

A Taxonomic Revision of the Hawaiian Species of the Genus *Sophora* Linnaeus (Family Leguminosae)¹

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THIS PAPER is based upon a study of the endemic Hawaiian species of the genus *Sophora* L. Previous to the present revision, these endemic taxa were identified as: *Sophora chrysophylla* (Salisb.) Seem., *S. chrysophylla* var. *glabrata* (Gray) Rock, *S. grisea* Degener and Sherff, and the taxon *unifoliata* (Rock, 1919: 44) as a variety of *S. chrysophylla* or as a species (Degener and Sherff, in Sherff, 1951: 24).

In addition to these species, there are three introduced species in the Hawaiian Islands: *S. tomentosa* L., *S. japonica* L., and *S. tetraptera* Forst. The latter two were introduced by Rock (1920: 21). These species are not included in this revision.

The plants of Hawaii are noted for polymorphism. This is thought to be due to the isolation and varied ecological habitats of the Hawaiian Islands, and the high endemism (94.4%) of the flora (Fosberg, 1948: 107). St. John (1946: 379-380) has stated that:

Some Hawaiian genera contain species that are homogeneous and widespread, occurring unmodified on all or nearly all of the large islands. . . .

There are other Hawaiian species widespread among the larger islands, but which are not homogeneous, having a tendency to vary. These variations are in part recognized as described

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varieties but in large part are unrecognized, forming a part of the heterogeneous population now included in the species. . . .

Other genera, usually with many species, show a conspicuous segregation into species, usually each species being restricted to a single island or even to a single mountain range or valley on that particular island. . . .

The Hawaiian plants . . . illustrate a progressive series: 1, genera monotypic in Hawaii occurring as invariable wides on all the principal islands; 2, species that are invariable wides, belonging to genera with several Hawaiian species; 3, species that are wides, but showing variability on the various islands; and 4, general [sic] with many Hawaiian species, typically with different, distinct species on each island. These species represent degrees of increasing differentiation and presumably of decreasing age. They show evidences of speciation.

Application of the modern concept of the subspecific entities in a systematic study of the Hawaiian species of *Sophora* has resulted in a revision which clearly reveals the polymorphism of the species, *S. chrysophylla*. This species is usually found in the dry forests from almost sea level to an altitude of 10,000 feet (Rock, 1920: 121). It is also found in two localities in the rain forest at altitudes of 4,000 feet. In the dry forest it is usually the dominant species, and as such is very common on the younger islands of Maui and Hawaii. Its habit may vary from a shrub about 2 meters high to a tree 12 meters high.

The Hawaiians used the wood of this spe-

cies, which they called mamane (sometimes incorrectly spelled mamani), in making house posts (Brigham, 1908: 84); the runners of holua sleds; and the digging stick, the o'o, which was also used as a club and spear in time of war (Malo, 1951: 21). Ranchers on the island of Hawaii use the wood for fence posts, since mamane wood is very hard and durable (Hillebrand, 1888: 109; Rock, 1913: 189; Hosaka and Ripperton, 1944: 60).

Sophora chrysophylla is valuable in the Hawaiian Islands in the formation of the "dry forest" and in the prevention of soil erosion and excessive dessication of the soil. It is associated with species of *Acacia*, *Diospyros*, *Dodonaea*, and *Myoporum* on the island of Hawaii (Webster, 1951: 52), where it is most abundant. The seeds of mamane retain their viability for a long period of time and this property should prove useful in reforestation (Akamine, 1951: 45).

Acknowledgements

Dr. Harold St. John suggested a revision of this genus and directed my work. Research facilities of the Bernice P. Bishop Museum were made available by Miss Marie Neal. Other institutions (see Abbreviations), including the University of Michigan, graciously provided research facilities or loaned specimens. Dr. M. L. Lohman and Mr. A. R. H. Lamberton of the University of Hawaii assisted in the collections made on the island of Hawaii. Mr. James K. K. Park of the University of Hawaii illustrated the specimens, and Professor Harley H. Bartlett of the University of Michigan supplied the Latin diagnoses.

TAXONOMIC RESUMÉ

The genus *Sophora* was described by Linnaeus in *Genera Plantarum* (1754: 175), based on six species (1753: 373–374): *S. alopecuroides*, *S. tomentosa*, *S. heptaphylla*, *S. genistoides*, *S. tinctoris*, and *S. lupinoides*.

Salisbury (1808: 295–300) established the genus *Edwardsia*, segregating from the genus *Sophora*: *E. microphylla*, from *S. microphylla*

and *S. tetraptera*; *E. grandiflora*, from *S. tetraptera*; and described *E. chrysophylla* from a specimen collected by Dr. A. Menzies, botanist on Capt. Vancouver's expedition, presumably from Hualalai, on the island of Hawaii (Wilson, 1920: 162).

Seemann (1865: 66) reduced *Edwardsia* to a section in the genus *Sophora*. Since that time, the Hawaiian species *chrysophylla* has generally been placed in the genus *Sophora*.

