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A Revision of the Genus *Crinodendron* (Elaeocarpaceae)

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ABSTRACT. The taxonomic revision of the genus *Crinodendron* utilizes several lines of evidence including herbarium and field studies, cytotaxonomy, and wood anatomy. *Crinodendron* comprises four species: *C. patagua*, *C. tucumanum* (including *C. boliviensis*), *C. brasiliense*, and *C. hookerianum*. *Crinodendron hookerianum* and its close relationship to *Dubouzetia* of the South Pacific is discussed. *Dubouzetia* is retained as an independent genus until the specific limits of that genus can be studied in full. *Tricuspidaria* is a synonym of *Crinodendron*.

Crinodendron Molina is a genus comprising four completely allopatric species growing in central and southern Chile, northwestern Argentina, central Bolivia, and southern Brazil (fig. 1), from sea level to 2800 meters in elevation.

Systematic literature concerning *Crinodendron* includes the original publication by Molina (1782), and publications by Ruíz and Pavón (1798), Hooker (1833), Gay (1845), Miers (1868), Cunningham (1871), Lillo (1916), Descole and O'Donell (1938), Reitz and Smith (1958), Carenzo (1966), and Coode (1988).

In spite of these earlier works, several problems concerning the generic limits, species limits, and nomenclature of *Crinodendron* remain. One problem in studying this genus involves the wide distances separating each species. As a result of the geographic isolation of each species no one researcher has studied more than two currently recognized species at a time in the field. The objective of this study was to present a comprehensive systematic revision using evidence based on herbarium and field studies, cytotaxonomy, and wood anatomy.

MATERIALS AND METHODS

Approximately 350 specimens of *Crinodendron* were examined from the collections of the following herbaria: A, ASU, CAS, CONC, CTES, F, GH, LIL, LP, MICH, MO, NY, SGO, SI, UC, and US. The habitats of three species in Argentina (*C. tucumanum* Lillo) and Chile (*C. patagua* Molina and *C. hookerianum* C. Gay) were visited in Dec 1987 and Jan 1988. Observations were made of the habit, habitat, distribution, and reproductive biology of each species. My collections for this study have been deposited at ASU, CONC, and LIL.

Young flower buds were collected for chromosome counts in pollen mother cells from native plants of *C. tucumanum* and from individuals of *C. patagua* and *C. hookerianum* cultivated at the Strybing Arboretum, Golden Gate Park, San Francisco, California. The buds were fixed in a 3:1 (95% ethanol:glacial acetic acid) solution. Anthers were dissected, squashed in acetocarmine, and mounted in Hoyer's medium (after Beeks 1955).

Wood maceration preparations of xylem vessel elements were made using a modified Franklin's Method (Berlyn and Miksche 1976, p. 128). The study included one specimen each of *Crinodendron patagua* (*Bricker 204*), *C. hookerianum* (*Bricker 247*), *Dubouzetia galorei* Coode (*Streimann & Martin s.n.*, LAE #52826 at A) and *D. campanulata* Brongn. and Gris (*Buchholz 1563*, A).

RESULTS AND DISCUSSION

Cytotaxonomy. The results of the cytological studies yielded a count of $n = 21$ for *C. hookerianum*—the first for the genus. No chromosome counts have been reported for either *Dubouzetia* Brongn. & Gris or *Peripentadenia* L. S. Smith, apparently closely related to *Crinodendron*. Previous chromosome counts for the Elaeocarpaceae indicate $n = 12$, 14, or 15, for *Elaeocarpus hookerianus* Raoul, *Aristotelia* L'Hér., and *E. sikkiminensis* Mast., respectively (Cronquist 1981; Federov 1969, p. 263). Little can be said of the polyploid patterns within the Elaeocarpaceae until further research is completed.

Generic Relationships. The relationship of *Crinodendron* to other members of the Elaeocarpaceae is relatively well established. Most earlier workers (e.g., Coode 1988; Schumann 1895; Sprague 1907a) agreed that *Crinodendron* is most closely related to *Dubouzetia* of the South Pacific and Coode (1988) considered *Crinodendron* to be most closely related to *Dubouzetia* and *Peripentadenia*, with all three genera tentatively com-

