A REVISION OF THE GENUS LUNASIA (RUTACEAE) *

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THE GENUS *Lunasia* Blanco, with the exception of its occurrence in the Cape York Peninsula of Australia, is entirely Malesian, ranging from the Philippines and Borneo south to Java and east through New Guinea (see MAP 1). It is readily distinguishable from other genera of the Rutaceae in that area by its having trimerous flowers arranged in small, head-like clusters. The uniqueness of these floral features is indicated in Engler's treatments of the family (1896 & 1931) where they provide the basis for the placement of *Lunasia* in a separate subtribe, the Lunasiinae, of the tribe Xanthoxyleae, subfamily Rutoideae.

While the nearly apocarpous gynoecium and pellucid oil dots clearly place *Lunasia* in the Rutaceae, the small, trimerous flowers, swollen petiole apices and croton-like trichomes give it a superficial resemblance to some of the Euphorbiaceae. This is reflected in Blanco's original placement of the genus between the genera *Stilago* (*Antidesma*) and *Excoecaria* in the "Dioecia Triandra." *Mytilococcus* Zoll. and *Androcephalium* Warb., now considered to be synonyms of *Lunasia*, were also initially placed in the Euphorbiaceae.

I was able to study and collect *Lunasia* in New Guinea while employed as a botanist for the Australian Commonwealth Scientific and Industrial Research Organization, Phytochemical Survey of New Guinea, 1961–1965. This study is otherwise based on herbarium specimens. The contributing herbaria are listed below, with abbreviations from Lanjouw and Stafleu's *Index Herbariorum*, Part I. ed. 5 (Regnum Vegetabile, 31. 1964).

A	Arnold Arboretum of Harvard University, Cambridge
GH	Gray Herbarium of Harvard University, Cambridge
K	Royal Botanic Gardens, Kew
L	Rijksherbarium, Leiden
MICH	University Herbarium, University of Michigan, Ann Arbor
NY	New York Botanical Garden, New York
US	U.S. National Museum (Department of Botany), Smithsonian Institution, Washington

I wish to thank the directors and curators of these herbaria for making specimens in their care available to me.

Lunasia Blanco, Fl. Filip. ed. 1. 783. 1837. Type species: *Lunasia amara* Blanco.

* This is the second of a series of studies on the Rutaceae of Malesia.

Rabelaisia Planch. London Jour. Bot. **4**: 519. 1845. Type species: *Rabelaisia philippinensis* Planch.

Mytilococcus Zoll. Natuurk. Tijd. Ned. Ind. **14**: 173. 1857. Type species: *Mytilococcus quercifolius* Zoll.

Androcephalium Warb. Bot. Jahrb. **18**: 196. 1893. Type species: *Androcephalium quercifolium* Warb.

Erect shrubs or small trees; dioecious; evergreen. Branchlets, leaves, inflorescences and fruits with gray to reddish brown, scale-like and/or stellate trichomes. Pellucid oil dots scattered in the leaves, perianths, and cotyledons. Leaves alternate, simple; petioles swollen apically; leaf blades pinnately veined. Inflorescences axillary, paniculate, the flowers in small, head-like clusters. Flowers unisexual; sepals and petals 3, valvate; stamens 3, rudimentary in carpellate flowers, opposite the sepals, with 2-celled, dorsifixed anthers; gynoecium 3-carpellate, rudimentary in staminate flowers, carpels connate basally, 1-locular, each with a single, pendulous ovule, placentation upper axile, styles 3, stigmas 3. Fruits 1–3 1-seeded, 2-valved follicles; follicles dehiscent along the apical and adaxial edges, in 3's, 2's or single with 0, 1 or 2 persistent, undeveloped carpels, respectively; pericarp dry at maturity, the endocarp cartilaginous and discharged from the follicle with the seed. Seeds with fleshy, oily cotyledons; endosperm absent.

It has been with considerable hesitation that I have decided on the conservative treatment presented here. *Lunasia* is extremely variable in certain vegetative features, and specimens such as the types of *L. parvifolia*, *L. quercifolia*, *L. mollis*, and *L. obtusifolia* certainly look distinct from the neotype of *L. amara*. I have found, however, that the variations represented by these and other specimens are repeated, in varying degrees of similarity, in scattered patterns of distribution that, without the correlation of specialized habitats, can hardly be considered those of natural populations. Although the ecological data I have are far from complete, there is no sound evidence of such ecologic specialization. The genus is apparently confined entirely to lowlands and grows in habitats ranging from well-drained rain forests to garden regrowth and rather dry thickets. Similar ecologic amplitude may be found in a number of well-marked Malesian species.

Trichomes in the genus vary from flat, scale-like structures composed of as many as 60 connate, radiating cells to stellate structures composed of as few as 2 separate, ascending cells. The range of variation in these structures is illustrated in Fig. 1. With the exception of the large, relatively simple trichome illustrated as Type VI, a clinal gradation exists in the genus from scale-like (Type I) to stellate (Type V). To some extent this gradation may be found in single specimens, the tendency being for the least dissected trichomes to occur on the lower midrib and petiole and the more stellate trichomes to occur, progressively, on the lower surface of the leaf blade, the inflorescence branches, and the flowers and fruits.

