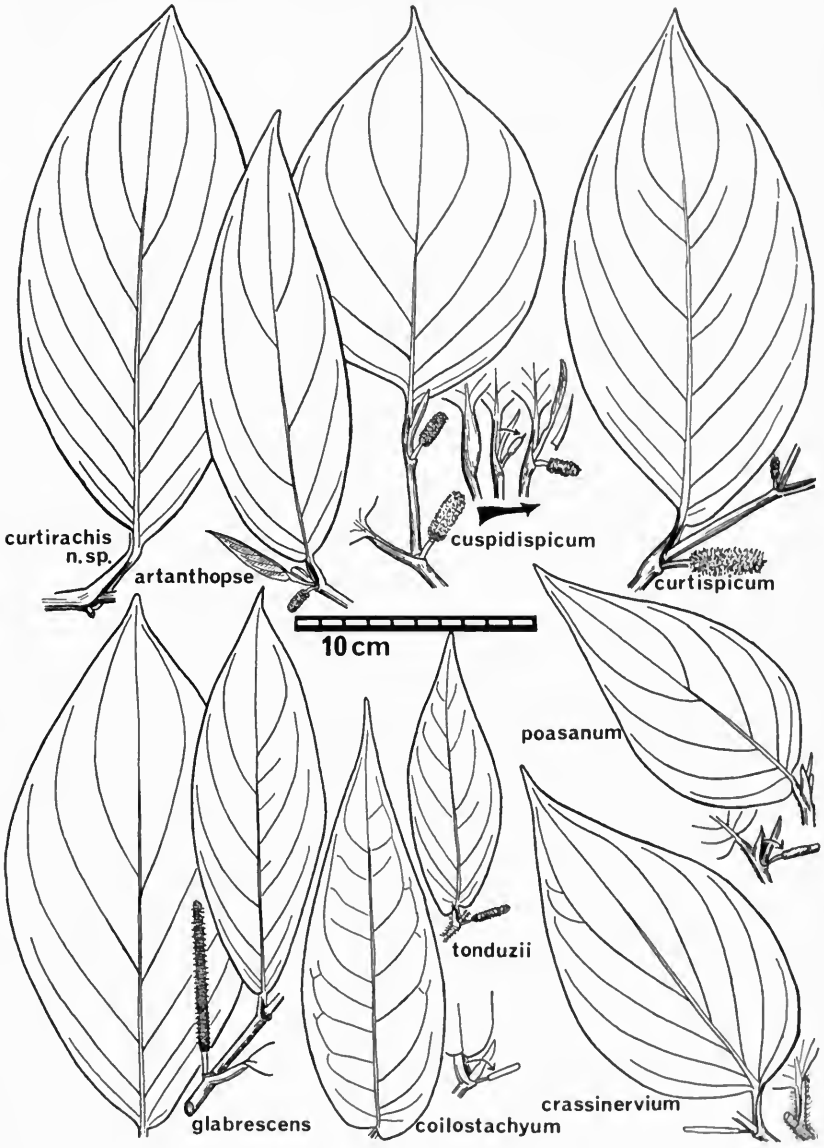

FIG. 4. Species of *Piper* with both shoot-apex and inflorescence arising from within the leaf-base.