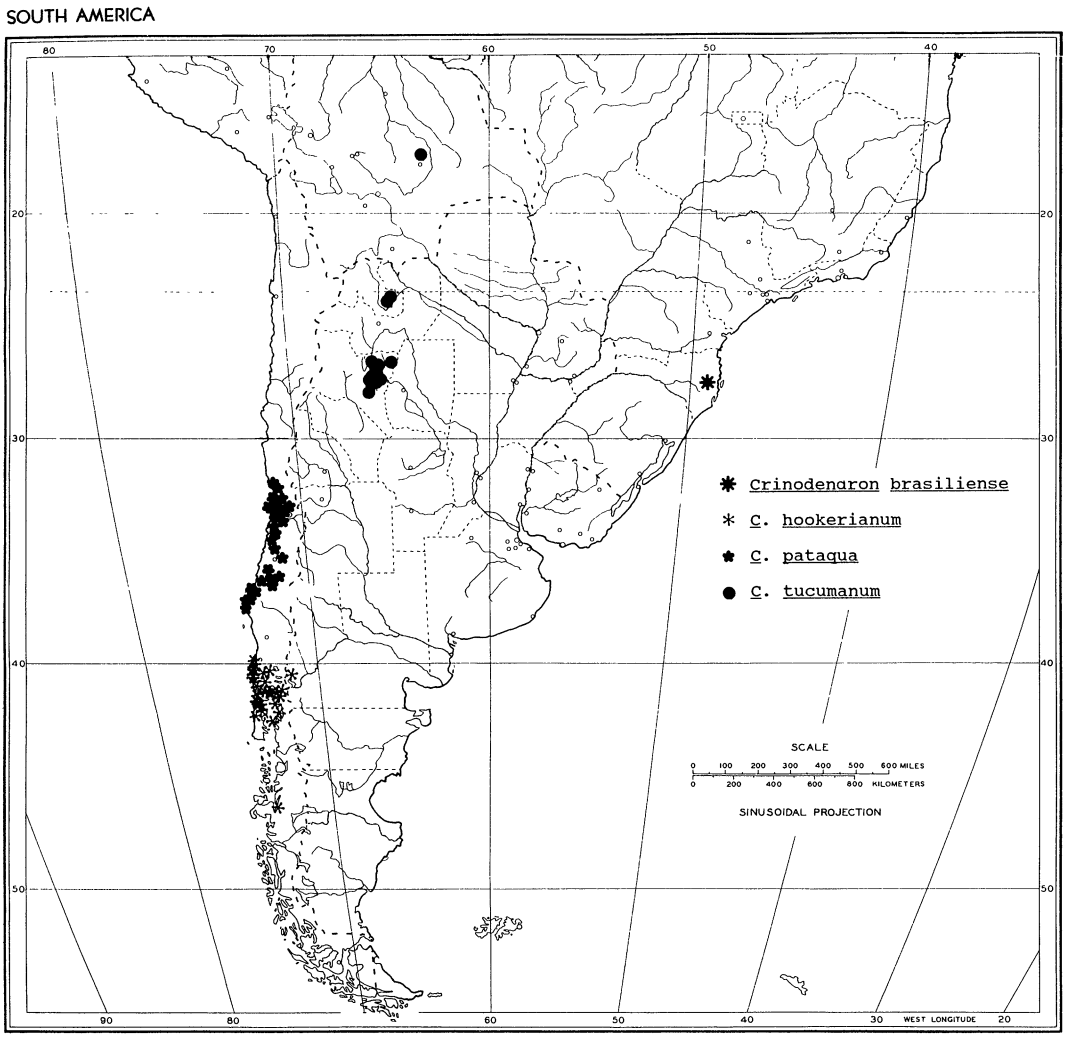

FIG. 1. Distribution of *Crinodendron*.

prising the tribe Tricuspidarieae (Miers 1868). Coode reported the characters uniting the three genera include: "disc lobed or 'cog-wheel' shaped, anthers opening by a single apical pore or transverse apical slit, leaves always penninerved, seeds fewer than ovules, fruit dehiscent, thin-walled."

Although Sprague (1907a) and Coode (1988) agreed that *Crinodendron* and *Dubouzetia* are closely related, the characters that are used to define the two historically have been poorly defined and often misunderstood. Bocquillon (1866, as cited in Sprague 1907a) stated that the two genera were best separated by fruit dehiscence. The capsule of *Crinodendron* was thought to be septicidally dehiscent and *Dubouzetia* loculicidally dehiscent. Later studies by Brongniart and Gris (1868, as cited in Sprague 1907a) indicated that fruits of *D. campanulata* simultaneously are septicidally and loculicidally dehiscent. Baillon (1873) proposed uniting *Dubouzetia* and *Crinodendron* under the older name *Crinodendron*.

Szyszylowicz (1885) kept *Crinodendron* and *Dubouzetia* separate based on several characters. These included carpels opposite the sepals in *Crinodendron* vs. opposite the petals in *Dubouzetia*; seeds with a wing-like strophiole (an extension of the hilum) in *Crinodendron* vs. a spiral strophiole in *Dubouzetia*; sepals connate in *Crinodendron* vs. distinct in *Dubouzetia*.

Sprague (1907a, based on information pro-

vided by L. A. Boodle) utilized additional anatomical characters to distinguish between *Crinodendron* and *Dubouzetia*: the cell walls of the upper epidermis were said to be undulate in *Crinodendron* vs. straight in *Dubouzetia;* the spongy parenchyma of the leaves was denser and with less chlorophyll in *Crinodendron* than in *Dubouzetia;* each leaf epidermal cell bore many papillae in *Crinodendron* vs. few papillae in *Dubouzetia; Dubouzetia* had raised stomata vs. stomata flush with the surface in *Crinodendron;* and the stem vessels of *Crinodendron* (*C. hookerianum* =*Tricuspidaria lanceolata* Miq.) had spiral thickenings, while the vessels of *Dubouzetia* (*D. campanulata*) lacked spiral thickenings.

In reporting the anatomical differences to Sprague (1907a), Boodle stressed that these characters alone were insufficient to determine if the two genera should be united or not. Sprague (1907a) chose to follow the precedent of Szyszylowicz (1885) and recognized two genera. In his revision of *Dubouzetia* (1907b) Sprague stated that there was sufficient evidence to recognize *Crinodendron* and *Dubouzetia* as distinct genera. The arguments he provided relied on three characters of *Dubouzetia* (absent in *Crinodendron*): capsules septicidally dehiscent, carpels opposite the petals, and a spiral strophiole at the chalazal end of the seed.

The most recent study of *Crinodendron* was by Coode (1988) who described *Crinodendron* as having ". . . a unique calyx—a few-toothed tube which spits almost to base down 1–2 lines and then detaches completely; also the stamens are reduced in number to 15(–18) and the flowers solitary." He continued by saying these are: ". . . confirmatory derived but not unique characters. Certain species in *Dubouzetia* also have a reduced number of stamens and a tendency for the calyx not to separate into 5 discrete sepals." Coode also noted that "two species of *Crinodendron* have watery, translucent sarcotestas; perhaps the other three do also—one needs fresh material to be sure—and if so the distinctness of *Crinodendron* would be confirmed by what seems to be another unique and derived specialism of the sarcotesta."

In my review of the characters that separate *Dubouzetia* from *Crinodendron,* I found the five carpels appear to be opposite the petals in *Dubouzetia;* however, in *Crinodendron* there are only three or four locules per ovary and therefore they cannot be exactly opposite the five petals. As a result, the carpel arrangement in relation to the petals is not a reliable character upon which to separate *Crinodendron* from *Dubouzetia.*

I have never observed a spiral strophiole of the seed in *Dubouzetia.* It may be that Sprague (1907a) was mistaking the dried sarcotesta as a spiral strophiole (Coode 1988). I have observed the watery sarcotesta (integuments fleshy at maturity) in *C. patagua, C. tucumanum,* and *C. hookerianum* but observations in *Dubouzetia* still need to be made.

My studies of the vessel anatomy of *Crinodendron hookerianum* (=*Tricuspidaria lanceolata*) and *Dubouzetia campanulata* confirm Sprague's (1907a) observations. *Dubouzetia campanulata* vessels lack spiral thickenings while those of *Crinodendron hookerianum* have spiral thickenings. I also examined *C. patagua* and *D. galorei* and observed that both of these species lack vessel spiral thickenings. I conclude that the vessels of *Crinodendron hookerianum* differ from the other species of *Crinodendron* and *Dubouzetia* included within this study.

The sepals of *Crinodendron* are connate, forming a tube that is circumscissile and is shed as a unit at floral maturity. *Dubouzetia,* in contrast, has distinct sepals that are retained as the flower reaches maturity. I have found that all the species of *Crinodendron* have loculicidal capsules whereas *Dubouzetia* has septicidal capsules (Sprague 1907b). The differences in capsule dehiscence and connation of the sepals are two characters that help in defining the two genera.