While the leaves are exceptionally variable in size, texture, number of

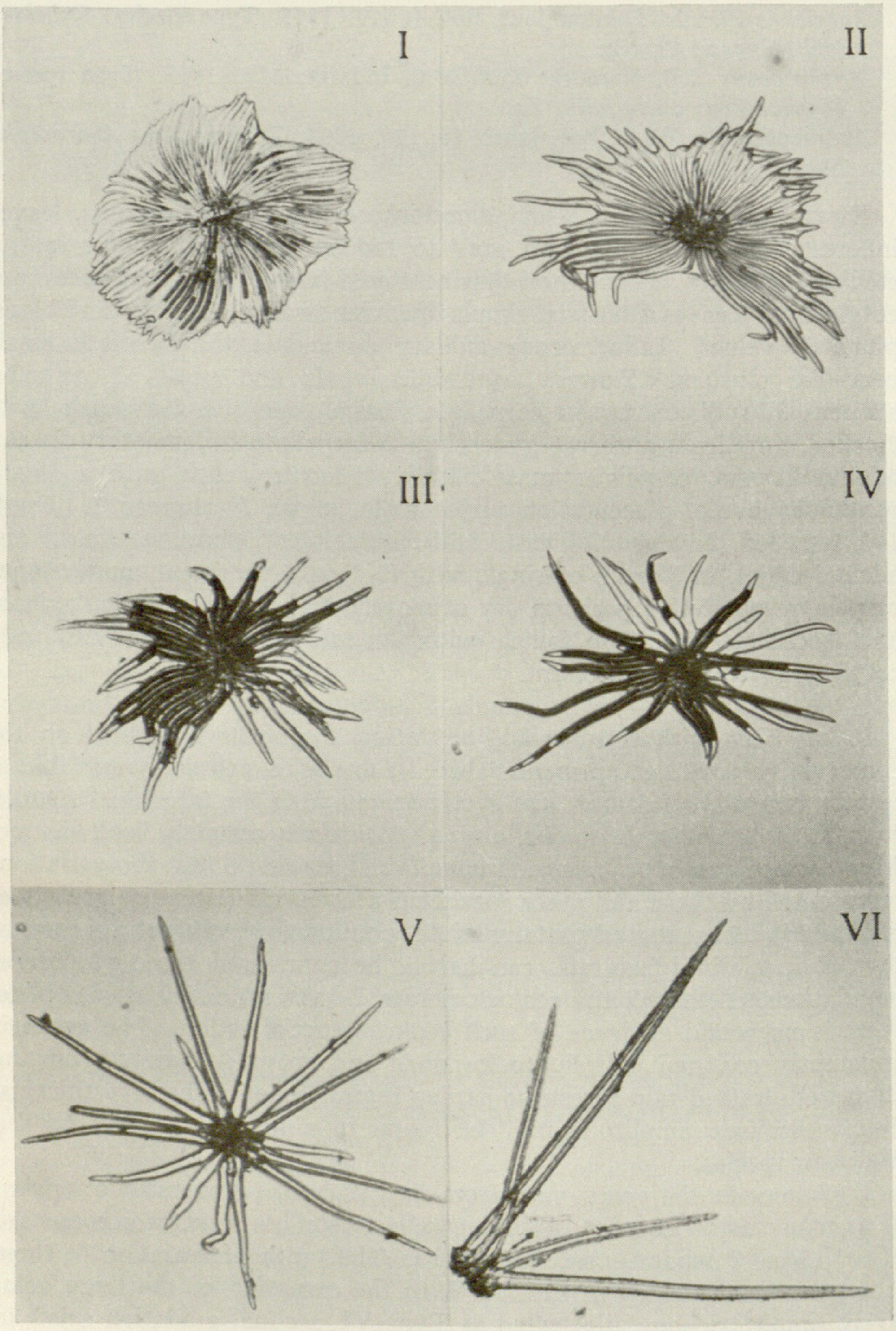


FIG. 1. Range of variation of trichomes in *Lunasia*. TYPES I–V, × 120. TYPE VI, × 67.

lateral veins and irregularities of the margins, they are nevertheless very distinctive. Apparently without exception the petioles are conspicuously swollen just below the insertion of the blade. Usually 5–10 mm. long and about one-half as wide (in dried specimens), this swelling tends to be thickest on the abaxial side of the petiole, resulting in an upward bending at that point. With only occasional exceptions the leaf blades are broadest well above the middle, tapering rather abruptly to the apex and gradually to a narrow base. The margins are seldom entire and the irregularities, ranging from undulations to sinuses, tend to become increasingly prominent toward the blade apex.

In dried condition the lateral faces of the follicles are generally marked with rather conspicuous, transverse ribs. In two collections from the Babuyan Islands, northern Philippines, the follicles are covered with twisted, simple or 2–3-branched processes which originate from the main vascular bundles (the above-mentioned ribs) of the pericarp. Other than this variation in the follicle and some variation in size of parts, the reproductive structures of *Lunasia* are remarkably uniform. The flowers, especially, vary only slightly throughout the genus.

Lunasia is well known in native medicine of the Philippines and Indonesia and reportedly has a number of uses including treatment of snake bite, skin diseases, swollen limbs and inflamed eyes. It is also reported to be taken in the treatment of digestive disorders, apparently in very dilute solution since small amounts are reputed to cause vomiting and cramps.

There are several reports of a substance from the bark being used for arrow poison. In tests on laboratory animals (Wirth, Jour. Am. Pharm. Assoc. **20**: 1254. 1931) it has been established that injections of two of the alkaloids from the bark, lunasin and lunacrin, result in decrease in responsiveness of isolated voluntary and smooth muscle, constriction of blood vessels and diminution of contractions of the heart. The lethal effect, in Wirth's tests, proved to be simultaneous stoppage of circulation and respiration.

The alkaloids have long been of interest to phytochemists and reports of their occurrence are found in the literature as far back as the late 1800's. In a recent paper dealing with the distribution of alkaloids in the Rutaceae (Price, 1963) a total of fourteen are listed for *Lunasia*. Ten of these, hydroxylunacridine, hydroxylunacrine, hydroxylunidine, hydroxylunine, kokusaginine, lunacridine, lunacrine, lunine, skimmianine and lunasine belong to a structural category of alkaloids known as furoquinolines and four, lunamarine, 4-methoxy-2- (3′, 4′ -methylenedioxyphenyl) -quinoline, eduleine and 4-methoxy-2-phenylquinoline belong to a category known as quinolines. The author points out that both these types of compounds are of wide occurrence in the Rutaceae and that they are rarely found (only one or two instances in the case of the simple quinoline derivatives) outside the family.

The following comments concern the citation of collections:

1. The collections are cited in the same geographic sequence followed in the initial paper (1966) of this series of studies.

2. The sex of each collection is indicated by the appropriate symbol fol-

lowing the collection number, or, in instances where two or more specimens of a collection from two or more herbaria are of different sex, by the appropriate symbol in parentheses following each herbarium citation. Herbarium sheets with male and female specimens of one collection are indicated by "♂ & ♀." Specimens for which I do not give an indication of sex are either sterile or at a stage where the determination could not be made.

3. Where applicable, the abbreviations listed in my previous paper of this series (1966, 175) are used for collections numbered in series. The following are additions:

BRUN State Forest Office, Brunei
SAN Forestry Department, Sandakan, Sabah (British North Borneo)

1. **Lunasia amara** Blanco, Fl. Filip. ed. 1. 783. 1837. Neotype: *Escritor BS 20776* (*Merrill Species Blancoanae 5*), Philippines, Luzon Island.

The synonyms are listed with the varieties.

KEY TO THE VARIETIES

1. Follicles transversely ribbed (the ribs sometimes obscured by trichomes) on the lateral surfaces, otherwise smooth .... 1a. var. *amara*.
1. Follicles densely covered with twisted, stellately pubescent processes to 8 mm. long .... 1b. var. *babuyanica*.