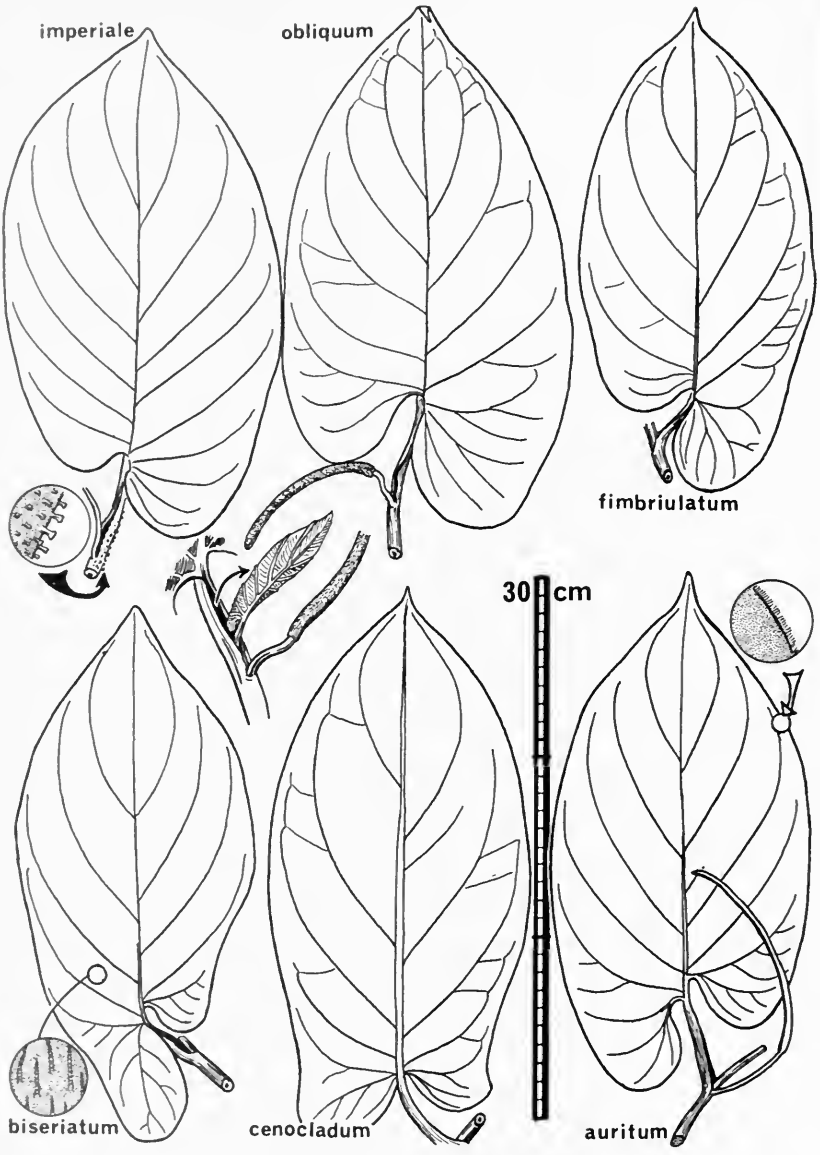

FIG. 5. Species of *Piper* with large unequally cordate leaves and the shoot-apex emerging from within the leaf-base at flowering nodes.

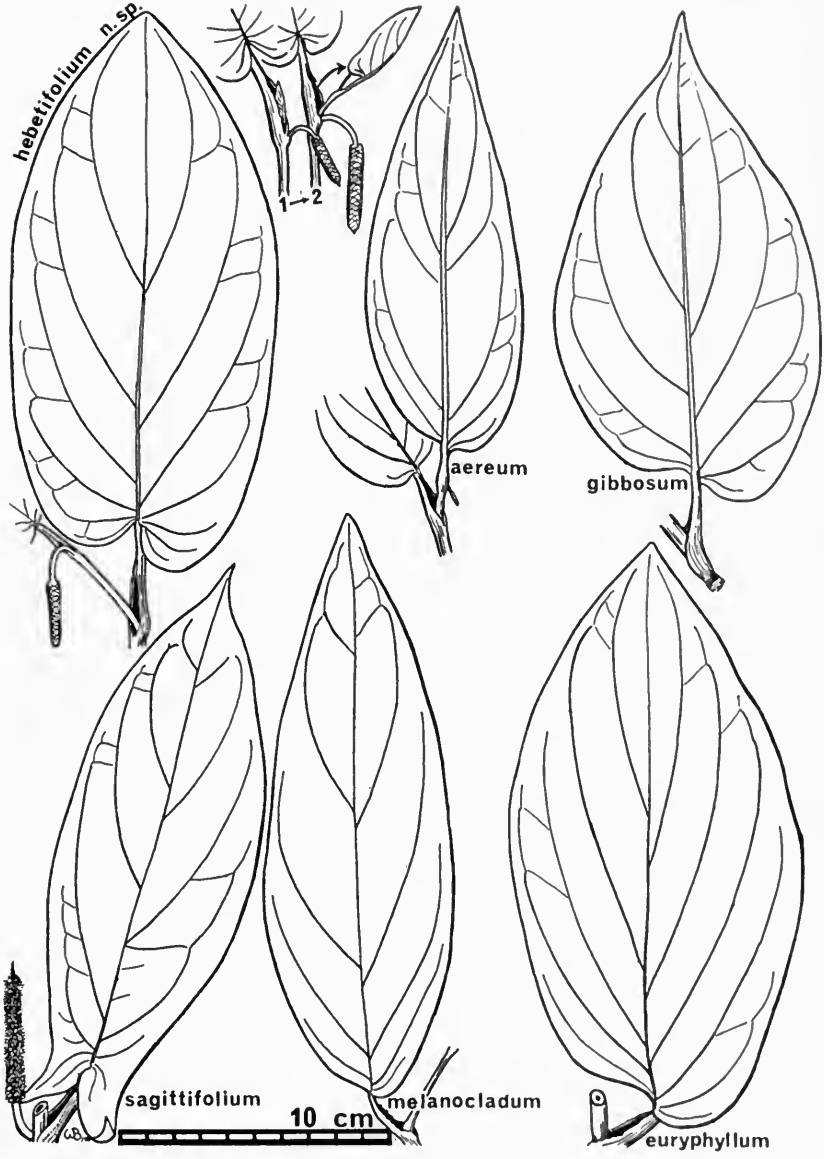

FIG. 6. Species of *Piper* with the shoot-apex emerging from within the leaf-base at flowering nodes; plants of wet forests.

FIG. 7. Rare and unusual species of *Piper*; the inflorescence and shoot-apex emerging from within the leaf-base (in *P. biolleyi* and *P. pitteri*) or the shoot-apex emerging from within the prophyll at flowering nodes.