In addition to the above characters, I have found a previously unreported character for the Tricuspidarieae. The stamens of *Crinodendron, Dubouzetia,* and *Peripentadenia* are borne in two whorls, an inner whorl of five and an outer whorl of ten or more stamens. The outer whorl may or may not be inserted into and enclosed by the basal sacs of the petals during floral development.

For the present, *Crinodendron* and *Dubouzetia* will be considered as separate genera. The characteristics distinguishing them are summarized in the key below. Further study of the remainder of *Dubouzetia* is needed before any taxonomic changes are made.

1. Petal apices strongly 3-lobed; sepals fused into a tube; filaments bent at apex, directing the anther toward the center of the flower; tips of anthers not tapered before dehiscence, rounded after dehiscence; fruit a loculicidal capsule; temperate South America .... *Crinodendron*

1. Petal apices not lobed; sepals distinct; filaments straight; tips of anthers tapered before dehiscence, bifid after dehiscence; fruit a septicidal capsule; New Caledonia, Australia, or New Guinea ..... *Dubouzetia*

TAXONOMIC TREATMENT OF *CRINODENDRON*

Crinodendron Molina, Sag. Stor. Nat. Chile, 1st ed. p. 179. 1782.—TYPE: *Crinodendron patagua* Molina.

Tricuspidaria Ruíz Lopez & Pavón, Fl. Peruv., t. XXXVI, p. 64. 1794.—TYPE: *Tricuspidaria dependens* Ruíz Lopez & Pavón (=*C. patagua*).

Trees or shrubs to 30 m tall and 1 m d.b.h. Trichomes unicellular, unbranched. Leaves simple, opposite, sub-opposite or alternate, occasionally whorled. Laminas oblanceolate, obovate or ovate; venation semicraspedodromus; lower surface pubescent to glabrous or barbate in axils of major veins. Petioles often caniculate. Flowers solitary on long axillary peduncles, usually borne 2 per node. Calices tubular, tearing into 2–4 parts, each with 1–3 weak lobes, often shed as a unit before the flower reaches maturity. Corollas emerging through the calyx tubes. Petals 5, white, saccate at base, 3–5-lobed. Stamens (12)15(18), borne in 2 whorls, the outer whorl of 10 stamens inserted into the basal petal sacs, the inner whorl of 5 stamens free from the petals. Discs swollen, of 10 lobes in 5 pairs, each pair corresponding to the petal sacs. Filaments white, distinctly arched. Anthers tetrasporangiate, basifixed, poricidally dehiscent; surface scabrous; apex obtuse; base cuneate. Styles subulate, 4–6. Ovaries superior, 4–6-locular, pilose to glabrous. Ovules anatropous, axile, 4–15 per locule. Fruits loculicidal capsules, sub-ovoid or ovoid, 3–4-winged or wingless, pilose or glabrous. Seeds 1–5 per locule, ovoid or ellipsoid, fleshy sarcotesta, drying at maturity. Embryo dicotyledonous, the cotyledons orbicular, sessile, 3-veined. Endosperm copious.

NOMENCLATURE OF *CRINODENDRON*. *Crinodendron* was described as a monotypic genus by G. I. Molina in 1782. Molina did not cite a type specimen for *C. patagua* and some confusion exists (Ruíz and Pavón 1798; Sprague 1907a) as to the true identity of the plant he was describing, although it fits closely a plant that is native to central Chile, known locally by the vernacular name "pataqua." His description does, however, differ from the plant called pataqua in three rather important characters. Molina stated that his plant had: 1) no calyx, 2) six petals, and 3) 10 filaments connate in a cylinder. In actuality, the pataqua of central Chile has five connate sepals, five petals, and 15 distinct filaments.

Ruíz and Pavón (1798) described a "pataqua" from central Chile in addition to the *Crinodendron patagua* of Molina. In their discussion of the plant they note that there are several plants throughout Chile known as pataqua. Their pataqua had five petals and fifteen stamens. The petals were three-lobed and the capsule four-loculate. They concluded that their pataqua was different from the pataqua (*C. patagua*) that Molina had described. As a result, Ruíz and Pavón announced that their plant represented a new genus and species, which they described as *Tricuspidaria dependens*.

Tricuspidaria is here treated as a synonym of *Crinodendron*. Molina's description of *Crinodendron* agrees with Ruíz and Pavón's *Tricuspidaria* on all points except calyx type, petal number, and stamen number and arrangement. I reject (for reasons discussed below) Ruíz and Pavón's conclusion that Molina was referring to a pataqua different from their own.

Molina wrote his natural history of Chile while living in Bologna, Italy. He was residing in Europe after having been expelled from South America with the rest of his Jesuit colleagues. His specimens and manuscript were confiscated and only later did he regain possession of his notes from which he wrote of the Chilean natural history. It is understandable that Molina could make errors in light of this series of events.

Molina stated that *Crinodendron* lacked a calyx. He most likely reached this conclusion after examining specimens in which the calyx had been shed after the flower had reached maturity, which normally happens in *C. patagua*. I suspect Molina mistook the stamen insertion into the swollen disk as being connate filaments, but his mistake regarding stamen number is unexplained.

The characters provided by Molina cannot easily be confused. The bell-shaped, lily-like flowers borne on long pedicels, with ovate ovaries, subulate styles, and three-locular capsules given in Molina's (1782) general discussion of

pataqua are not easily confused with any other plant from that region of the world. These floral characters along with the leaves being opposite, lanceolate, and serrate-margined all suggest Molina and Ruíz and Pavón were describing the same plant. The common name "pataqua" adds to the evidence that Ruiź and Pavón's plant was the same as that of Molina's *Crinodendron.*

Hooker (1833) reviewed (after the discovery of a second species from Chiloé, Chile) the writings of both Molina and Ruíz and Pavón. He concluded Ruíz and Pavón had discovered a pataqua (*T. dependens*) that was different from the one of Molina. Molina's pataqua was thought to be the species he had in hand, a conclusion Hooker reached after reviewing Molina's description along with drawings communicated by Molina to Cavanilles. The drawings had been published by Cavanilles (1788) and evidently contained illustrations of two rather than a single species (Sprague 1907a). Hooker's plant was thought to be the same as Molina's, namely *C. patagua.* Hooker accepted Ruíz and Pavón's *Tricuspidaria dependens* as the name for the pataqua of central Chile. Thus he proposed, in agreement with Ruíz and Pavón (1798), that there were two pataquas growing in south-central Chile.