1a. **Lunasia amara** Blanco var. **amara**

Pilocarpus amara (Blanco) Blanco, Fl. Filip. ed. 2. 540. 1845.
Rabelaisia parvifolia Planch. London Jour. Bot. **4**: 519. 1845. Type: *Webb*, Celebes, Boeton Island.
Rabelaisia philippinensis Planch. *Ibid.* Syntypes: *Cuming 501*, *1501* (not seen) and *1512*, Philippines.
Mytilococcus quercifolius Zoll. Natuurk. Tijd. Ned. Ind. **14**: 173. 1857. Type: *Zollinger 2687*, Java (not seen).
Mytilicoccus costulatus Miq. Fl. Ind. Bat. **1**(2): 388. 1859. Type: *Zollinger 2687*, Java? (not seen).
Mytilicoccus grandifolius Miq. *Ibid.* Type: *Zollinger 2687 bijvoegsel*, Lesser Sunda Islands, Sumbawa (not seen).
Lunasia grandifolia (Miq.) Miq. Ann. Mus. Lugd.-Bat. **3**: 89. 1867.
Lunasia costulata (Miq.) Miq. *Ibid.*
Lunasia parvifolia (Planch.) Miq. *Ibid.*
Lunasia philippinensis (Planch.) F.-Vill. Novis App. 35. 1880.
Androcephalium quercifolium Warb. Bot. Jahrb. **18**: 197. 1893. Type: *Hellwig 131*, Territory of New Guinea.
Lunasia quercifolia (Warb.) Laut. & K. Sch. Fl. Deutsche Schutzgebiete Sudsee 376. 1901.
Lunasia repanda Laut. & K. Sch. *Ibid.* Type: *Lauterbach 2805*, Territory of New Guinea (not seen).
Lunasia amara Blanco var. *costulata* (Miq.) Hochreutiner, Bull. Inst. Bot. Buitenzorg **19**: 54. 1904.

Lunasia reticulata Elmer, Leafl. Philip. Bot. **4**: 1511. 1912. Type: *Elmer 12119*, Philippines, Sibuyan Island.

Lunasia mollis Merr. Philip. Jour. Sci. Bot. **9**: 299. 1914. Type: *Ramos BS 11026*, Philippines, Cebu Island.

Lunasia macrophylla Merr. *Ibid.* 300. Type: *Whitford & Hutchinson FB 9299*, Philippines, Mindanao Island (not seen).

Lunasia obtusifolia Merr. *Ibid.* 300. Type: *McGregor BS 1273*, Philippines, Bohol Island.

Lunasia nigropunctata Merr. *Ibid.* 301. Type: *Escritor BS 21188*, Philippines, Luzon Island.

Lunasia amara Blanco var. *repanda* Merr. *Ibid.* 302. Type: *Fénix BS 15842*, Philippines, Mindanao Island.

Lunasia amara Blanco var. *repanda* (Laut. & K. Sch.) Laut. Bot. Jahrb. **55**: 247. 1918 (nomen illegit.).

Lunasia gigantifolia Merr. Philip. Jour. Sci. Bot. **21**: 519. 1922. Type: *Agama BS 582*, British North Borneo.

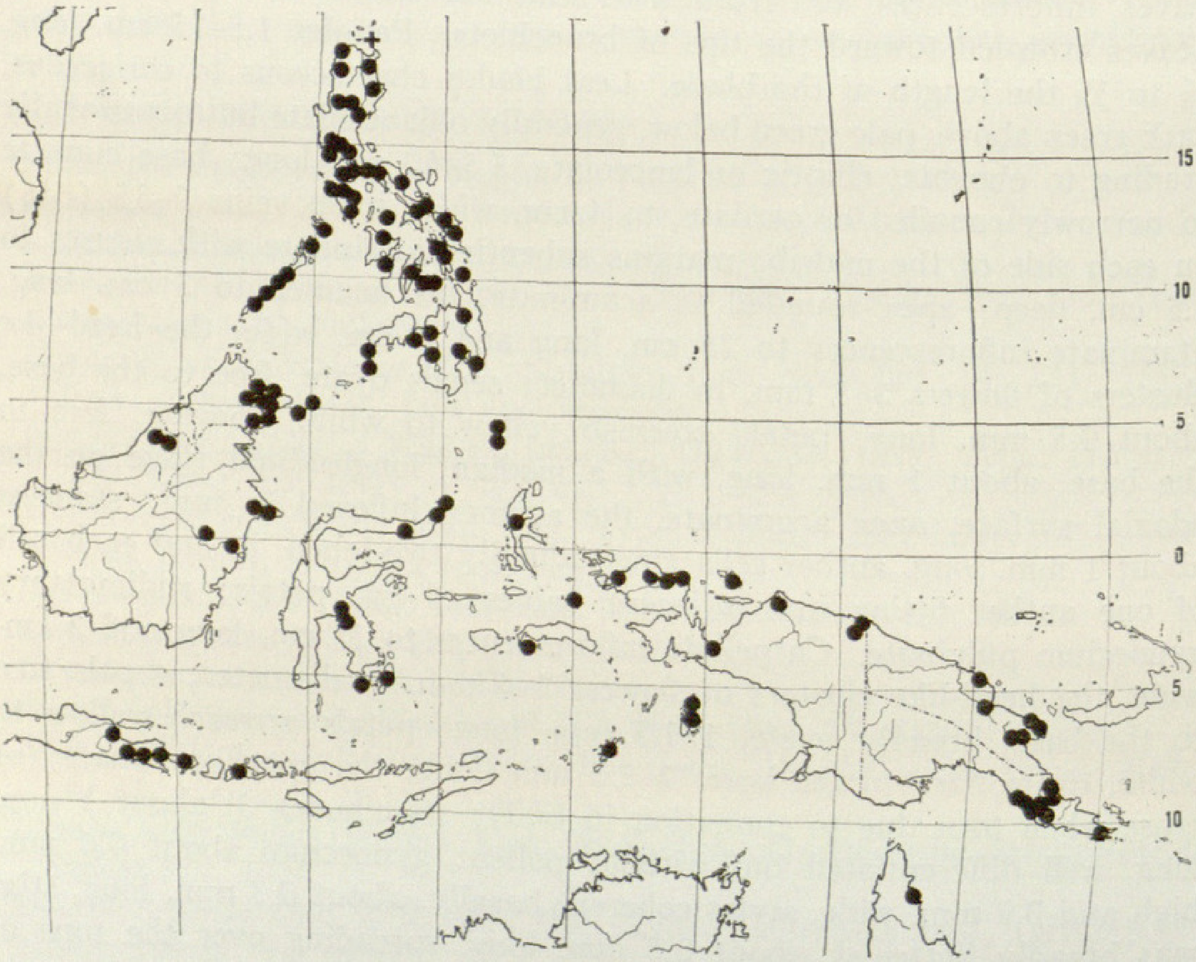
Lunasia pubifolia Merr. *Ibid.* **29**: 481. 1926. Type: *Ramos BS 43358*, Philippines, Bohol Island.

Lunasia quercifolia (Warb.) Laut. & K. Sch. var. *lanceolata* C. T. White, Jour. Arnold Arb. **7**: 232. 1926. Type: *Brass 761*, Papua.