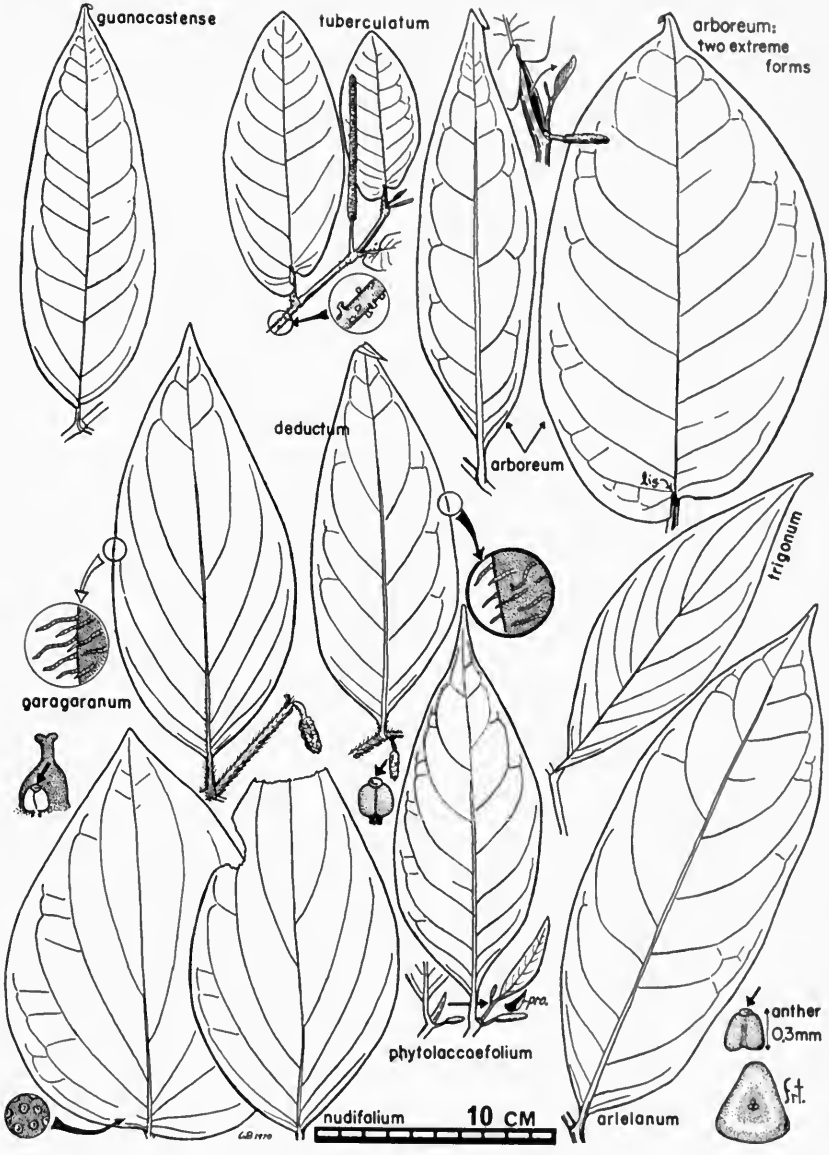

FIG. 8. Species of *Piper* with gland-tipped anthers or with pinnate venation; the shoot-apex emerging from within the leaf-base (*P. arboreum* and *P. tuberculatum*) or from within the prophyll at flowering nodes.