Gay (1845) reexamined the problem and concluded that Hooker was in error. He determined that *Crinodendron patagua* and *Tricuspidaria dependens* were one and the same. Gay's conclusion was based, in part, on the fact that Molina (1810) had taken up *Tricuspidaria dependens* in his second edition of "Saggio Sulla Storia Naturale del Chili" as a replacement for his *Crinodendron patagua* (1782). Gay accepted *Tricuspidaria dependens* as the correct name. The second species from Chiloé, first reported by Hooker but under the name *C.patagua,* was then given the epithet *hookerianum.* The generic name, *Crinodendron,* was used by Gay for the plant. He considered the genus to have been described by Hooker and not the same as Molina's genus by citing it as "*Crinodendron* Hooker, Endlicher-Non Molina." This does not appear to be the intention of Hooker (1833) and in any case would now be considered a later homonym and thus illegitimate.

Miers (1868) revised four genera of the Elaeocarpaceae from South America. In his treatment he followed the precedent of Gay in using *Tricuspidaria* for Molina's species and *Crinodendron* for Hooker's species. In *Tricuspidaria* he described a second species, *T. patagua* (non-Molina).

Cunningham (1871, p. 342) appears to be the first worker to consider *Tricuspidaria dependens* (*Crinodendron patagua*) and *Crinodendron hookerianum* to be congeneric. He was followed by later workers (Carenzo 1966; Coode 1988; Reitz and Smith 1958) who correctly used the rules of priority in accepting Molina's *Crinodendron* as the correct generic name.

Key to the Species of *Crinodendron*

1. Petals red; leaves lanceolate or elliptic; ovary pilose, 5-loculed; fruit subglobose, tomentose ..... 2. *C. hookerianum*
1. Petals white; leaves ovate, obovate, or oblanceolate; ovary glabrous, rarely strigose, 3- or 4- (rarely 5-) loculed; fruit ovoid, sub-ovoid, or sub-globose, glabrous.
   2. Leaves with trichomes scattered over entire abaxial surface; petals 3-lobed; inner ovary surface lacking glands ..... 3. *C. patagua*
   2. Leaves with trichomes along veins and with axillary "tufts" on the major veins of the abaxial surface; petals 3-5-lobed; inner ovary surface covered with glands.
      3. Flowers greater than 1 cm long; leaves not clumped at the ends of the branches .. .. 4. *C. tucumanum*
      3. Flowers less than 0.5 cm long; leaves most often clumped at the ends of the branches ..... 1. *C. brasiliense*

1. Crinodendron brasiliense Reitz & Lyman B. Smith, Sellowia 9:19–22. 1958.—Type: Brasil, Santa Catarina, Mun. Bom Retiro, dwarf forest below rancho, Fazenda Campo dos Padres, Campo dos Padres, alt. 1650 m, Nov 18, 1956, *Smith, Reitz & Klein 7758* (holotype: HBR; isotype: US).

Shrubs 2–4 m tall. Apical buds lanate, deltoid. Twigs sericeous becoming glabrescent, brown becoming tan to off-white with age. Leaves alternate sometimes sub-opposite or whorled, 22–34 mm long, 7–12 mm wide, 2.4–3.6 times longer than wide; bases cuneate; apices obtuse; upper surfaces dark green; lower surfaces lighter green, glabrous except for trichomes along veins and "tufts" in the axils of the lateral veins; margins crenate; petioles 3–6 mm long, less than 1 mm wide, lanate. Flowers elliptic, 4 mm long;

peduncles 7–22 mm long, ca. 1 mm wide, glabrous or with scattered trichomes. Calyces tomentose within, trichomes usually limited to distal half, weakly pubescent without, tearing into 2 equal parts, these parts 3 mm long, ca. 2 mm wide, 1–3-lobed, usually shed before flower fully opens. Petals (4)6, white, 4 mm long, 2 mm wide, tomentose adaxially, glabrous abaxially. Discs (7)10-lobed. Stamens (12–13)18. Filaments white, puberulent. Anthers 2 mm long, puberulent. Styles 2 mm long. Ovaries 3-locular, glabrous. Ovules 4 per locule. Fruits brown, glabrous, 3-winged, sub-globose, 10–20 mm long, 15–22 mm wide, the surface muricate. Seeds ovate, 5 mm long, 2 mm wide.

The common name of this plant is "cinzeiro" (Klein 1978). *Crinodendron brasiliense* is limited to the municipality of Bom Retiro of Santa Catarina in the Serra Geral, Brazil. It grows at high elevations in the life zone known as the "floresta nebular dos aparados da Serra Geral" (Klein 1978), associated with *Drimys brasiliensis* Miers, *Ilex microdonta* Reiss., *Myrceugenia euosma* (Berg) Legrand, and *Weinmannia humilis* Engl.

Representative specimens examined. BRAZIL. **Prov. Santa Catarina.** Dept. Mun. Bom Retiro: Campo dos Padres, dwarf forest, 1400–1650 m, 16 Nov 1956, *Smith, Reitz & Klein 7661* (paratype: UC); Campo between Fazenda Campo dos Padres and Fazeda Santo Antonio, Campo dos Padres, 1400–1600 m, 22 Jan 1957, *Smith, Reitz & Klein 10298* (paratype: A); Campo dos Padres, dwarf forest, 1900 m, 15 Dec 1948, *Reitz 2335* (paratype: UC); Campo dos Padres, 1650 m, 23 Jan 1957, *Smith & Reitz 10369* (paratype: GH, UC, MO).

2. CRINODENDRON HOOKERIANUM C. Gay (as *Crinodendrum hookerianum*), Fl. Chil. p. 340. 1845. *Tricuspidaria hookeriana* (Gay) Cunningham, Notes on the Natural History of the Strait of Magellan and West Coast of Patagonia. p. 342. 1871.—TYPE: Chile, "Valdivia, in sylvis yanquihue, Corral, etc.," September, 1835, *Gay 1018* (holotype: SGO!).

Tricuspidaria lanceolata Miq., Linnaea 25:650–54. 1853.—TYPE: Chile, Valdivia, Prope Corral, December, *Miquel 269* (holotype: U!).

Crinodendron eriocladum Gand., Bull. Soc. Bot. France. 60:457. 1913.—TYPE: Chile, *Philippi* (holotype: LY).