Lunasia truncata Elmer, Leafl. Philip. Bot. **10**: 3782. 1939. Type: *Elmer 15140*, Philippines, Luzon Island (nomen illegit.).

Erect, sparsely branched shrubs or small trees to 12 m. Branchlets, leaves, inflorescences, and fruits with scale-like and/or stellate trichomes. Leaves crowded toward the tips of branchlets. Petioles 1.5–15 cm. long, ⅛ to ⅓ the length of the blade. Leaf blades chartaceous to coriaceous, dark green above, pale green below, generally oblanceolate but occasionally grading to obovate, elliptic or lanceolate, 5.5–60 cm. long; base cuneate to narrowly rounded or cordate, to 4 cm. wide; main veins 9–35 (?45) on each side of the midrib; margins subentire to sinuate with sinuses to 1.5 cm. deep; apex rounded to acuminate, the acumen to 3 cm. long. Staminate inflorescences to 28 cm. long and 8 cm. wide, the head-like clusters of flowers 3–5 mm. in diameter; sepals ovate, free to the base, about 0.5 mm. long; petals greenish yellow to white, obovate, free to the base, about 1 mm. long, with a median, longitudinal ridge on the adaxial surface, apex acuminate, the acumen inflexed in bud; stamens about 1 mm. long, anther cells longitudinally two-lobed, in bud each cell of one anther fitting into adjacent halves of two petals; rudimentary gynoecium pulvinate. Carpellate inflorescences to 25 cm. long and 2 cm. wide, the head-like clusters of flowers 3–6 mm. in diameter; sepals free to the base, broadly ovate, 1–1.5 mm. long; petals greenish yellow to white, ovate, free to the base, 2–2.3 mm. long, the apex acuminate (or erose when torn due to connation in bud); staminodes 3, about 1 mm. long, well differentiated but without pollen; gynoecium about 0.6 mm. high and 0.9 mm. wide, styles coherent basally, about 0.3 mm. long, stigmas broadly flattened, about 0.5 mm. long, spreading over the tops of each of the three carpels. Follicles obovate-truncate, somewhat flattened laterally, transversely ribbed on the lateral surfaces, otherwise smooth, 6–15 mm. high, 5–10 mm. wide, generally beaked at the abaxial apical angle, the beak to 5 mm. long. Seeds obovoid, the testa dark brown to reddish brown, sublustrous, papery.

Java. EASTERN JAVA. Surabaja Residency, Patjet, *Altman 421* ♂ (A). Besuki Residency: Near Puger, G. Watangan, *Backer 36482* ♂&♀ (L), *Jacobs 4715* ♂ (L); Puger, *Koorders 21584β* ♀ (K, L), *21585β* ♀ (K, L). Banjuwangi, *Anonymous* ♀ (L). KANGEAN ISLAND. Terrein N van Ardjasa, *Backer 26883* ♀ (L). **Lesser Sunda Islands etc.** BALI. *Anonymous* ♀ (L). SUMBAWA. Mt. Batulanteh, *Kostermans 18686* ♂ (A, L). TANIMBAR ISLANDS. Jamdena Island: central part near Ranarmoje River, near Norkesi, *Borssum Waalkes 3239* ♂ (K, L); Weri Ranarmoje, ca. 28 km. E of the coast, *Buwalda 4717* [A, K(♀), L]; Makatian, *NIFS bb 24406* (A, L). **Borneo.** EAST BORNEO. Koetai: G. Kombeng, *Endert 5120* ♀ (K, L); 15 km. upstream from Samarinda, *Kostermans 4816* ♂ (K, L); Sg. Susuk region (NE of Sangkulirang Bay), *Kostermans 5603* ♀ (L); Sangkulirang District, Mt. Medadam, N of Sangkulirang, *Kostermans 13446* ♀ (L). BRITISH NORTH BORNEO (SABAH). Tawau, *Elmer 20849* ♀ (A, GH, L, NY); Semporna, Segarong Forest Reserve, *Symington & Agama North Borneo Forestry Dept. 9257* ♀ (A, K, L); Lamag District, Sopiloring Hill, *Ampuria SAN 35283* (K); Lahad Datu District, Mt. Silam, *Hujin SAN 37830* (L); Sukau, *Meijer SAN 26594* (L); Port Myburgh, *Creagh*, ca. 1895 (K); Sandakan, *Agama BS 582* [A(♂), K(♀)] — isotypes of *Lunasia gigantifolia* Merr.; Gomantong Hill Forest Reserve, *Wing SAN 38106* ♀ (K, L); Gomantong Caves Hill, E edge of Libing payu hole, *Wood SAN A4628* ♀ (L). SARAWAK. Baram District: Ulu



MAP 1. Distribution of *Lunasia amara* Blanco var. *amara* (dots) and var. *babuyanica* (Merr.) Hartley (plus sign).