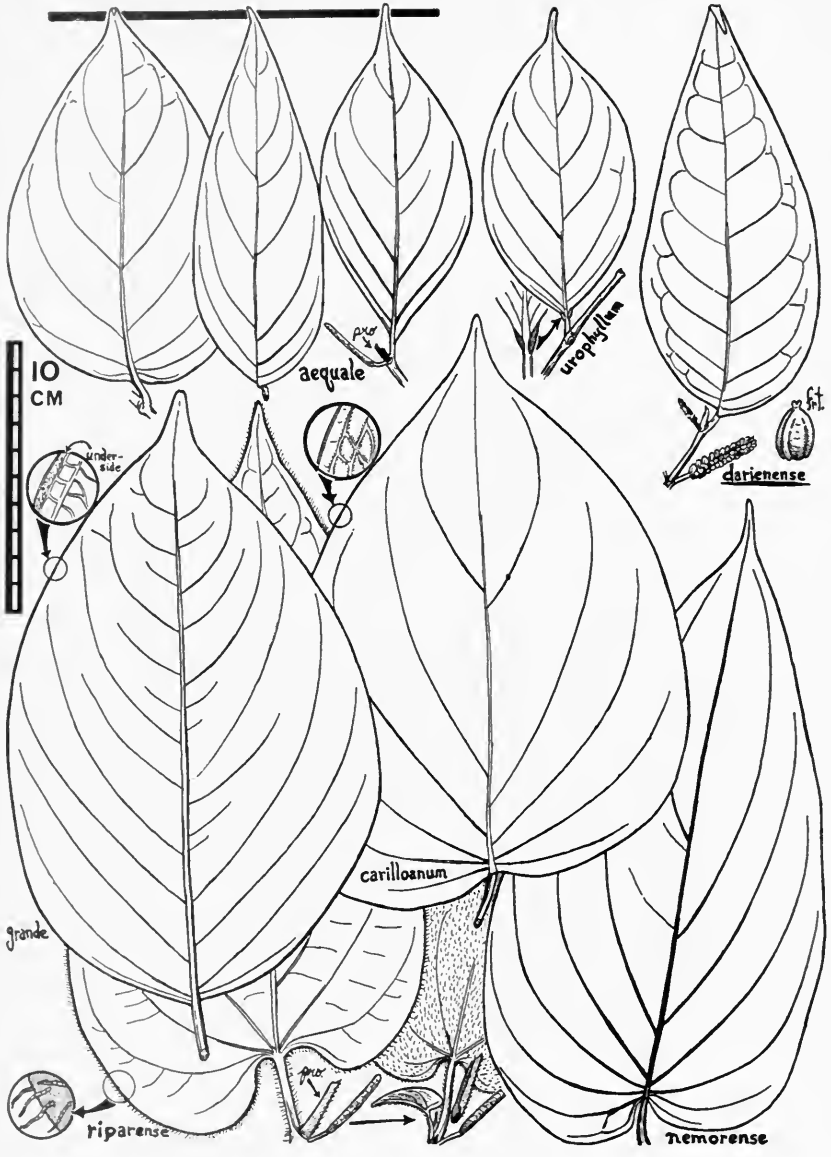

FIG. 9. Species of *Piper* with the leaves usually drying gray and the shoot-apex emerging from within the prophyll at flowering nodes; the prophyll apically blunt or oblique.

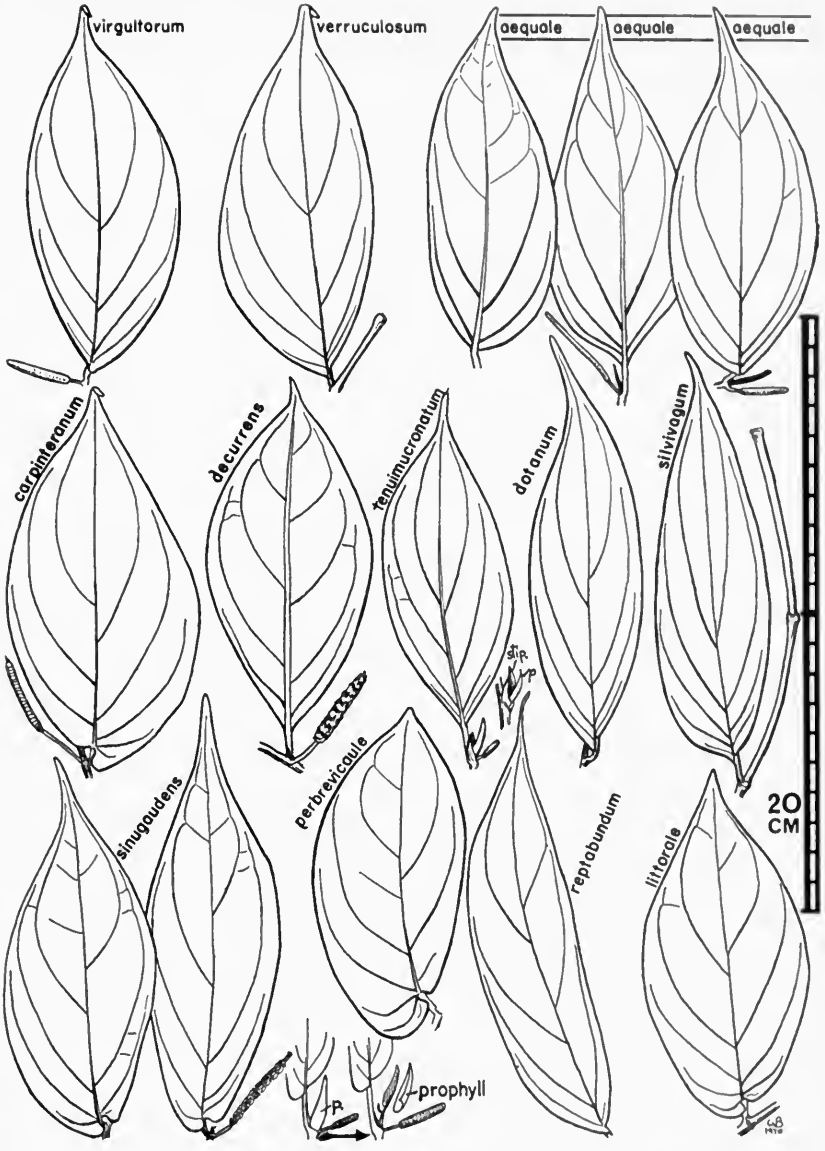

FIG. 10. Species of *Piper* with small leaves and the shoot-apex emerging from within the prophyll at flowering nodes; generally glabrous (upper row), usually montane (middle row), and low elevation (bottom row) species.