Trees 3–8 m tall. Apical buds lanate. Twigs pubescent, later becoming glabrescent, gray, becoming amber with age. Leaves opposite, occasionally alternate or whorled, elliptic, oblanceolate, or ovate, 15–80 mm long, 7–21 mm wide at widest point, 2–5(8) times longer than wide; bases cuneate to oblique; apices acute; adaxial surfaces dark green; abaxial surfaces lighter green with slight reddish coloration with trichomes located along major veins; margins serrate or occasionally entire; petioles 1.5–9 mm long, 1–3 mm thick, hirsutulose. Flowers ovoid; peduncles 2–6.1 mm long, 1–2.5 mm wide, sericeous. Calices reddish, sericeous within and without, more densely so near apices, 5-lobed, tearing into 2 or 3 parts, the parts 5–7 mm long, 4–8 mm wide. Petals 5–6, red, 14–24 mm long, 3–8 mm wide, hirsute adaxially, glabrous abaxially, weakly 3-lobed, the lobes 0.5–3 mm long. Discs ca. 6 mm in diam., 10-lobed, the lobes 2 mm long, ca. 1 mm wide. Stamens 15. Filaments red, hispid, 7–13 mm long. Anthers ca. 9 mm long. Styles 1–15 mm long, 1 mm wide. Ovaries pilose, 5-loculed, ca. 9 mm long, ca. 4 mm wide, the locules pubescent. Ovules 12–15 per locule, ca. 1 mm long, ca. 0.5 mm wide. Fruits tomentose without, hirsutulous within, 15–45 mm long, 11–21 mm wide, subglobose, all locules fertile. Seeds brown, elliptic, 2–14 per locule, 7–9 mm long, ca. 5 mm wide. Embryos 1–3 mm long, 0.4–1.0 mm wide, the cotyledons 0.6–2.2 mm long, 0.4–0.7 mm wide, radicles plus hypocotyls 0.5–0.9 mm long. $n = 21$.

This plant is usually known by the common names "polizon" or "chaquihue" (Miers 1868). It is a low, understory tree inhabiting wet forests of southern Chile (Provinces of Chiloé, Llanquihue and Valdivia) in association with *Amomyrtus* (Burret) D. Legrand & Kausel sp., *Myrceugenia parvifolia* (DC.) Kausel, evergreen *Nothofagus* Blume sp., *Tepualia stipularis* Griseb., and *Ugni candollei* Berg.

This species has little commercial value other than as an ornamental. Its large, pendant, red flowers (fig. 2) and its preference for a cool maritime climate make it ideal for gardens in places such as Great Britain, northern California, the Pacific Northwest, and southern British Columbia.

Representative specimens examined. CHILE. **Prov. Chiloé.** Dept. Ancud: Aquas Buenas, NE corner of island, 9 May 1972, *Landrum 896* (MICH). Dept. Castro: Lago Huillinco, bosques en la orilla, 1 km al interior de Huillinco, 42°46'S 73°50'W, 15 m, 13 Jan 1975, *Marticorena et al. 164* (CONC). Dept. Chaitén: Ayacora, 18

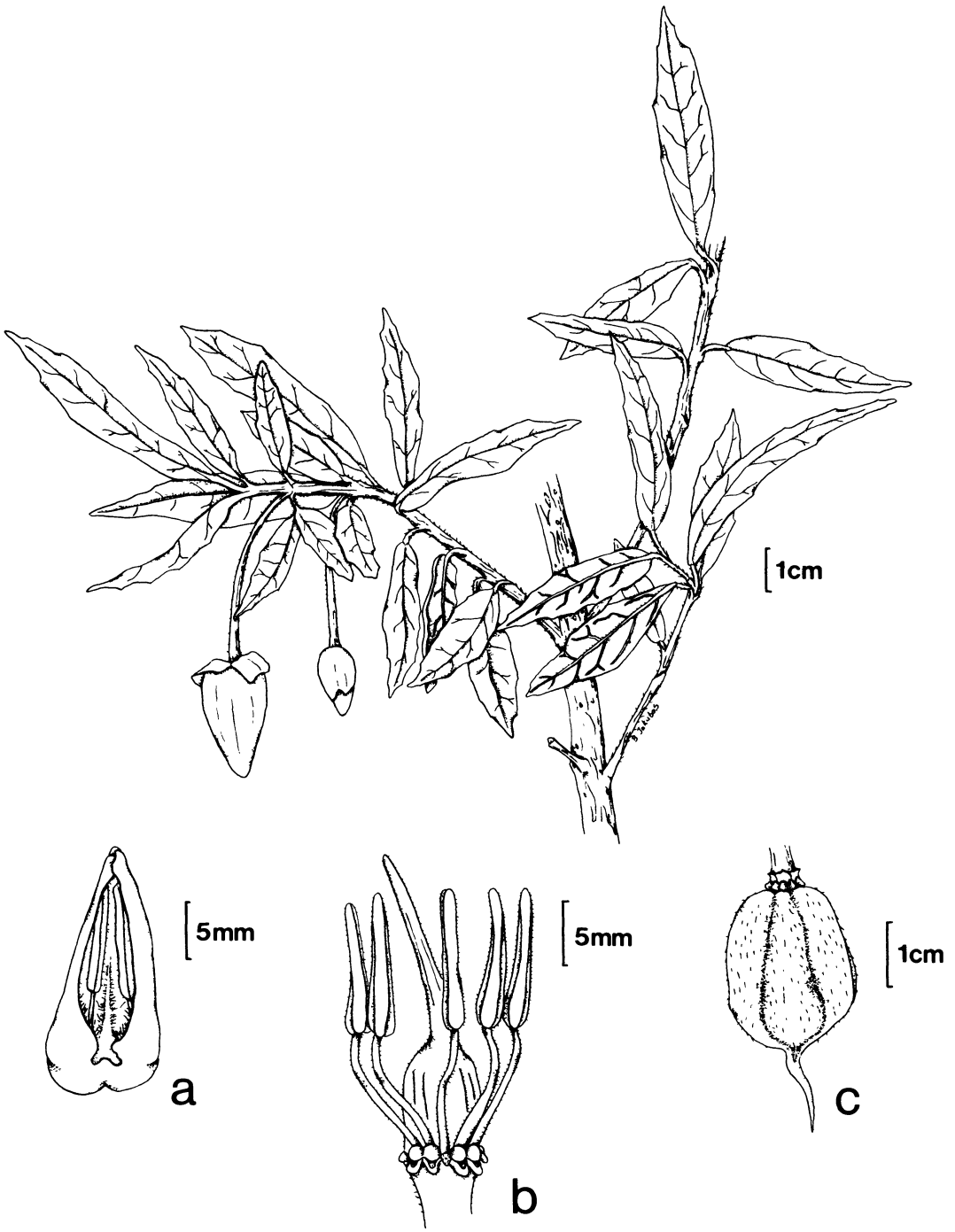

FIG. 2. *Crinodendron hookerianum*. a. Saccate petal enclosing two stamens of the outer whorl. b. Flower, with petals removed, showing insertion of stamens. c. Immature fruit.