Melinau, *Ashton BRUN 3206* [K(♀), L]; Melinau Gorge, Lat 4° 10′ N., Long. 114° 55′ E., *Chew Wee-Lek 485* ♀ (K); G. Api, *Wilford SAR 4269* ♀ (K). **Philippines.** PALAWAN ISLAND. Malinao Mt., *Ebalo 628* ♂ (A); Mt. Mantalingajan, *Edaño BS 77576* ♂ (NY); Mt. Pulgar, near Puerto Princesa, *Elmer 13022* ♀ (GH, L, NY, US); Quezon, Lipuum Point, *Gutierrez & Espiritu PNH 80798* ♂ (L); E-wi-ig River, *Merrill 743* ♀ (GH, NY, US); Victoria Mts., between Panacan and Aborlan, *Sulit PNH 12353* ♂&♀ (A); Maitiaguit, *Vidal 1205* ♀ (L); without definite locality, *Agama FB 21597* ♀ (A, US), *Bermejos BS 247* ♀ (NY, US). CALAMIAN GROUP. Coron Island, *Ramos BS 41156* ♀ (A). MINDORO ISLAND. Puerto Galera vicinity, *Bartlett 13504* ♀ (A), *13515* ♀ (A), *Santos 5161* ♀ (L, US); Mansalay vicinity incl. Mt. Yagaw, *Conklin PNH 18588* ♀ (A, L, US), *PNH 39202* ♀ (A, L), *Sulit PNH 17049* ♀ (A, L), *Sulit & Conklin PNH 16907* ♀ (A, L); Paluan, *Ramos BS 39751* ♀ (A); Pinamalayan, *Ramos BS 41047* ♂ (A). LUZON ISLAND. Ilocos Norte Province, Mt. Quebrada, *Edaño PNH 17871* ♂ (L). Cagayan Province, Penablanca vicinity, *Adduru 111* two sheets, one ♂ and one ♀ (A), *240* (A, US). Abra Province, Mt. Portoc, *Alcasid et al. PNH 1601* ♂ (L). Isabela Province: Sierra Madre Mts., San Mariano, *Gutierrez PNH 78065* ♀ (A, L); without definite locality, *Velasco FB 28124* ♂ (A). Benguet Subprovince, *Curran & Merritt FB 15825* ♂ (K, US). Nueva Vizcaya Province: Dupax vicinity, *McGregor BS 11184* ♀ (L), *BS 11264* ♂ (US); without definite locality, *Cenabre FB 28496* ♀ (A). Aurora Province, Baler, *Escritor BS 21188* ♀ (US — isotype of *Lunasia nigropunctata* Merr.), *Merrill 1104* ♀ (NY, US), *Quisumbing PNH 2409* ♀ (A). Pampanga Province, Arayat, *Merrill 1357* ♀ (GH, K, NY, US). Bulacan Province, Angat, *Ramos BS 21751* ♀ (US). Rizal Province: Manila, Laguna de Bay, *Andersson*, January, 1853 (NY); Montalban, *Loher 219* [K, NY, US(♀)], *220* [K(♂&♀), US(♂)], *5712* ♀ (US), *5723* ♂ (US), *5742* ♂ (K, US); Antipolo, Morong, *Loher 221* ♀ (US); Morong, Tanay, *Merrill 2339* ♂ (US); Antipolo, *Vidal 135 bis* ♂ (A); San Mateo, *Vidal 136* ♂&♀ (A); without definite locality, *Ahern's collector FB 2462* ♀ (K, NY, US), *FB 3106* ♂ (K, NY, US), *Ramos BS 38* ♀ (US), *BS 1830* [GH (♂), US], *BS 22688* ♀ (A). Bataan Province: Mt. Mariveles, *Elmer 6664* ♀ (NY); Mt. Mariveles, Lamao River, *Ahern's collector FB 1436* ♂ (NY, US), *Borden FB 745* ♀ (K, NY, US), *Merrill 3161* ♀ (NY, US), *Meyer FB 2261* ♀ (K, NY, US), *Whitford 5* ♀ (K, NY, US), *508* ♂ (NY, US), *Williams 34* [GH (♀), NY (♀), US], *518* ♂ (NY, US); Lamao, *Barnes FB 180* ♀ (A, NY, US); between Bagac and Moron, *Vidal 135* [A, (♀), K (♂), L (♀)]; without definite locality, *Williams*, 1905 ♀ (A). Laguna Province: Mt. Makiling, *Agra PNH 35334* ♀ (L), *Forestry Guard PNH 4311* ♀ (A), *Orden PNH 33478* ♀ (L, US); Los Baños, *Elmer 8115* (K, NY), *8119* ♂ (K), *Tamesis FB 11908* ♀ (L); without definite locality, *Cuming 501* ♀ (L, NY) — isosyntypes of *Rabelaisia philippinensis* Planch. Batangas Province, *Cuming 1512* ♂ (GH, L, NY) — isosyntypes of *Rabelaisia philippinensis* Planch. Quezon Province: Guinayangan, *Escritor BS 20776* (*Merrill Species Blancoanae 5*) ♀ (A — neotype of *Lunasia amara* Blanco, GH, L, NY, US), *Oro FB 30904* (NY); Tayabas, Laguimanoc, *Merrill 2126* ♀ (US). Camarines Sur Province, Isarog, *Vidal 682* ♀ (L). Sorsogon Province, Irosin, Mt. Bulusan, *Elmer 15140* ♀ (A, GH, K, L, NY, US) — isotypes of *Lunasia truncata* Elmer. Without definite locality, *Loher 218* (NY, US), *223* ♀ (US). SIBUYAN ISLAND. Capiz Province, Magallanes (Magdiwang), Mt. Giting-Giting, *Elmer 12119* [A (♂), K (♂), L (♂), NY (♂&♀), US (♂)] — isotypes of *Lunasia reticulata* Elmer. TICAO ISLAND. *Clark FB 1083* ♀ (NY, US). SAMAR ISLAND. Mt. Sarawag, *Edaño PNH 15331* ♂&♀ (A); Mt. Purog, Baniz, *Gachalian PNH 15463* ♀ (A); without definite locality, *Ramos BS 17509* [L (♀), US (♂)]. LEYTE. Mt. Abucayan, *Edaño BS 41677* ♀ (A, US); Leyte Province, Palo, *Elmer 7093* ♀ (A, K, NY); without definite locality, *Wenzel 1515* ♂ (A, GH, NY). BOHOL ISLAND. Kalingohan. *Ramos BS 43358* ♀ (A, K, US) — isotypes of *Lunasia pubifolia* Merr.; without definite locality, *Catalan FB 25108* (GH), *FB 25110* (A, US), *McGregor BS 1273* ♂ (NY, US) — isotypes of *Lunasia obtusifolia* Merr., *Ramos BS 42705* ♂ (A, US). CEBU ISLAND. Limusan, *Ramos BS 11026* (K, US) — isotypes of *Lunasia mollis* Merr. PANAY ISLAND. Capiz Province, *Edaño BS 46237* ♀ (L); Mt. Salibongbong, *Martelino & Edaño BS 35616* ♂ (A, L). GUIMARAS ISLAND. Bo. Tubod, Buenairsta, *Sulit PNH 11730* ♀ (A, L). SULU ISLANDS. Sibutu Island, *Herre 1228* ♀ (A), *1238* ♀ (A, NY, US); Tawitawi Island, *Ramos & Edaño BS 44031* ♀ (L), *BS 44306* ♀ (NY); without definite locality, *Kondo & Edaño PNH 38853* (A). BASILAN ISLAND. *Miranda FB 20080* ♀ (L). MINDANAO ISLAND. Zamboanga Province: Zamboanga, *Ahern*, 1901 ♀ (US), *559* ♀ (NY, US); Tetuan, *Quadras 369* (US). Lanao Province, Malabang Mt., *Ebalo 1097* ♂ (US). Bukidnon Province, Tanculan vicinity, *Fénix BS 26059* ♀ (A, US). Cotabato Province, Nutol, *Ramos & Edaño BS 84944* ♂ (A); Cotabato vicinity, *Whitford FB 11791* (US). Agusan Province, Asiga River, *Ramos & Convocar BS 83696* ♂ (A). Davao Province, Mt. Mansamuga, *Edaño PNH 11141* ♀ (A, L); Quinonoan River, *Edaño PNH 11452* ♂ (A, L); Davao District, *Fénix BS 15842* ♂ (K, US) — isotypes of *Lunasia amara* Blanco var. *repanda* Merr.; Mati, *Ramos & Edaño BS 49223* ♂ (L). SIARGAO ISLAND. *Ramos & Pascasio BS 34973* ♂ (A, L). **Celebes and neighboring islands.** CELEBES. North Peninsula: Minahassa Province, *Koorders 16946β* ♀ (L), *16948β* ♂ (L), *16953β* ♂ (L); prope Tanairanto (probably Tanahwangko, Minahassa Province), *Reinwardt 15016* ♀ (L). Gorontalo, *Riedel* ♀ (K). Central Celebes, Ond. Malili, Kawata, *NIFS bb V-271* (L), *NIFS bb V-276* ♂ (A, L). Without definite locality, *Reinwardt*, September, 1821 (L), *de Vriese & Teysmann*, 1859–1860 ♀ (L). KABAENA ISLAND. *Elbert 3238* (A, L). BOETON ISLAND: *Webb* (K — holotype of *Rabelaisia parvifolia* Planch.), *Zippelius* $\frac{31}{6}$ ♂ (L). **Moluccas.** TALAUD ISLANDS. Karakeland Island: E of Beo, *Lam 2661* ♂ (A, L); summit of G. Piapi, *Lam 3291* (A, K, L); E slope of G. Piapi, *Lam 3305* ♂ (L). Kaburuang Island, N of Mangarang, *Lam 3181* ♂ (L). HALMAHEIRA ISLAND: het fortje Dodinga Gilolo (Djailolo); *Forsten*; July 1841 (L); Lebengon Djiko djira; *Nedi 307* (L): AMBON ISLAND. *Zippelius* $\frac{69}{c}$ ♀ (L). **West New Guinea (West Irian) and neighboring islands.** SCHOUTEN ISLANDS. Biak, *Aet & Idjan 860* ♂ (A, K, L). MISOÖL ISLAND. near Waima, *Pleyte 1048* ♂ (A, K, L). AROE ISLANDS. P. Wokam, Dosinamalaoe, *Buwalda 4937* ♂ (A, GH, K, L); P. Wokam, Selibatabata, *Buwalda 5232* [A, K, L (♂)]; Soengey Waskai, *Jensen 253* ♂ (A, L). VOGELKOP PENINSULA. Sorong, near Remoe, *Main 564* ♀ (K, L); Kebar Valley, ca. 100 km. W of Manokwari, *van Royen 5073* ♂ (K, L); Sidai, ca. 65 km. W of Manokwari, *Koster BW 6803* ♂ (L); Manokwari, Tafelberg, *van Royen & Sleumer 6685* ♂ (L). GEELVING BAY. Nabire, *Kanehira & Hatusima 11527* (A). NORTHERN WEST NEW GUINEA. Mamberamo, Otken River, *Docters van Leeuwen 11382* ♂ (A, K, L); Sawia, *Gjellerup 621* ♂ (L); SE Depapre; near Cp: Maribu; *Lam 7803* [L (two sheets; one ♂ and one ♀)]. WITHOUT DEFINITE LOCALITY. *Zippelius* $\frac{192}{c}$ ♀ (L). **Papua.** CENTRAL DISTRICT. Kanosia, *Carr 11358* ♀ (A, K, L, NY), *11171* [A, (♂), K (♀), L (♂), NY (♂)]; Kairuku Subdistrict, Rubberlands Estate, head of Galley Reach, *Pullen 3505* ♂ (L); Yule Island, *White 705* ♂ (A); Sapphire Creek, *White 819* ♀ (A); Port Moresby vicinity, 6 miles N of Bootless Inlet, *Pullen 3099* ♂ (L); 2 miles E of Karema, Brown River, *Schodde 2564* ♀ (L); Laloki River, *Brass 1646* ♂ (A); tributary of Laloki River 2 miles E of Rouna, *Hartley 10641* [L (♂), A (♂&♀)]; Astrolabe Range, Sogeri Plateau, *Womersley NGF 14047* ♀ (L), *NGF 19121* ♂ (L); Budatobara, *Brass 761* ♀ (A — isotype of *Lunasia quercifolia* (Warb.) Laut. & K. Sch. var. *lanceolata* C. T. White); headwaters of U-uma River, *Brass 1459* ♂ (A). NORTHERN DISTRICT. ca. 5 km. N of Divinikoari Village, *Hoogland 3687* ♀ (A, K, L, US); Yodda Valley, ca. 10 km. from Kokoda along Wairopi Road, *Hoogland 3930* ♀ (A, L). MILNE BAY DISTRICT. Sagarai Valley, inland from Mullins Harbour, *Womersley NGF 19280* ♂ (L), *NGF 19282* ♂&♀ (L). **Territory of New Guinea.** SEPIK DISTRICT. Aitape Subdistrict, near Romei Village, *Darbyshire & Hoogland 8043* ♀ (L). MADANG DISTRICT. Hatzfeldthafen, *Hollrung 373* ♂ (K); Gurumbu, Lat. 5° 50′ S., Long. 145° 50′ E., *Henty & Sayers NGF 20537* ♂ (L), *NGF 20555* ♂ (L). MOROBE DISTRICT. Kajabit (Kaiapit) Mission vicinity, *Clemens 10641* ♂ (A, MICH), *10684* ♀ (A, MICH); Sankwep River, ca. 15 miles N of Lae, *Hartley 11330* ♂ (A, L); Bupu River, near Lae, *Henty NGF 10524* ♂ (K, L); Busu River, near Lae, *Millar NGF 12229* ♀ (A); Kelana, *Hellwig 131* ♂ (K — isotype of *Androcephalium quercifolium* Warb.); Sattelberg, *Clemens 883* (L). **Australia.** QUEENSLAND. Cape York Peninsula, Iron Range, *Brass 19317* ♂ (A), *19655* ♂ (A). **Cultivated.** JAVA. Bot. Gard. Bogor, *Hochreutiner 112* (L, NY), *113* (L, NY), *Rastini 101* (L), *Warburg 1548* ♂ (A, NY), *Woejantoro 34* ♀ (L).