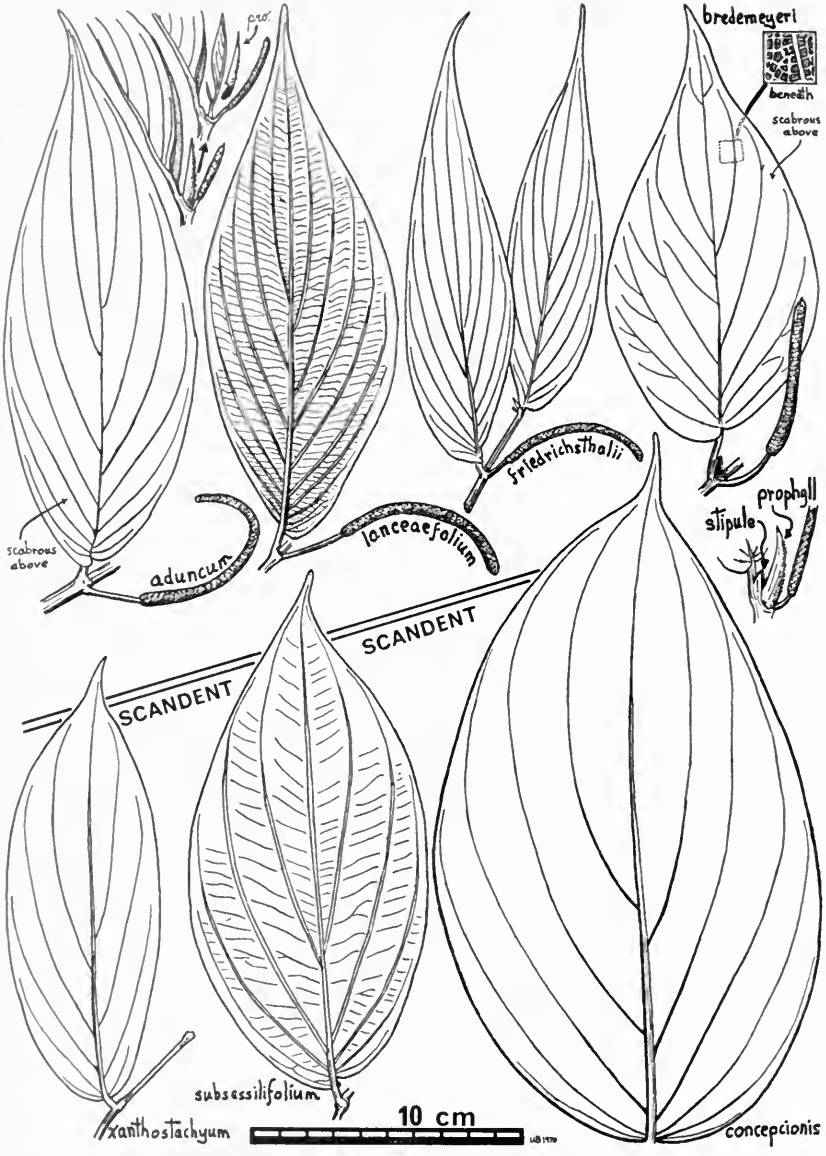

FIG. 11. Species of *Piper* with scandent habit or curved spikes and a species with rugose leaves (*P. bredemeyeri*); the shoot-apex emerging from within the prophyll at flowering nodes.

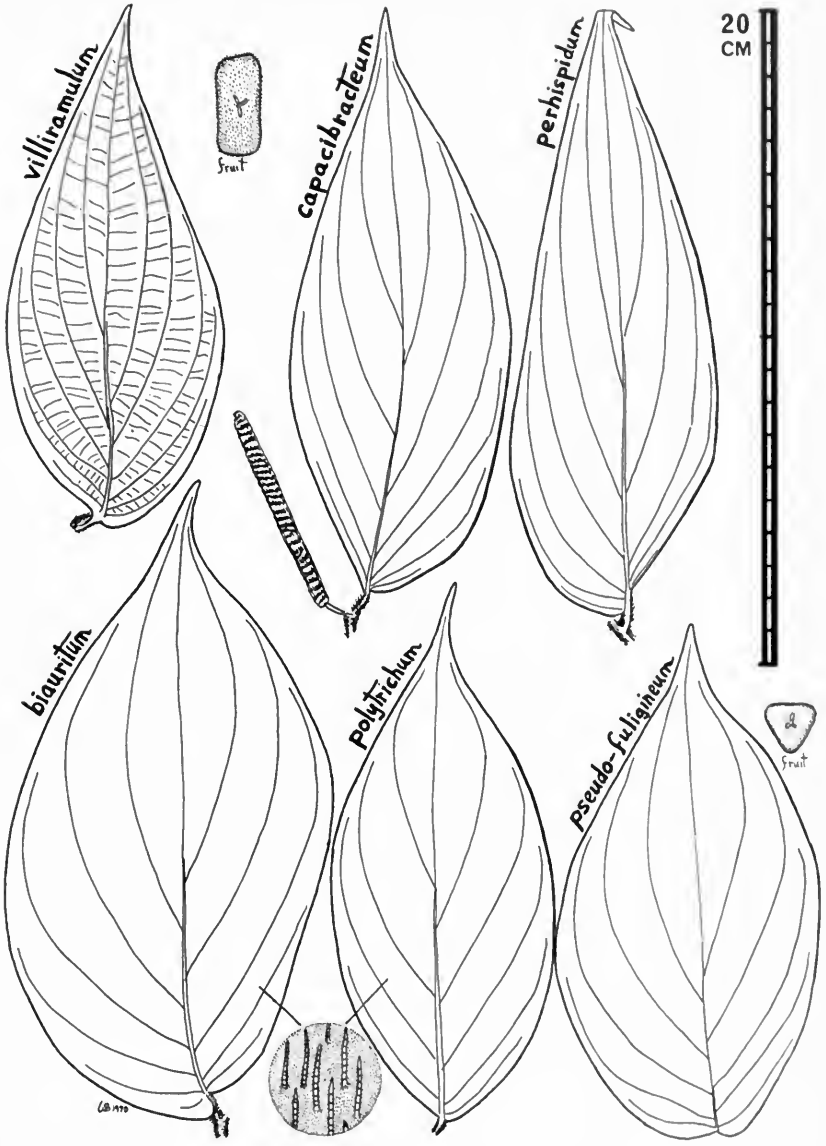

FIG. 12. Species of *Piper* with the lamina conspicuously puberulent above and the shoot-apex emerging from within the prophyll at flowering nodes; closely related to *P. hispidum* (except *P. pseudo-fuligineum*).