Feb 1952, *Levi 1559* (CONC). Dept. Isla Talcan: 18 Feb 1961, *Marticorena 1678* (CONC). Dept. Quemchi: Quemchi, ca. 1 km W of town along road leading from plaza up hill (42°10'S 73°30'W), ca. sea level, 10 Feb 1978, *Landrum 3189* (ASU). **Prov. Llanquihue.** Dept. Llanquihue: near Río Tepu, slopes of Volcan Calbuco, ca. 2 km from Lago Llanquihue, 25 m, 23 Mar 1939, *Morrison 17603* (GH, UC). Dept. Los Muermos: ca. 0.3–1.0 km along road from Cumbre Alta to Quenuil, 18 Jan 1988. *Bricker 243, 246, 247* (ASU). Dept. Maullin: Fundo Penchen, 22 Feb 1944, *Kausel 1445* (LIL). Dept. Puerto Montt: Camino entre Chamiza y Lago Chapo, Río Correntoso, 140 m.s.m., 41°26'S 72°40'W, 6 Mar 1980, *Marticorena & Quezada 1701* (CONC, CTES). Dept. Puerto Varas: camino de Puerto Varas a Puerto Montt, 14 Feb 1964, *Kausel 4754* (LIL). **Prov. Valdivia.** Dept. Corral: La Aquada, 24 Nov 1935, *Gunckel 8067* (CONC). Dept. La Union: Bima district, W of La Union, Cordillera de la Alerce, Alerce forest swamp, 500–900 m, 10 Feb 1958, *Eyerdam 10661* (F, SGO, UC, US); Llancucura, Frutillar, 40°16'S 73°24'W, 700 m, 27 Nov 1967, *Schlegel 6112* (CONC). Dept. Valdivia: Cultivated in the botanical garden at University de Austral de Chile, 20 Jan 1988, *Bricker 245* (ASU).

3. CRINODENDRON PATAGUA Molina, Sag. Stor. Nat. Chili, 1st ed. p. 179. 1782.—TYPE: None indicated by Molina. Chile, Dept. Quinta Normal, Santiago, Apr 1960, *R. Auviedo s.n.* (neotype: K, selected by Coode 1988).

Tricuspidaria dependens Ruíz Lopez & Pavón, Syst. Veg. Fl. Peruv. Chil. 1(3):112. 1798.—*Crinodendron dependens* (Ruíz Lopez & Pavón) Kuntze, Revis. Gen. Pl. 1:82. 1891.—TYPE: *Ruíz & Pavón 9766* (holotype: MA, phototype F!, GH!).

Tricuspidaria hexapetala Turcz., Bull. Soc. Imp. Naturalistes Moscou. 36:576. 1863.—TYPE: Chile, *Bridges 613* (holotype: KW; isotype SI!).

Tricuspidaria patagua Miers, Ann. Mag. Nat. Hist. Series 4, 2:39–54. 1868. An identical entry is also found in: Contr. Bot. 2:186. 1870.—TYPE: Chile, *Bridges 159* (holotype: BM).

Trees or shrubs 3–20 m tall. Apical buds sericeous, deltoid. Twigs lanate becoming puberulent, brown becoming gray with age. Leaves opposite, ovate to oblanceolate, 22–72 mm long, 6–34 mm wide at midpoint, 1.4–2.6 times longer than wide; bases cuneate; apices obtuse to rounded; adaxial surfaces green, glabrous; abaxial surfaces gray, canescent; margins serrate, occasionally crenate; petioles 2–7 mm long, 0.4–1.0 mm thick, caniculate strigose. Flowers subelliptic; peduncles 11–33 mm long, 0.5–1.0 mm wide, strigose or puberulent. Calyces tubular; adaxial surface sericeous; abaxial surface strigose, tearing into 2–4 parts which are usually joined at the base, these parts 3–4 mm long, ca. 4 mm wide, 0–3-lobed, commonly shed as a unit as the flower reaches maturity. Petals 5, white, 1–1.8 cm long; adaxial surfaces generally villose, pubescent along veins, glabrous at apex; abaxial surfaces puberulent along margins, otherwise glabrous; 3-lobed, lobes ca. 3 mm long. Stamens 15. Filaments white, ca. 7 mm long, lanulose, slightly adaxially arched at junction with anther. Anthers ca. 6 mm long, scabrous. Styles 7–10 mm long. Ovaries 4–(5)-loculed, 3–5 mm long, 3 mm wide, sub-ovate, glabrous or sericeous without, having stiff hairs within. Ovules usually 12 per locule, biseriate, 0.5–0.7 mm long, 0.2–0.3 mm wide. Fruits 11–26 mm long, 2–11 mm wide, obovoid or sub-ovoid, surface glabrous to strigose, crimson when fresh, drying brown with tan speckles, or tan, fruit walls recurving and exposing the seeds. Seeds dark purple, elliptic or ovate, ca. 4 mm long, ca. 2 mm wide, sarcotestate. Embryos ca. 3 mm long, ca. 2 mm wide, cotyledons ca. 2 mm long, ca. 2 mm wide, conical radicles plus hypocotyls ca. 1 mm long, ca. 0.2 mm wide.

The common name of this plant is "pataqua" (Molina 1782). It is found in the valleys of central Chile (between Anconcaqua and Concepción) usually along river beds or in low moist areas often associated with *Baccharis juncea* Desf., *Fuchsia magellanica* Lam., *Luma chequen* Phil., *Myrceugenia exsucca* Berg, *Peumus boldus* Schult., and *Psoralea glandulosa* L.. The plant flowers in December and January and the entire tree is covered with attractive, white flowers. The fruits may remain on the plant until March. This plant is sold in the southern United States, coastal and northern California, and New Zealand as an ornamental for its attractive flowers. Molina (1782) reported that the wood was utilized regionally as a lumber resource.

In the revision of *Tricuspidaria* (now *Crinodendron*) by Miers (1868), two species were recognized, *T. dependens* and *T. patagua*. Miers stated that *T. dependens* had darker petals, subfleshy capsules, smaller leaves, and spinelike branches in comparison to *T. patagua*, which had fruits when opened that curved back exposing the

seeds, lighter petals, larger leaves, and no spine-like branches. I have found no evidence of a second white-flowered species from Central Chile.