DISTRIBUTION. Eastern Java, Borneo and the Philippines east to extreme southeastern New Guinea and Cape York, Queensland; well-drained rain forests, moist to rather dry thickets, gallery forests, and garden regrowth; from sea level to 900 m. elevation. See MAP 1.

ILLUSTRATIONS. PLANCHON, J. E., London Jour. Bot. **4**: *t. XVII* and *XVIII*. 1845, as *Rabelaisia philippinensis*. VIDAL Y SOLER, Flora Forestal del Archipielago Filipino, Atlas, *t. 24*. 1883. LAUTERBACH, C., Bot. Jahrb. **55**: *t. 4*. 1918, as *Lunasia amara* var. *repanda* (*A–D*), and *L. quercifolia* (*E–L*). ENGLER, A., Nat. Pflanzenfam. ed. 2. **19a**: *t. 99*. 1931, from LAUTERBACH, *loc. cit.*

Rabelaisia parvifolia Planch. [*Lunasia parvifolia* (Planch.) Miq.] was based on a collection from Boeton Island, Celebes, with unusually small leaves 6–12 cm. long and 2–4 cm. wide. Similar small-leaved plants occur sporadically, however, in Java, Borneo, the Philippines (Luzon and Mindoro islands) and Papua, and it appears that this feature is merely a response to dryer, more open conditions than the plant normally grows in.