Gray (1854: 459) described the variety *glabrata* under *E. chrysophylla*, which was later transferred by Rock (1919: 42–44) to *Sophora*. Hillebrand (1888: 108–109) treats the *Sophora* of Hawaii as one species, without a variety, although he cites Gray as a reference, and notes that the "lower forms are nearly glabrate and bear smaller flowers." Rock (1919: 44) established a new variety, *unifoliata*, from Puu Waawaa, Hawaii.

Until 1951 Degener (in Sherff, 1951: 24) continued to classify mamane under the genus *Edwardsia*, and in 1932 (1932: fam. 169c) raised the var. *unifoliata* to a species (*E. unifoliata* (Rock) Degener). Degener and Sherff (Sherff, 1951: 24) later transferred this species to the genus *Sophora*. In the same paper, *S. grisea* Degener and Sherff was described from collections made by Degener and Greenwell on the island of Oahu.

RELATIONSHIPS OF THE GENUS

The genus *Sophora* consists of more than 25 species, distributed over the warmer regions of both hemispheres, which are found in Asia, South America, the southwest United States, New Zealand, the islands of the South Pacific Ocean, and Hawaii (Rock, 1913: 187).

Our species is a member of the section *Edwardsia*, which is characterized by the four-winged pods, and it is related to *S. tetraptera* Forst. of New Zealand, *S. macrocarpa* Sm. and *S. microphylla* Sol. in Ait. of Peru and Chile, *S. denudata* Bory of Réunion, *S. mollis* Grah. and *S. interrupta* Bedd. of India. *Sophora* is placed in the subfamily *Papilionatae*, and in the tribe *Sophoreae*.

TAXONOMICALLY USEFUL CHARACTERS

S. chrysophylla is a polymorphic species comparable to *Myoporum sandwicense* Gray, which has been treated by Webster (1951). It has been extremely difficult to find morphological characters which do not vary among the plants in a given area; even among the various taxa proposed in this revision, there are both similar and dissimilar characters among the individuals of each taxon. After study, it seemed that a valuable character might be the shape (ovate, obovate, circular, and elliptic) of the standard, which is more or less the same for each plant of the various populations. This is used to define the subspecies.

The shape of the apex and base of the standard, wing, and keel petals; the margin of the wing and keel petals; and the shape and pubescence of the leaflets are used to define the variety, subvariety, and form.

Except in two subvarieties (*ovatifoliolata* and *grisea*), the characteristic leaflet shape is oblong-obovate. The pubescence is strigose, and ranges from abundant to none, and from golden brown to silver. The upper surface ranges from being abundantly pubescent to glabrate. The lower surface is more pubescent than the upper surface.

The calyx tube is usually goblet shaped, and the lobing of the tube may vary, as well as the degree of the parting of the calyx teeth.

The size of the fruit and the width of the wings may vary greatly. Although certain taxa may be characteristically narrow or wide winged, both of these, as well as intergrading widths, may be found on the same plant. Seed color has been found to be an unreliable character, although all of the seeds of a certain taxon may have the same color. It has been found that a fungus infects the seed coat and produces fruiting structures and mycelia which cause changes in the coloration of the seed coat, especially around the hilum, where a gray-black discoloration may appear, which is surrounded by the characteristic yellow-brown color of most mamane seeds.

Seeds in one collection (Chock, *et al.*, 594) ranged from yellow, to brown, to red, to gray-black.

These characters are somewhat useful in the classification of the subspecific taxa of *S. chrysophylla*. Abundant flowering material is necessary to determine the different taxa because of the variations that occur within that taxon.

DISTRIBUTION

Collections have been made from the major islands of the Hawaiian group, excepting Kahoolawe and Niihau. However, this species may have occurred on these islands before the dry forest was wiped out by introduced fauna and flora, and erosion.

On the island of Kauai, it is found in the forests of Kokee Territorial Park, at elevations of 3,600 to 4,000 feet. On the island of Oahu, it has been reported or collected from the lee and windward sides of the Waianae Mountains.

On the island of Maui, it is very common on the slopes and in the crater of Haleakala, from 5,000 to 10,000 feet; collections have also been made from the leeward slopes at lower altitudes (1,500 feet). Along the windward slopes, in the rain forest east of Olinda, there is a small population of mamane (4,000 feet). In Olowalu Valley on West Maui, Forbes collected a specimen, the leaflets of which are much smaller than any other known. This material is sterile, however, and has not been rediscovered.

Forbes made a collection from the island of Molokai with a note on the specimen sheet that it was "very rare" on Puu Kolekole. Forbes' collections from Olowalu, Maui, and Puu Kolekole, Molokai, were not included in this revision. On the island of Lanai, Rock (1913: 189) thought that the mamane was planted by man, although this could not be established. G. C. Munro (1954: personal correspondence), a long-time resident of Lanai, however, is of the opinion that it is native to that island.