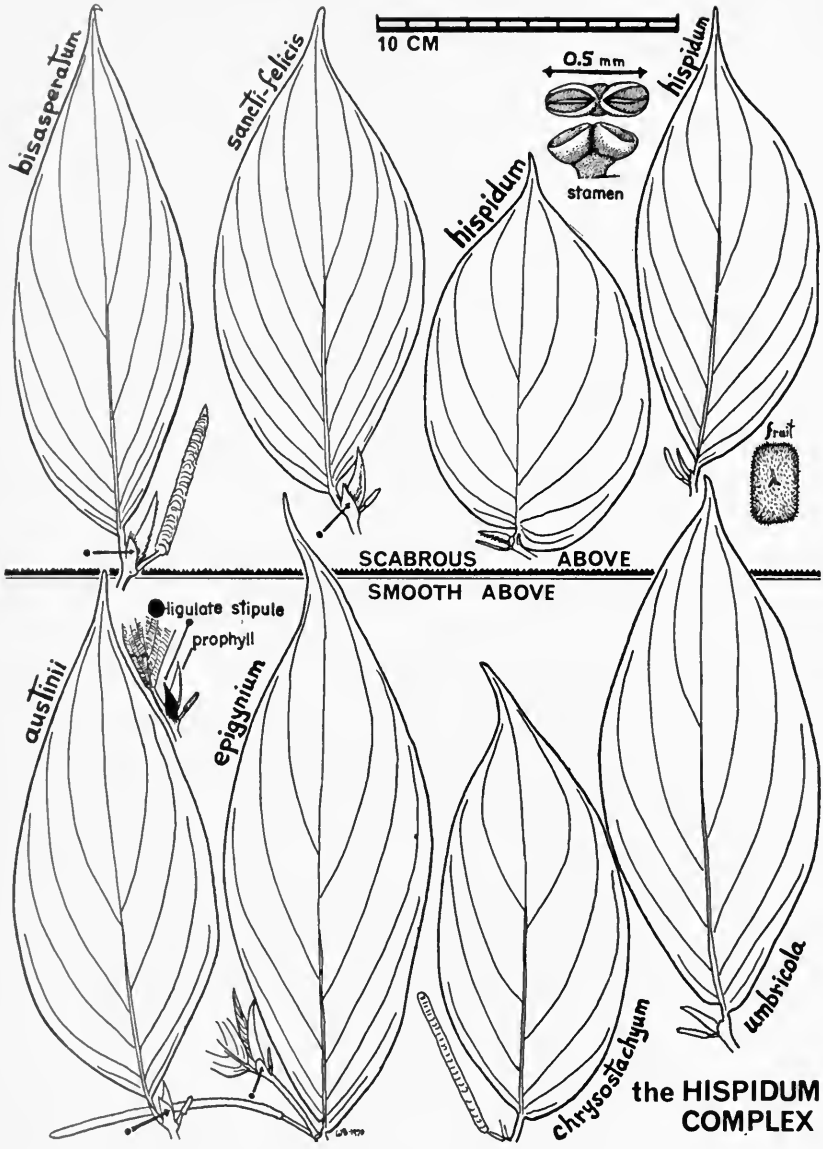

FIG. 13. *Piper hispidum* and closely allied species with tetragonous puberulent fruit, anthers dehiscing upward, stipular development, and laminae not densely puberulent above (compare fig. 12); the shoot-apex emerging from within the prophyll at flowering nodes.