Rabelaisia philippinensis Planch. [*Lunasia philippinensis* (Planch.) F.-Vill.] was reduced to synonymy under *Lunasia amara* by Merrill, Enum. Philip. Fl. Pl. **2**: *332*. 1923. The two syntypes examined, *Cuming 501* and *1512*, are almost identical with the neotype of *L. amara*.

I have not seen the type of *Mytilococcus quercifolius* Zoll., the type species of the genus *Mytilococcus*, but judging from the description (". . . flores glomerulati, glomerulis brevissime pedicellatis densifloris. Fructus 3-coccus, cocci profunde separati obverse mytiliformes extus ab apice dehiscentes.") it is almost certainly a *Lunasia*. Miquel apparently did not consider Zollinger's publication of the genus valid (presumably because of Zollinger's expressed hesitancy about describing it as new) and redescribed it, citing it, with a slightly different spelling, as "*Mytilicoccus* Zolling. mss." He then described two species, *M. costulatus* and *M. grandifolius*, on the basis of Zollinger's original collection number. Later (Ann. Mus. Bot. Lugd.-Bat. 3: 89. 1867) Miquel reduced *Mytilicoccus* to *Lunasia* and listed *Mytilococcus quercifolius* Zoll. as a synonym, in part, under both *Lunasia costulata* and *L. grandifolia*. Thus it seems that he considered Zollinger's species to be based on a mixed collection. Although this problem cannot be fully clarified without examination of the Zollinger collections in question, it seems reasonable to include the names here as synonyms. None of them antedate *L. amara* and, judging from the descriptions, the collections they represent would fall within the range of variation of that species. In support of this last point is the fact that *L. costulata* was reduced to a variety of *L. amara* by Hochreutiner and that later Engler (1931, p. 236) listed both *L. costulata* and *L. grandifolia* as synonyms of *L. amara*.

Whereas the neotype of *Lunasia amara* var. *amara* and the majority of specimens from almost throughout the range of the genus have scale-like trichomes (TYPES I–III) on the lower surface of the leaf blades grading to stellate trichomes (TYPES III–V) on the inflorescence and fruit, the type collections of *L. mollis* Merr., from Cebu Island, Philippines, and *L. pubifolia* Merr., from Bohol Island, Philippines, and a number of other specimens from scattered localities including Luzon Island, Sarawak, East Borneo, Celebes, and New Guinea represent an extreme in which the plants have exclusively stellate trichomes (TYPE V). Other specimens, including the type of *Androcephalium quercifolium* Warb. and a number of other scattered collections from New Guinea, Cape York Peninsula, and the Philippines (Luzon and Palawan Islands), have a mixture of scale-like and stellate trichomes (TYPES I–V) on the lower surface of the leaf blades. There are also several collections, from scattered localities, with leaves that are glabrous at maturity except for a few scale-like trichomes on the lower midrib, and a single collection from Celebes Island, *NIFS bb V-276*, has mature leaves that are densely lepidote below with overlapping scale-like trichomes. One of the functions of trichomes is to regulate water loss, and it seems that these variations probably reflect necessary adaptations in that regard. The genetic differences involved appear to be slight, since there do not seem to be any consistent correlating features.

I have not seen the type of *Lunasia repanda* Laut. & K. Sch., from New Guinea, but I did see a collection (*Gjellerup 621*) cited by Lauterbach in a later paper in which he reduced the species to *L. amara* var. *repanda* — a name invalidated by the earlier *L. amara* var. *repanda* Merr., from the Philippines. The leaves of the *Gjellerup* collection and the type of Merrill's variety are similar, each with 5–8 blunt lobes along each margin.

Approximately one-fourth of the specimens treated here as *L. amara* var. *amara* have similarly repand leaves and there are numerous gradations to the shallowly undulate (as in the neotype of *L. amara*) and subentire types of leaves. Furthermore, in a number of collections, especially from New Guinea where the repand leaves are predominant, subentire, shallowly undulate, and lobed leaves all may be found on a single branchlet.

Lunasia reticulata Elmer, from Sibuyan Island, Philippines, was based on a single collection with rather pronounced tertiary veins in the dried leaves. This is a minor variation and the venation pattern of these leaves is the same as in typical *L. amara*. Similar reticulate leaves were also noted in collections from Luzon Island and Celebes Island. *L. reticulata* was previously listed as a synonym of *L. amara* by Merrill, Enum. Philip. Fl. Pl. 2: 332. 1923, and by Engler (1931).

I have not seen the type collection of *Lunasia macrophylla* Merr., from Mindanao Island, Philippines, and I suspect that there were no isotypes distributed from Manila. Merrill described it as differing from *L. amara* in the following features: leaf blades to 45 cm. long, coriaceous, subentire, main veins to 45 pairs, petiole about 10 cm. long. Open flowers and fruits were not seen. With the exception of the high number of veins, the specimen described would fall within the range of variation I have outlined for *L. amara* var. *amara*. A number of specimens from throughout the range of that taxon have leaves similar in size and texture. The largest number of veins I have encountered, however, is 35, in a collection (*Ahern*, 1901) from the same district of Mindanao as Merrill's type. Similar specimens, with more than 30 pairs of veins, were encountered in collections from a number of other scattered localities including Borneo, Luzon Island, Celebes Island, West New Guinea, and Territory of New Guinea. Since Merrill, in the English portion of his description, stated, "Lateral nerves of larger leaves up to 45 on each side," I think it is probable that some of the leaves had considerably fewer veins and were sufficiently close, in that respect, to warrant inclusion of *L. macrophylla* with *L. amara* var. *amara*. Furthermore, in his Enumeration of Philippine Flowering Plants 2: 332. 1923, Merrill cited another Mindanao collection, *Ahern 559*, as *L. macrophylla*, the leaves of which, at least in two duplicates I have examined, have about 29 pairs of veins.

Lunasia gigantifolia Merr., from British North Borneo, was also based on a large-leaved specimen which, Merrill noted, is allied to *L. macrophylla* but ". . . easily distinguished by its membranaceous, much fewer-nerved leaves and much longer petioles." It is surprising that Merrill considered this a distinct species. The petiole lengths in his two descriptions overlap (9–15 cm. for *L. gigantifolia* and about 10 cm. for *L. macrophylla*) and leaf textures vary considerably in much of the Philippine material he identified as *L. amara*. Also, the number of lateral veins he described for *L. gigantifolia* (". . . . about 26 on each side of the midrib") is very close to that of the *Ahern* collection, mentioned above, that he later determined as *L. macrophylla*.