On the island of Hawaii, it is very common, being one of the dominant endemic species. It is found as such along the slopes of Mauna Loa and Mauna Kea; in the lower forests of the Kau District; and from almost sea level near Puu Waawaa to the slopes of Hualalai. It has also been reported at lower elevations near Milolii by E. Y. Hosaka. Rock (1913: 23) considered this species as the main element in the forest above 3,700 feet. Ripperton and Hosaka (1942: 14) considered it as the dominant species in the "forest formation" from 5,000 feet to the timber line at 10,000 feet, and in the "parkland formation" (zones E₁ and E₂).

The lowest subspecific taxa proposed in this revision are restricted to definite localities on an island. In some localities, however, several taxa may be present.

ABBREVIATIONS

The majority of the specimens which were examined and cited are deposited in the herbarium of Bernice P. Bishop Museum (BISH) in Honolulu, Hawaii. Specimens deposited elsewhere are indicated by the use of the following abbreviations (Lanjouw and Stafleu, 1954):

BM—British Museum of Natural History; F—Chicago Natural History Museum; GH—Gray Herbarium of Harvard University; NY—New York Botanical Garden; US—U. S. National Museum, Smithsonian Institution.

The completeness of the specimens cited is indicated by the following abbreviations: bd.—bud; lv.—leaves; fl.—flower; fr.—fruit; st.—stem; wood—wood specimen collected by A. R. H. Lamberton.

SYSTEMATIC TREATMENT

Genus SOPHORA Linnaeus

Sophora Linnaeus, Species Plantarum, 373, 1753; Genera Plantarum, 175, 1754.

Edwardsia Salisbury, Linn. Soc., Trans. 9: 296–300, 1808.

Shrub to tree; leaves usually pinnate; leaflets usually small and numerous; flowers in simple, terminal racemes or several forming a terminal panicle; calyx cupshaped, with short teeth; corolla yellow, white, rarely purple; standard obovate, elliptic, ovate or orbicular, often shorter than the keel, rarely longer; wing usually oblong, shorter than the keel; stamens free or rarely connected at the base in a ring, with dorsifixed anthers; ovary with many ovules; pod cylindrical to somewhat flattened, often constricted between the seeds, often four-winged (in the section *Edwardsia*), fleshy or woody, usually indehiscent; seeds ovoid or globose.

TYPE SPECIES: *Sophora tomentosa* L. has been chosen as the lectotype of the genus (Camp, *et al.*, 1947: 117).

Section EDWARDSIA (Salisbury) Seemann

Edwardsia Salisbury, Linn. Soc., Trans. 9: 296–300, 1808 (as a genus).

Edwardsia (Salisb.) Seem., Flora Vitiensis, 66, 1865 (as a section).

Fruit constricted between the seeds, with four longitudinal wings on the pod. Leaves usually pinnate, without stipules.

1. *Sophora chrysophylla* (Salisb.) Seem., Flora Vitiensis, 66, 1865

Edwardsia chrysophylla Salisb., Linn. Soc., Trans. 9: 299; tab. 26, fig. 1, 1808.

Shrub to tree, 2–12 meters high, diameter 2–9 dm.; branches longitudinally ridged, the younger branches brown, with abundant golden brown strigose pubescence, becoming gray-black, and silver and glabrate, the older branches glabrous, the ridges not as deep as on the younger branches; leaves alternate, usually pinnate, rarely unifoliolate, bifoliolate, or trifoliolate; leaflets usually opposite and usually oblong-obovate, sometimes broadly elliptic to oblong to oblong-ovate, 3–23 mm. broad, 7–50 mm. long, the apex obtuse to retuse, the base cuneate, the lower surface

usually abundant golden brown strigose, becoming silver, the upper surface glabrate; petiolule 0.5–2 mm. long; rachis-petiole length up to 17 cm., moderately to deeply channeled along the rachis; flowers in terminal racemes or panicles; pedicels 6–30 mm. long; calyx tube goblet-shaped, five lobed, 5–19 mm. broad, 4–12 mm. high; corolla yellow, glabrous; the standard ovate, obovate, circular, or elliptic, the apex obtuse to retuse, the base obtuse to cuneate, 8–20 mm. broad, 11.5–20 mm. long, reflexed when mature, the claw 3–8 mm. long; the petals of the wings oblong-lanceolate to oblong to elliptic, the apex acute to obtuse to truncate, the base asymmetrical or symmetrical, margin entire or irregularly indented, 3–9.5 mm. broad, 12.5–28 mm. long, the claw 3–5.5 mm. long; the petals of the keel elliptic to oblong to ovate to lanceolate, the apex obtuse to acute, the base asymmetrical or symmetrical, the margin entire or irregularly indented, 3.5–12 mm. broad, 14–25 mm. long, the claw 2–6 mm. long; stamens 10, the anthers golden brown, dorsifixed; pistil recurved, abundantly covered with golden brown hairs, with a small terminal stigma; pods 2–16 cm. long, 5–18 mm. broad, including the wings, which are 1–7 mm. wide, tan, but often with a fungus giving the mature fruits a black appearance, abundant to sparse golden brown strigose, becoming silver and glabrate, constricted between the seeds, with four longitudinal wings; seeds oblong-ovoid, ovoid or globose, moderately compressed, golden brown to orange to gray-black, 3–6 mm. wide, 4.5–8 mm. long, 2–4.5 mm. thick.