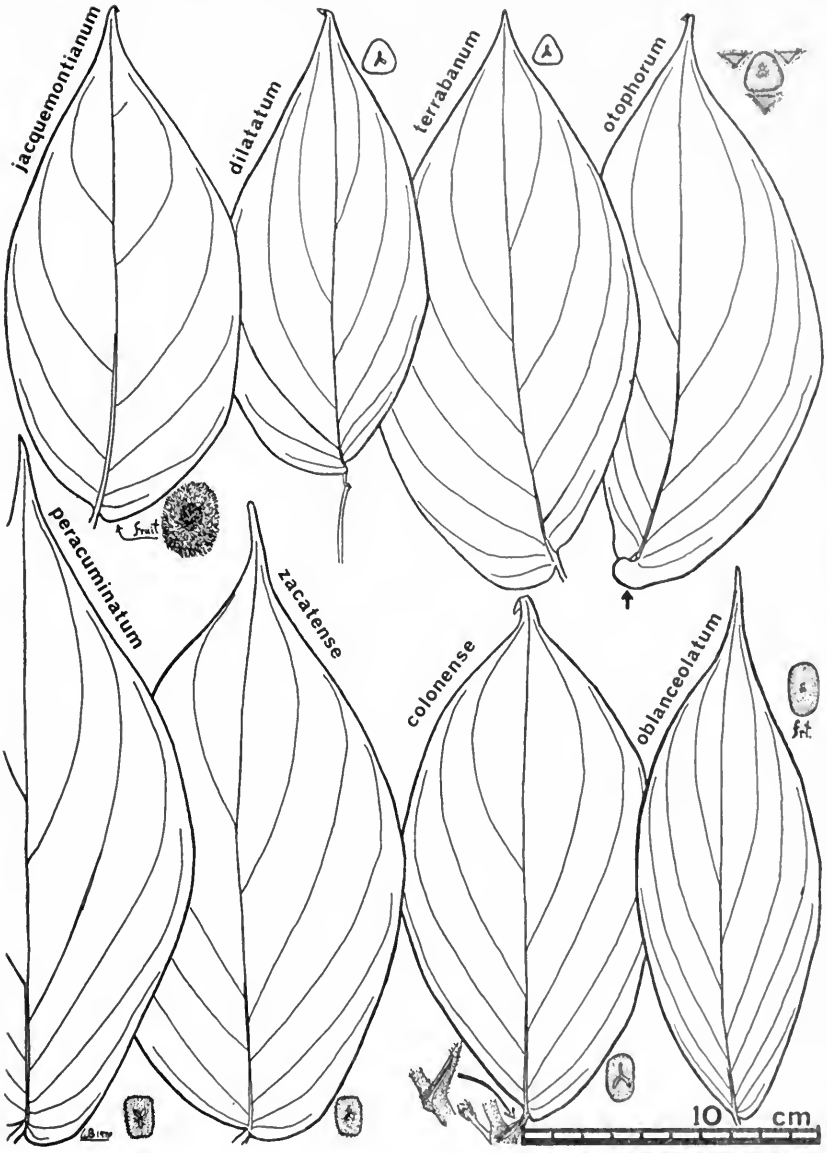

FIG. 14. Species of *Piper* with the leaves smooth above or only slightly scabrous; the shoot-apex emerging from within the prophyll at flowering nodes; plants very similar to species of the *P. hispidum* complex.

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ADDENDUM

The holdings of Piperaceae at the Museo Nacional in San Jose, Costa Rica were reviewed in July, 1971, while this work was in press. Type material seen there and not present in the United States permitted assignment of the following names to synonomy.

PEPEROMIA

P. acutilimba C.DC. ex Trel., Contr. U.S. Nat. Herb. 26:213. 1929. = *P. dotana* Trel.

P. borucana C.DC., Bull. Soc. Bot. Belg. 30, pt. 1:232. 1891. = *P. macrostachya* (Vahl) A. Dietrich.

P. delicatissima Trel., Contr. U.S. Nat. Herb. 26:191. 1929. = *P. rotundifolia* (L.) H. B. K.

P. dyscrita Trel., Contr. U.S. Nat. Herb. 26:198. 1929. = *P. glabella* (Sw.) A. Dietrich.

P. lagartana C.DC., Anal. Inst. Fis.-Geog. Costa Rica 9:177. 1897. = *P. pseudo-dependens* C.DC.

P. nicoyana C.DC. ex Schroeder, Candollea 3:129. 1926. = *P. pseudo-dependens* C.DC.

P. palmana var. *oppositifolia* C.DC., Anal. Inst. Fis.-Geog. Costa Rica 9:180. 1897. = *P. palmana* C.DC.

P. peninsularis Trel., Contr. U.S. Nat. Herb. 26:216. 1929. = *P. obtusifolia* (L.) A. Dietrich.

P. podocarpa C.DC., Anal. Inst. Fis.-Geog. Costa Rica 9:175. 1897. = P. distachya (L.) A. Dietrich.

P. scutellata C.DC., Bull. Soc. Bot. Belg. 30, pt. 1:230. 1891. = probably *P. macrostachya* (Vahl) A. Dietrich.

P. tonduzii C.DC., Bull. Soc. Bot. Belg. 29, pt. 2:70. 1890. = probably *P. rotundifolia* (L.) H.B.K.

P. tremendalensis Trel., Contr. U.S. Nat. Herb. 26:216. 1929. = *P. pseudo-alpina* Trel.

PIPER

P. hirsutum var. *carpinterae* C.DC., Anal. Inst. Fis.-Geog. Costa Rica 9:160. 1897. = *P. bisasperatum* Trel.

P. machucanum Trel., Contr. U.S. Nat. Herb. 26:174. 1929. = *P. villiramulum* C.DC.

P. magnifolium (C.DC.) Trel., l. c. 26:131. 1929. = *P. pseudo-lindenii* C.DC.

P. pacacanum Trel., l. c. 26:150. 1929. = *P. obliquum* R. & P.

P. pachystylum Trel., l. c. 26:139. 1929. = *P. nudifolium* C.DC.

P. pseudo-lindenii var. *magnifolium* C.DC., Linnaea 37:336. 1872. = *P. pseudo-lindenii* C.DC.

P. sepicola C.DC., Bull. Soc. Bot. Belg. 30, pt. 1:202. 1891. = *P. hispidum* Sw.

P. stenocladophorum Trel., Contr. U.S. Nat. Herb. 26:168. 1929. = *P. oblanceolatum* Trel.

P. suberythrocarpum C.DC., Anal. Inst. Fis.-Geog. Costa Rica 9:160. 1897. = *P. chrysostachyum* C.DC.

INDEX

New species and references to illustrations are in **bold face**. Common names and Latin names in synonymy are *italicized*.