Lunasia obtusifolia Merr. was based on a collection from Bohol Island, Philippines, with obovate leaves that are obtuse to rounded at the apex and cordate at the base. Although the majority of specimens examined have leaves that are oblanceolate with acuminate apices and narrowly rounded or subcordate bases, a few, from scattered localities, have leaves almost identical with the type of *L. obtusifolia*. Also, there are a number of specimens, including ones from Java, Sumbawa, Borneo, the Philippines, Celebes, the Moluccas, West New Guinea, and Papua that are variously intermediate. It seems probable that shortening and widening of the leaf blade is a response to environment. The type of *L. obtusifolia* was collected on beach cliffs and similar specimens, especially from Papua, are from similarly dry, exposed habitats.

The type collection of *Lunasia nigropunctata* Merr., from Luzon Island, Philippines, has leaves with scattered oil dots that appear black. In transmitted light, however, they are pellucid and not at all different in appearance from those in the other specimens of *Lunasia* examined. Varying degrees of similar blackish dots were noted in several other collections from scattered localities, and I am satisfied the character is of no taxonomic value.

Lunasia quercifolia (Warb.) Laut. & K. Sch. var. *lanceolata* C. T. White was based on a collection from Papua with subentire, lanceolate leaves. In his original description, White stated that he had hesitated a long time before applying a varietal name since there were intermediates with the type of *L. quercifolia*. The existence of such intermediates is even more evident today, with many more New Guinea collections available, and some of the specimens even have "*quercifolia*" and "var. *lanceolata*" leaves on a single branchlet. Also, lanceolate leaves almost identical with those of White's variety have turned up in scattered collections from the Philippines.

The name *Lunasia truncata* Elmer is illegitimate since no Latin description was included in the original publication. The type collection, from Luzon Island, Philippines, differs only slightly from the neotype of *L. amara* in having very short-beaked follicles. This is a variable character and follicles with more or less obsolete beaks as well as ones with beaks to 5 mm. long occur sporadically almost throughout the range of *L. amara*. The epithet *truncata* refers to the apex of the short-beaked follicle.

Trichomes such as those illustrated in FIG. 1 as TYPE VI were noted on the leaves and/or fruits of six collections from the following localities: Kangean Island, Halmaheira Island, Ambon Island, the Vogelkop Peninsula in West New Guinea, and the Sepik and Morobe Districts of the Territory of New Guinea. In each of the specimens they are sparsely distributed on the plant and are mixed in with a predominance of the usual scale-like to stellate trichomes. Although these unusually large trichomes do not seem to grade into the other types, they nevertheless seem to represent a rather minor variation. Certainly, in view of their discontinuous geographic occurrence, they cannot be used as a taxonomic character.

1b. **Lunasia amara** var. **babuyanica** (Merr.) Hartley, stat. nov.

Lunasia babuyanica Merr. Philip. Jour. Sci. Bot. 3: 411. 1908. Type: *Fénix BS 4050*, Philippines, Babuyan Islands, Camiguin Island.

Shrub 2 m. Branchlets, petioles, lower leaf blade and inflorescences with stellate (TYPES IV & V) trichomes. Petioles 8–12 cm. long. Leaf blades chartaceous, narrowly obovate, 23–47 cm. long, 10–18 cm. wide; base obtuse to rounded, to 2 cm. wide; main veins 21–22 on each side of the midrib; margins repand toward the apex; apex obtuse to bluntly short acuminate. Follicles densely covered with twisted, simple or 2–3-branched, stellately pubescent processes to 8 mm. long.

Philippines. BABUYAN ISLANDS. Camiguin Island: Cagayan Province, Camiguin Volcano, forest slopes at 1200 ft., *Edaño BS 79141* ♀ (NY); in thickets near the seashore, *Fénix BS 4050* ♂ & ♀ (K, US) — isotypes.

It is difficult to say what taxonomic rank, if any, should be assigned to this material. While the follicles appear very different from those of var. *amara*, there are no other distinguishing features and it is impossible to identify staminate or sterile specimens. I am reasonably certain that the follicular processes, which are vascularized outgrowths from the main vascular strands of the pericarp, are the result of normal growth and not such as might result from an insect sting; the fruits contain normal seeds and the two collections were made at different localities some years apart (Fénix's in 1907 and Edaño's in 1930).

2. Collection of uncertain identity: *Wood SAN A4170* ♂ & ♀ (A, L), British North Borneo (Sabah), Lahad Datu District, NE ridge of Mt. Silam, 12 miles WSW of Lahad Datu.

The two sheets of this collection each have two staminate branchlets and a single, unattached fruit. The staminate specimens are in bud only, but match vegetatively other large-leaved specimens of var. *amara* from Borneo and the adjacent Philippines. The follicles are slightly larger, however (1.5 cm. high and 1.2 cm. wide), and the seeds differ in having trichomes sparsely scattered over the surface of the testa (which was glabrous in all other material of *Lunasia* examined). Although these seed trichomes are scale-like they are otherwise atypical for *Lunasia* in that they are 3 or 4 cells thick in the central area. Since there is a possibility that the unattached fruits of these specimens were gathered from the ground or from a different plant and do not belong with the branchlets, taxonomic designation will have to be delayed until complete material can be examined.

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INDEX TO EXSICCATAE

All of the collections listed below, with three exceptions that are indicated otherwise, are *Lunasia amara* var. *amara*.

Oro *FB 30904*
Pleyte *1048*
Pullen *3099*, *3505*
Quadras *369*
Quisumbing *PNH 2409*
Ramos *BS 38*, *BS 1830*, *BS 11026*, *BS 17509*, *BS 21751*, *BS 22688*, *BS 39751*, *BS 41047*, *BS 41156*, *BS 42705*, *BS 43358*
Ramos & Convocar *BS 83696*
Ramos & Edaño *BS 44031*, *BS 44306*, *BS 49223*, *BS 84944*
Ramos & Pascasio *BS 34973*
Rastini *101*
Reinwardt *15016*
van Royen *5073*
van Royen & Sleumer *6685*
Santos *5161*
Schodde *2564*
Sulit *PNH 11730*, *PNH 12353*, *PNH 17049*
Sulit & Conklin *PNH 16970*
Symington & Agama *North Borneo Forestry Dept. 9257*
Tamesis *FB 11908*
Velasco *FB 28124*
Vidal *135*, *135 bis*, *136*, *682*, *1205*
Warburg *1548*
Wenzel *1515*
White *705*, *819*
Whitford, *5*, *508*, *FB 11791*
Wilford *SAR 4269*
Williams *34*, *518*
Wing *SAN 38106*
Woerjantoro *34*
Womersley *NGF 14047*, *NGF 19121*, *NGF 19280*, *NGF 19282*
Wood *SAN A4170* (identity uncertain); *SAN A4628*
Zippelius $\frac{31}{6}$, $\frac{69}{c}$, $\frac{192}{c}$