2. *Sophora chrysophylla* ssp. *chrysophylla*
Figs. 1*d*; 5

Sophora chrysophylla (Salisb.) Seem., Flora Vitiensis, 66, 1865.

Edwardsia chrysophylla Salisb., Linn. Soc., Trans. 9: 299; tab. 26, fig. 1, 1808.

Tree, 4–8.3 meters high; leaves pinnate; leaflets oblong-obovate, 5–17 mm. broad, 10–34 mm. long; rachis-petiole up to 12 cm. long; pedicels 8–23 mm. long; calyx tube 5–13 mm. broad, 5–12 mm. high; the standard obovate, the base cuneate; the petals of the wing 6–9 mm. broad, 16–28 mm. long, the

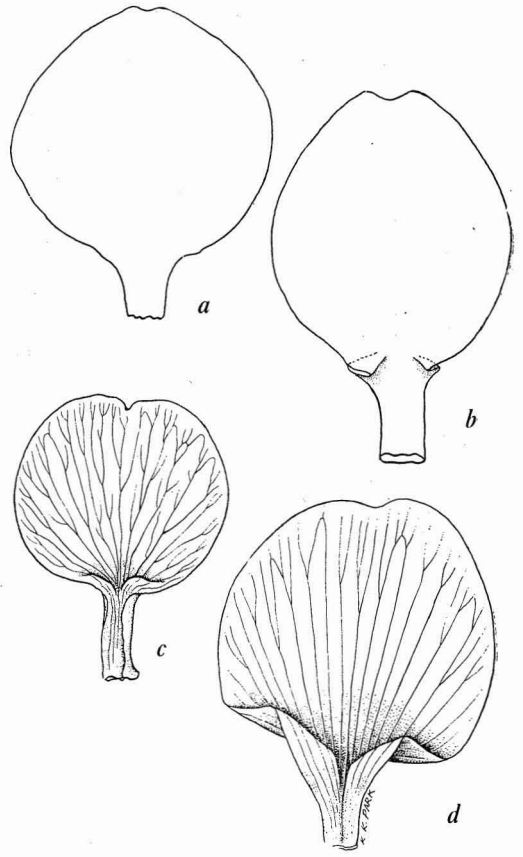


FIG. 1. Standard, X 2: a, ssp. *glabrata*, Chock et al. 577; b, ssp. *unifoliata*, Degener et al. 19, 327; c, ssp. *circularis*, Chock et al. 749; d, ssp. *chrysophylla*, Chock et al. 575.

- KEY TO THE SUBSPECIES OF *S. chrysophylla*
- A. Standard obovate or ovate B
 - A. Standard circular or elliptic C
 - B. Standard obovate. (2). ssp. **chrysophylla**
 - B. Standard ovate. (8). ssp. **glabrata**
 - C. Standard circular. . . (27). ssp. **circularis**
 - C. Standard elliptic. . . (30). ssp. **unifoliata**

base truncate, but sometimes truncate on one side and cuneate or sagittate on the other side; the petals of the keel 3.5–10 mm. broad, 16.5–23 mm. long; pods 3.1–13 cm. long, including the beak, which is 4–28 mm., 8–15 mm. wide, including the wings, which are 1–4 mm., 1–8 seeded; seeds golden brown to brown to gray-black.

KEY TO SUBSPECIES *chrysophylla*

- A. Width of standard under 10 mm., oblong-obovate 7. var. **makuaensis**
- A. Width of standard over 10 mm., broad obovate B. (3. var. **chrysophylla**)
- B. Rachis-petiole length always under 6.5 cm.; pedicels 15–23 mm. long 5. f. **haleakalaensis**
- B. Rachis-petiole length always over 6.5 cm.; pedicels 8–16 mm. long C
- C. Margin of keel irregularly indented, the apex obtuse 6. f. **obovata**
- C. Margin of keel entire, the apex acute 4. f. **chrysophylla**

3. *Sophora chrysophylla* ssp. **chrysophylla** var. **chrysophylla**

Sophora chrysophylla (Salisb.) Seem., Flora Vitiensis, 66, 1865.

Edwardsia chrysophylla Salisb., Linn. Soc., Trans. 9: 299; tab. 26, fig. 1, 1808.

The standard obovate, the apex retuse, 16–18 mm. broad, 11.5–18 mm. long.

4. *Sophora chrysophylla* ssp. **chrysophylla** var. **chrysophylla** f. **chrysophylla**

Figs. 1d, 2f, 3f, 4, 5

Sophora chrysophylla (Salisb.) Seem., Flora Vitiensis, 66, 1865.