Representative specimens examined. CHILE. **Prov. Aconcagua.** Dept. Cabildo: Cabildo, Jan 1970, *Marchtinez s.n.* (CONC). Dept. Los Andes: Olivar, 23 Nov 1930, *Behn s.n.* (CONC). **Prov. Arauca.** Dept. Lebu: Lebu, Jan 1877, *Phillipi 242f* (SGO). **Prov. Colchaqua.** Dept. Sta. Cruz: *Kausel 1809* (LIL). **Prov. Concepción.** Dept. Talcahuano: Fundo Hualpen, bosque al pie del Mirador, 36°47'S 73°08'W, 10 m, 5 Mar 1975, *Funetes s.n.* (CONC). Dept. Yumbel: ca. 12.4 km from cemetery at Yumbel on road to Rere, 120 m, 13 Jan 1988, *Bricker 203, 204, 205* (ASU). **Prov. Linares.** Dept. Parral: 3.5 km S of Puente Copihue on Ruta 5, 27 Jan 1988, *Landrum 5939* (ASU). **Prov. Ñuble.** Dept. Bulnes: 80 m, Feb 1953, *Castillo s.n.* (CONC). Dept. Chillan: Chillan, Jan 1877, *Phillipi 242a* (SGO). **Prov. O'Higgins.** Dept. Las Cabras: Hda. Cocalán, *Kausel 3515* (LIL); Las Cabras, *Sparre 2318* (LIL). **Prov. Santiago.** Dept. San Antonio: ca. 0.5 km E of Malvilla, along railroad and Estero El Sauce 10 Jan 1988, *Bricker 191, 192, 193* (ASU). Dept. Peñaflor: Peñaflor, 420 m, 29 Jan 1935, *Montero 2116* (CONC). Dept. San Cristobel: Cerro San Cristobal, Nov 1964, *Niemayer s.n.* (CONC). Dept. Santiago: Santiago, Avenida Sanchez Fontecilla, 33°27'S 70°33'W, Nov 1967, *Schlegel 6155* (CONC). Dept. Quinta Normal: city of Santiago, cult. at Museo Natural, 9 Jan 1988, *Bricker 185* (ASU). **Prov. Valdivia.** Dept. Valdivia: Valdivia, cult. in the Bot. Gard. at Univ. de Austral de Chile, 15 Jan 1988, *Bricker 236* (ASU). **Prov. Valparaiso.** Dept. Limache: Parque Nacional La Campana, ca. 6 km above Olmue, 33°00'S 71°08'W, 500 m, 24 Dec 1978, *Solomon 4215* (MO). Dept. Quillota: Casa Sr. Asorio, ca. 8 km E of Melon, 500 m, 15 Dec 1938, *Morrison 16925* (GH, UC, MO). Dept. Quilpué: Quilpué, 5 Dec 1976, *Zollner 9400* (MO). Dept. Valpariso: El Granizo, 32°59'S 71°10'W, Nov 1958, *Schlegel 74* (CONC). Dept. Viña del Mar: 23 Nov 1930, (LIL).

4. CRINODENDRON TUCUMANUM Lillo (as *C. tucumana*), Resena Fitogeografica de la Provincia de Tucumán, Primera Reunión Nacional de la Sociedad Argentina de Ciencias Naturales, Tucumán, Buenos Aires, p. 220. 1916.—TYPE. "Crece en los bosques subtropicales de sur de la provincia de Tucumán" (none indicated by Lillo). Argentina, Tucumán, Chicligasta, Est. Las Pavas, 1800 m, Flor blanca, 5 m., laderas del cerro, Nov 22, 1916, *S. Venturi 4649* (Lectotype designated by Descole and O'Donell, 1938: LIL!; isolectotypes: F! #720622, GH!)].

Crinodendron boliviensis Carenzo, Lilloa 32:15. 1966.—TYPE: Bolivia, Santa Cruz, Huerta, Comarapa, 2800 m alt., in sylvis montanis, Oct 26, 1928, *Steinbach 8562* (holotype: LIL!; isotypes: BA, GH!).

Trees 3–30 m tall, 0.2–1 m d.b.h. Apical buds strigose, deltoid. Twigs smooth, brown becoming amber or gray with age. Leaves alternate to sub-opposite, elliptical, obovate, or oblanceolate, 23–110 mm long, 11–35 mm wide, 1.2–4.3 times longer than wide; bases cuneate, sometimes rounded or oblique; apices acute, occasionally obtuse, rarely rounded or emarginate; adaxial surfaces dark green; abaxial surface gray-green with brown midribs and veins, trichomes along veins and "tufts" in axils of major veins; margins serrate or crenate. Petioles 2–11 mm long, 2–10 mm wide, villous adaxially, ± glabrous abaxially. Flowers elliptic; peduncles 18–46 mm long, 1–8 mm wide, glabrous. Calyces tomentose with ciliate margins within, glabrate without, tearing into 2 parts, each part 2–3-lobed, commonly shed before the flower reaches maturity. Petals 5 (rarely 6), white, 13–16 mm long, tomentose adaxially (especially along veins), glabrous abaxially, 3–5-lobed, lobes ca. 3 mm long. Stamens 15. Filaments ca. 5 mm long, bent near junction with anther, hispidulous, the trichomes white. Anthers 4 mm long, less than 1 mm wide; bases oblique; apices cuneate. Styles 5–7 mm long. Ovaries 3–4-loculed, glabrous without, having stiff hairs within. Ovules usually 6 per locule, ca. 0.6 mm long, ca. 0.2 mm wide, biseriate. Fruits 13–24 mm long, 14–21 mm wide, 3–4-winged, subglobose, brown to reddish brown, dry at maturity, walls recurving at maturity exposing the seeds, glabrous without, hirsute and covered with small glands within, glands ca. 0.10 mm in dia., locules filled with a watery fluid during development. Seeds deep purple, ellipitic, 1–5 per locule, ca. 6 mm long, ca. 3 mm wide. Embryos 4–5 mm long, radicles <0.5 mm long, ca. 0.1 mm wide; cotyledons 3–4 mm long, ca. 3 mm wide, epicotyls ca. 0.10 mm long.

The common name of this plant is "granadillo" (Digilio and Legname 1966). It flowers from October to December after which the fruits may remain on the plant until May. This species is found in the "región de los bosques subtropicales" (Lillo 1916) in the provinces of Cata-