Families of seed plants known or expected to occur in Costa Rica and adjacent areas numbered according to the sequence of Engler's *Syllabus der Pflanzenfamilien*, edition 11, reworked by L. Diels (1936).

1 Cycadaceae
2 Taxaceae
3 Podocarpaceae
4 Araucariaceae
5 Pinaceae
6 Cupressaceae
7 Gnetaceae
8 Typhaceae
9 Potamogetonaceae
10 Najadaceae
11 Alismataceae
12 Butomaceae
13 Hydrocharitaceae
14 Triuridaceae
15 Gramineae
16 Cyperaceae
17 Palmae
18 Cyclanthaceae
19 Araceae
20 Lemnaceae
21 Mayacaceae
22 Xyridaceae
23 Eriocaulaceae
24 Bromeliaceae
25 Commelinaceae
26 Pontederiaceae
27 Juncaceae
28 Liliaceae
29 Haemodoraceae
30 Amaryllidaceae
31 Velloziaceae
32 Dioscoreaceae
33 Iridaceae
24 Musaceae
35 Zingiberaceae
36 Cannaceae
37 Marantaceae
38 Burmanniaceae
39 Orchidaceae
40 Casuarinaceae
41 Piperaceae
42 Chloranthaceae
43 Lacistemaceae
44 Salicaceae
45 Garryaceae
46 Myricaceae
47 Juglandaceae
48 Batidaceae
49 Betulaceae
50 Fagaceae
51 Ulmaceae
52 Moraceae
53 Urticaceae
54 Podostemonaccae
55 Proteaceae
56 Olacaceae
57 Opiliaceae
58 Loranthaceae
59 Aristolochiaceae
60 Rafflesiaceae
61 Balanophoraceae
62 Polygonaceae
63 Chenopodiaceae
64 Amaranthaceae
65 Nyctaginaceae
66 Phytolaccaceae
67 Aizoaceae
68 Portulacaceae
69 Basellaceae
70 Caryophyllaceae
71 Nymphaeaceae
72 Ceratophyllaceae
73 Ranunculaceae
74 Berberidaceae
75 Menispermaceae
76 Magnoliaceae
77 Anonaceae
78 Myristicaceae
79 Monimiaceae
80 Lauraceae
81 Hernandiaceae
82 Papaveraceae, incl. Fumariaceae
83 Capparidaceae
84 Cruciferae
85 Tovariaceae
86 Resedaceae
87 Moringaceae
88 Droseraceae
89 Crassulaceae
90 Saxifragaceae
91 Brunelliaceae
92 Cunoniaceae
93 Hamamelidaceae
94 Rosaceae
95 Connaraceae
96 Leguminosae
97 Krameriaceae
98 Oxalidaceae
99 Geraniaceae
100 Tropaeolaceae
101 Linaceae, incl. Humiriaceae
102 Erythroxylaceae
103 Zygophyllaceae
104 Rutaceae
105 Simarubaccae
106 Burseraceae
107 Meliaceae
108 Malpighiaceae
109 Trigoniaceae
110 Vochysiaceae
111 Polygalaceae
112 Dichapetalaceae
113 Euphorbiaceae
114 Callitrichaceae
115 Buxaceae
116 Coriariaceae
117 Anacardiaceae
118 Cyrillaceae
119 Aquifoliaceae
120 Celastraceae
121 Hippocrateaceae
122 Staphyleaceae
123 Icacinaceae
124 Hippocastanaceae
125 Sapindaceae
126 Sabiaceae
127 Balsaminaceae
128 Rhamnaceae
129 Vitaceae
130 Elaeocarpaceae
131 Tiliaceae
132 Malvaceae
133 Bombacaceae
134 Sterculiaceae
135 Dilleniaceae
136 Actinidiaceae
137 Ochnaceae
138 Caryocaraceae
139 Marcgraviaceae
140 Quiinaceae
141 Theaceae
142 Guttiferae incl. Hypericaceae
143 Elatinaceae
144 Cistaceae
145 Bixaceae
146 Cochlospermaceae
147 Violaceae
148 Flacourtiaceae
149 Turneraceae
150 Passifloraceae
151 Caricaceae
152 Loasaceae
153 Begoniaceae
154 Cactaceae
155 Thymelaeaceae
156 Elaeagnaceae
157 Lythraceae
158 Punicaceae
159 Lecythidaceae
160 Rhizophoraceae
161 Combretaceae
162 Myrtaceae
163 Melastomataceae
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165 Halorrhagaceae
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185 Asclepiadaceae
186 Convolvulaceae
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191 Labiatae
192 Solanaceae
193 Scrophulariaccae
194 Bignoniaceae
195 Pedaliaceae
196 Martyniaceae
197 Orobanchaceae
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