Edwardsia chrysophylla Salisb., Linn. Soc., Trans. 9: 299; tab. 26, fig. 1, 1808.

Pedicels 10–15 mm. long; calyx tube 10–13 mm. broad, 7–8 mm. high; the petals of the wing elliptic, the apex obtuse, the base truncate, 9 mm. broad, 16 mm. long; the petals

of the keel elliptic, the base truncate on one side and sagittate on the other side, the apex acute; seeds brown.

SPECIMEN TYPICUM: "Insulis Sandwich, legit A. Menzies." (BM—examined by R. S. Cowan of the New York Botanical Garden).

SPECIMENS EXAMINED: **Hawaii**, Hualalai—just below summit, west slope, above Puu Laalau, about 7,500 feet, June 19, 1934,

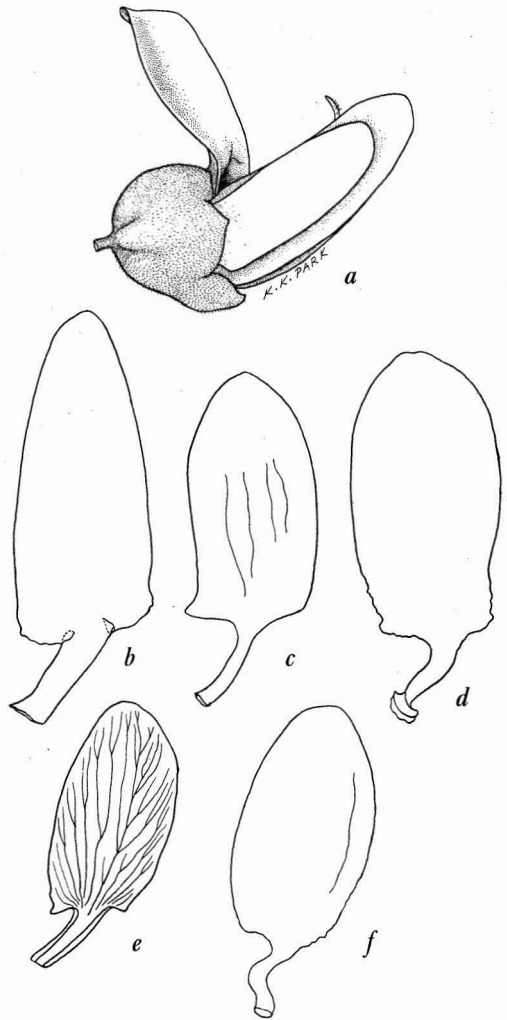


FIG. 2. a, Flower, X 2: f. *maunakeaensis*, Chock et al. 577. b–f, Keel petals, X 2: b, f. *olindaensis*, Chock et al. 286; c, var. *kauensis*, Chock et al. 749; d, var. *circularis*, Chock et al. 612; e, f. *obovata*, Chock et al. 584; f, f. *chrysophylla*, Neal (June 19, 1934).

Marie Neal (st. lv. bd. fl. fr.); slope, 7,000 feet, June 9, 1909, *Rock* (st. lv. bd. fl.); near summit, June 19, 1911, *Forbes 217H* (BISH, NY) (st. lv. fr.).

5. *Sophora chrysophylla* ssp. *chrysophylla*
var. *chrysophylla* f. *haleakalaensis*, forma
nov.

Figs. 4, 5

Rachide cum petiolo quam 6.5 cm. breviori; pedicellis 15–23 mm. longis; vexillo late obovato, 18 mm. lato, 16 mm. longo; petalis carinae oblonge ellipticis, apice retusis, basi uno latere truncatis altero sagittatis.

Rachis-petiole up to 6.5 cm. long; pedicels 15–23 mm. long; calyx tube 5 mm. wide and 12 mm. high; the standard broad obovate, 18 mm. broad, 16 mm. long; the petals of the

wing oblong, the apex acute, the base truncate on one side and sagittate on the other side, 7 mm. broad, 17 mm. long; the petals of the keel oblong-elliptic, the apex retuse, the base truncate on one side and sagittate on the other side, 8 mm. broad, 23 mm. long; seeds brown.

TYPE: **Maui**, Haleakala crater, small ravine opposite Ka moa o Pele, August 4, 1938, *Hawaiian Bog Survey 2798* (*Cranwell, Selling, and Skottsberg*) (BISH) (st. lv. bd. fl.).

SPECIMENS EXAMINED: **Maui**, Haleakala—crater, Aug., 1910, *Forbes 289M* (BISH, NY) (st. lv. bd. fr.); 1909, *Brigham, Anderson and Hosmer* (st. lv. fr.); west slope, 8,000 feet, May, 1911, *Rock*; near Koolau gap within crater, June 29, 1927, *Degener 17,948* (NY) (st. lv. bd. fr.); crater, 6,000 to 10,000 feet, Oct. 2–5, 1916, *Hitchcock 14,967* (US) (st. lv. bd. fl.); south side of Red Hill, 8,500 feet, Nov. 24, 1950, *Degener, et al., 21,112* (F) (st. lv. bd. fr.).