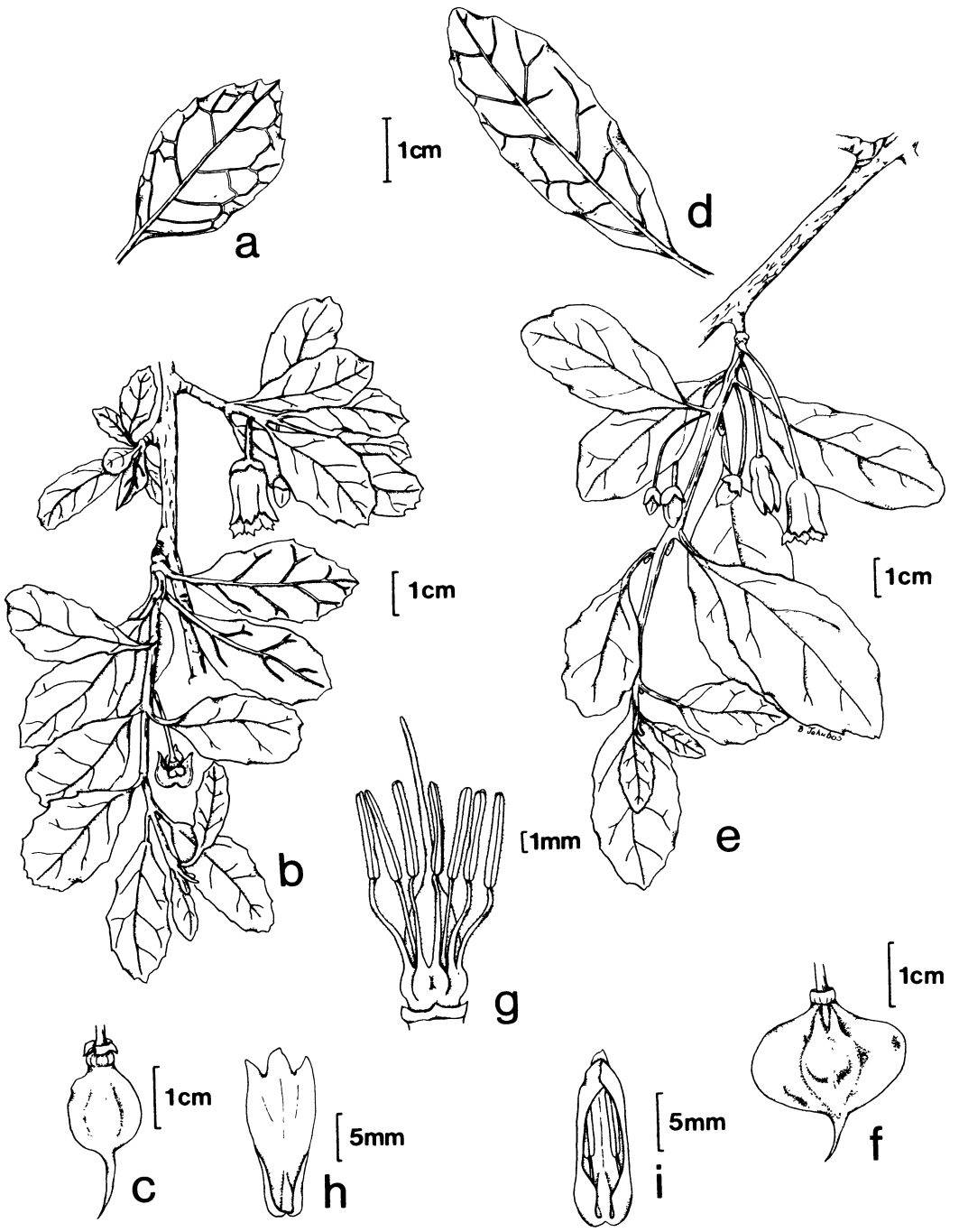

FIG. 3. Comparison of *Crinodendron patagua* and *C. tucumanum*. *Crinodendron patagua* (a–c, g–i), a. Leaf. b. Habit. c. Immature fruit. g. Flower with petals removed. h. Mature petal. i. Young petal enclosing two stamens. *C. tucumanum* (d–f). d. Leaf. e. Habit. f. Immature fruit.

TABLE 1. Comparison between *Crinodendron patagua* and *C. tucumanum*.

	C. tucumanum	*C. patagua*
Leaves:	larger (2.3–11.0 cm long, 0.6–3.4 cm wide at widest point), more ovate, with "tufted" trichomes in the axils of the lateral of the lower surfaces	smaller (2.2–7.2 cm long, 1.1–3.5 cm wide at widest point), obovate, with trichomes covering the entire lower surfaces
Petals:	3–5-lobed	3-lobed
Ovaries:	3-(occasionally 4) loculed	4-(rarely 5) loculed
Ovules per locule:	6	12
Immature fruit:	filled with fluid	lacking fluid
Calyx:	shed when the flower matures	usually persistent and dangling on the peduncle

marca, Salta, and Tucumán of northeastern Argentina and from Santa Cruz, Bolivia. It is found in association with such plants as *Alnus jorullensis* Benth., *Amomyrtella guili* (Speg.) Kausel, *Myrcianthes* Berg. spp., and *Phoebe porphyria* Mez. A large tree up to 30 m, it is easily recognized from afar by its habit, the main trunk dividing into three or more nearly vertical branches below the midpoint of the tree.

Descole and O'Donell (1938) recognized the Argentine *C. tucumanum* as a species distinct from the highly similar Chilean *C. patagua* (fig. 3). The differences between the two species are presented in table 1.

Carenzo (1966) described a new species, *C. boliviensis*, from Santa Catarina, Bolivia. I consider the Bolivian population to represent an ecological variant of *C. tucumanum*. The holotype, *Steinbach 8565*, (incorrectly cited by Carenzo in 1966 as *Steinbach 8265*) for *C. boliviensis* was collected in Santa Cruz, Bolivia, at 2800 m above sea level. This locality is 800 m higher than where *C. tucumanum* usually grows. The holotype differs from *C. tucumanum* only in the smaller size of vegetative and floral structures. The differences between the Argentinian and Bolivian populations are interpreted as the effects of the environment.

Representative specimens examined. ARGENTINA. **Prov. Catamarca.** Dept. Andalgala, Coman Enquina Grande, 12 Oct 1916, *Jorgensen 1526* (GH, LIL, MO, SI, UC, US). **Prov. Jujuy.** Dept. Ledesma: Parque Nac. Calilequa, camino entre Mesada y Abra de Cañas, 2 Dec 1981, *Brown 1728* (CTES). **Prov. Salta:** 2000 m, Nov 1937, *Deveto et al. 248* (LIL). **Prov. Tucumán.** Dept. Burroyero: Cerro del Campo, 2000 m, Dec 1928, *Venturi 7718* (CAS, F, GH, LP, MO, SI, UC). Dept. Chicligasta: ca. 34.4 km W of Highway 38 on road to Cochuna, at bridge over Arroyo El Calao, ca. 3500 ft elev., 23 Dec 1987, *Bricker 138* (ASU). Dept. Monteros: Predro Labrada, 1280 m, 25 Apr 1949, *Vervoorst 163* (LIL). Dept. Tafí: road to Tafí del Valle, 7200 ft elev., 25 December 1987, *Bricker 154* (ASU).

BOLIVIA. **Prov. Santa Cruz.** Bergwald, Huertas, 2800 m, 26 Oct 1928, Steinbach 8562 (GH, LIL).

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