This form is so named because it occurs on Haleakala.

6. *Sophora chrysophylla* ssp. *chrysophylla*
var. *chrysophylla* f. *obovata*, forma nov.

Figs. 1d, 4, 6a, b

Rachide cum petiolo quam 10.5 cm. breviori; vexillo obovato, 16 mm. lato, 19 mm. longo; petalis carinae ellipticis, apice obtusis, basi truncatis, margine prope basin irregulariter indentatis.

Rachis-petiole up to 10.5 cm. long; the standard obovate, 16–18 mm. broad, 17–18 mm. long; the petals of the keel elliptic, the apex obtuse, the base truncate, the margin irregularly indented toward the base, 9–10 mm. broad, 19–20 mm. long; seeds golden brown.

TYPE: **Hawaii**, Mauna Kea, south slope, 3.6 miles north of Humuula, Hale Pohaku-Humuula road, Aug. 30, 1952, *Chock, Lobman and Lamberton 575* (BISH) (wood, st. lv. bd. fl. fr.).

SPECIMENS EXAMINED: **Hawaii**, Mauna

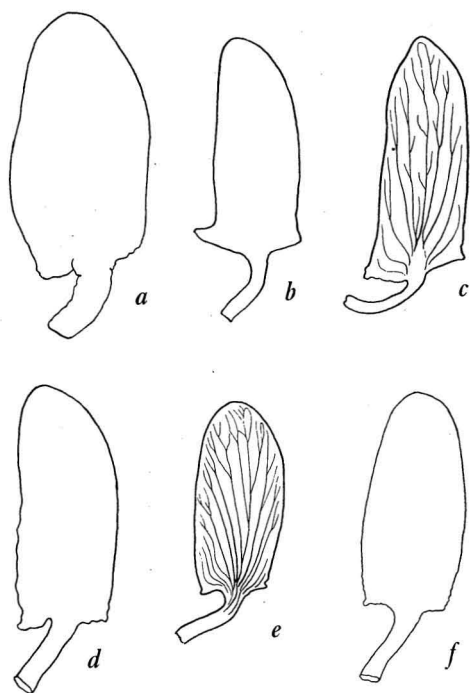


FIG. 3. Wing petals, $\times 2$: a, f. *mauiensis*, Chock et al. 283; b, var. *kauensis*, Chock et al. 749; c, f. *puuwaawaaensis*, Chock et al. 799; d, var. *circularis*, Chock et al. 612; e, f. *obtusata*, Chock et al. 584; f, f. *chrysophylla*, Neal (June 19, 1934).

Kea, south slope, Aug. 30, 1952, *Chock, et al.*, 579 (st. lv. bd. fl.).

This form is named for the obovate standard petal.

7. *Sophora chrysophylla* ssp. *chrysophylla* var. *makuaensis*, var. nov.

Figs. 4, 6c, d

Vexillo oblonge obovato, fere truncato, 8 mm. lato, 20 mm. longo.

Rachis-petiole up to 8 cm. long; pedicels 10–20 mm. long; the standard oblong-obovate, the apex obtuse, almost truncate, 8 mm. broad, 20 mm. long; the petals of the wing oblong-lanceolate, the base truncate on one side and cuneate on the other side, 6 mm. broad, 28 mm. long; the petals of the keel ovate-oblong, the apex obtuse, the base truncate on one side and cuneate on the other side, 3.5 mm. broad, 16.5 mm. long; pods 8–9.5 cm. long, the wings 1–2 mm. wide, 6–8 seeded; seeds gray-black.

TYPE: Oahu, Waianae Mountains, Makua, Nov. 1929, *Russ* (BISH), 4 sheets (st. lv. bd. fl. fr.).

C. S. Judd (1930(1): 12), former territorial forester, remarks in his report for December, 1929: "I discovered a clump of Mamani [sic] trees (*Sophora chrysophylla*) near the center of Makua Valley. Previously this tree was known only at Ohikilolo. The beautiful yellow blossom were long and slim. . . ."

This variety is so named because it occurs in Makua Valley, Oahu.

8. *Sophora chrysophylla* ssp. *glabrata* (Gray), comb. nov.

Figs. 1a, 7, 8

Sophora chrysophylla var. *glabrata* (Gray) Rock, Hawaii Bd. Commrs. Agr. and Forestry, Div. Forestry, Bot. Bul. 5: 42–44, 1919.

Edwardsia chrysophylla var. *glabrata* Gray, U. S. Expl. Exped., Botany, Phanerogamia 1: 459–460, 1854.

HAWAIIAN ISLANDS ASSEMBLED

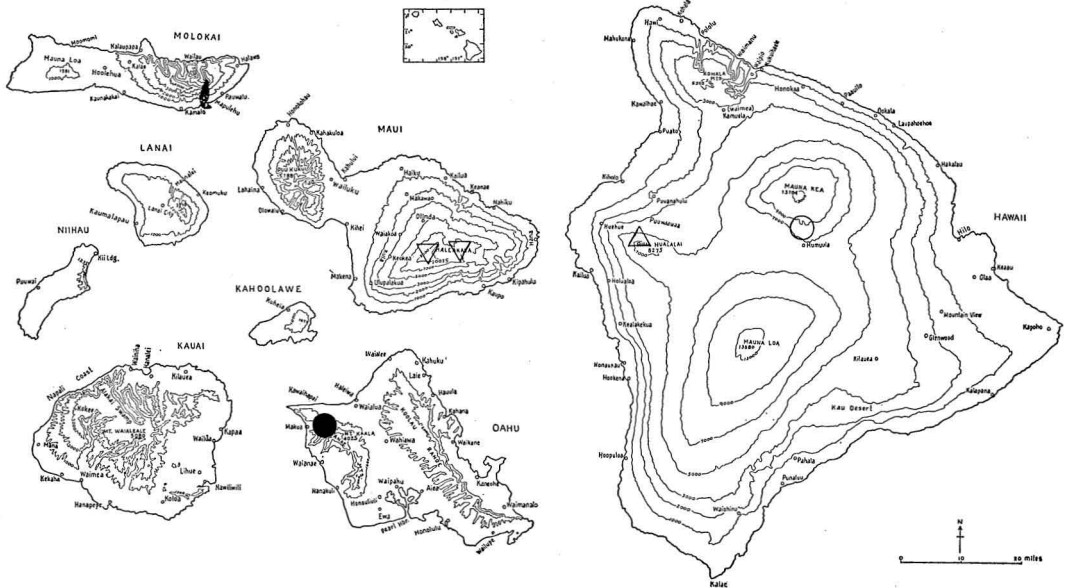


FIG. 4. Map of distribution of *Sophora chrysophylla* ssp. *chrysophylla*. Open erect triangles represent f. *chrysophylla*, open inverted triangles f. *haleakalaensis*, open circle f. *obovata*, solid circle var. *makuaensis*.

Shrub to tree, 2-12 meters high; leaves pinnate, leaflets broadly elliptic to oblong-obovate to oblong to oblong-ovate to oblong-lanceolate; the standard ovate to oblong-ovate, 9-23 mm. broad, 12-18 mm. long; the petals of the wing 3-9.5 mm. broad, 13-21 mm. long, the base usually truncate, the margin sometimes irregularly indented toward the base; the petals of the keel 5-12 mm. broad, 14-22 mm. long, the base usually truncate; pods 2-14.5 cm. long, including the beak, which is 3-20 mm., 5-18 mm. wide, including the wings, which are 0.5-7 mm., 1-8 seeded; seeds golden brown to red-brown to gray-black.

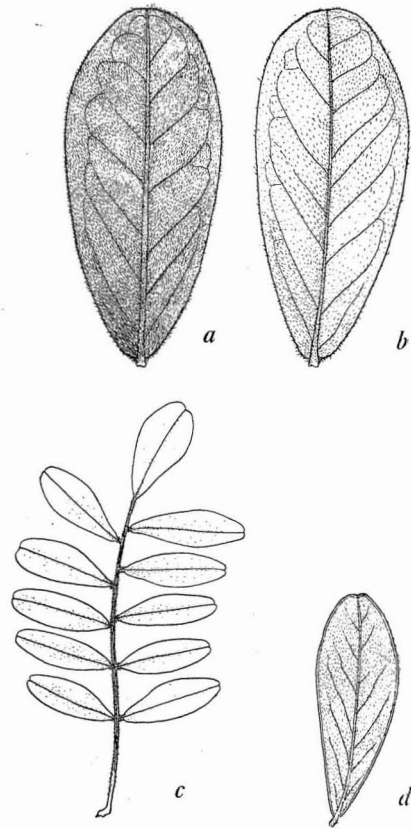
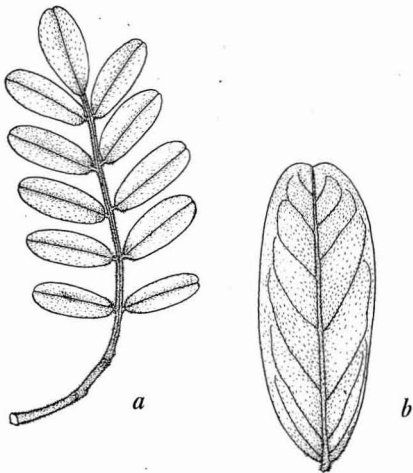


FIG. 6. Leaflet of *f. obovata*, Chock et al. 575: *a*, lower surface, $\times 2$; *b*, upper surface, $\times 2$. Var. *makuaensis*; *c*, leaf, upper surface, $\times 0.5$; *d*, leaflet, lower surface, $\times 1$.

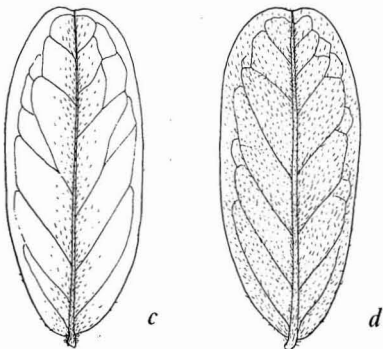


FIG. 5. *F. chrysophylla*, Neal (June 19, 1934): *a*, leaf, upper surface, $\times 0.5$; *b*, 1 after (median lateral), lower surface, $\times 2$. Leaflet of *f. balakalaensis*, Rock (May 1911): *c*, upper surface, $\times 2$; *d*, lower surface, $\times 2$.

KEY TO SUBSPECIES *glabrata*

- A. Leaflets glabrate B
- A. Leaflets abundantly strigose-pubescent. E
- B. Calyx tube 9-11 mm. broad, 4-6 mm. high 9. var. *glabrata*
- B. Calyx tube 7-8 mm. broad, 6-9 mm. high G
- C. Standard oblong-ovate, length 1.5 times width 10. var. *lanaiensis*
- C. Standard ovate, length equal to width, or almost so D
- D. Calyx tube 7-7.5 mm. broad, 7-8 mm. high; apex of standard obtuse 26. *f. parva*

- D. Calyx tube 8 mm. broad, 6–9 mm. high; apex of standard retuse. 14. f. **puuwaawaensis**
 - E. Apex of standard retuse. F. (11. var. **ovata**)
 - E. Apex of standard obtuse. K. (20. var. **grisea**)
 - F. Rachis-petiole up to 12 cm. long; largest leaflets 23 mm. broad, 50 mm. long. G. (12. subvar. **ovata**)
 - F. Rachis-petiole up to 17 cm. long; largest leaflets 12 mm. broad, 32 mm. long. I. (16. subvar. **mauiensis**)
 - G. Margin of wing or keel never irregularly indented; leaflets 3–23 mm. broad, 10–50 mm. long. 13. f. **ovata**
 - G. Margin of wing or keel always irregularly indented; leaflets 5–15 mm. broad, 10–34 mm. long. H
 - H. Margin of wing and keel indented; keel and wing base moderately hastate on one side, the other side truncate; lower surface of leaflets glabrate. 14. f. **puuwaawaensis**
 - H. Margin of keel indented, wing margin entire; keel and wing base truncate; lower surface of leaflets abundantly pubescent. 15. f. **maunakeaensis**
 - I. Base of keel truncate on both sides, symmetrical. 18. f. **lualailuaensis**
 - I. Base of keel truncate on only one side, asymmetrical; or not truncate. J
 - J. Base of keel truncate-oblique, the apex acute. 17. f. **mauiensis**
 - J. Base of keel obtuse to truncate-oblique, the apex obtuse. 19. f. **olindaensis**
 - K. Leaflets usually ovate-oblong. 26. subvar. **ovatifoliolata**
 - K. Leaflets usually obovate-oblong or broadly elliptic. L
 - L. Leaflets broadly elliptic, abruptly cuneate at the base. 21. subvar. **grisea**
 - L. Leaflets oblong to oblong-obovate, the base cuneate. M. (22. subvar. **obtusa**)
 - M. Base of wing sagittate. 23. f. **obtusa**
 - M. Base of wing not sagittate, but truncate or cuneate, or cuneate on one side and hastate on the other side. N
 - N. Base of wing truncate or cuneate, symmetrical. 24. f. **maunaloaensis**
 - N. Base of wing cuneate on one side and hastate on the other side, asymmetrical. 25. f. **parva**
9. *Sophora chrysophylla* ssp. *glabrata* var. *glabrata* (Gray) Rock, Hawaii Bd. Com-mrs. Agr. and Forestry, Div. Forestry, Bot. Bul. 5: 42–44, 1919.
- Fig. 7
- Edwardsia chrysophylla* var. *B. glabrata* Gray, U. S. Expl. Exped., Botany, Phanerogamia 1: 459–460, 1854.
- Rachis-petiole up to 8 cm. long; petiolule 0.5 mm.; leaflets oblong to oblong-obovate, glabrate, 6–10 mm. broad, 13–24 mm. long, upper surface very dark, shiny, lower surface dark, dull; calyx tube 9–11 mm. broad, 4–6 mm. high, pubescent; the standard 13 mm. broad, 9 mm. long, the base obtuse; the petals of the keel oblong, 5 mm. broad, 18 mm. long, the apex acute, the base truncate on one side and cuneate on the other side; fruit 8.5 cm. long, 13 mm. wide, including the wings, which are 3–4 mm.
- TYPE: "Sandwich Islands . . . Hawaii, 1,000 feet above Puna," U. S. Expl. Exped., under *Captain Wilkes* (type, US; isotype, G) (st. lv. fl. fr.).
- The variety was obviously named for the glabrate condition of the leaflets. The calyx is not glabrate, however, as stated by Gray

HAWAIIAN ISLANDS ASSEMBLED

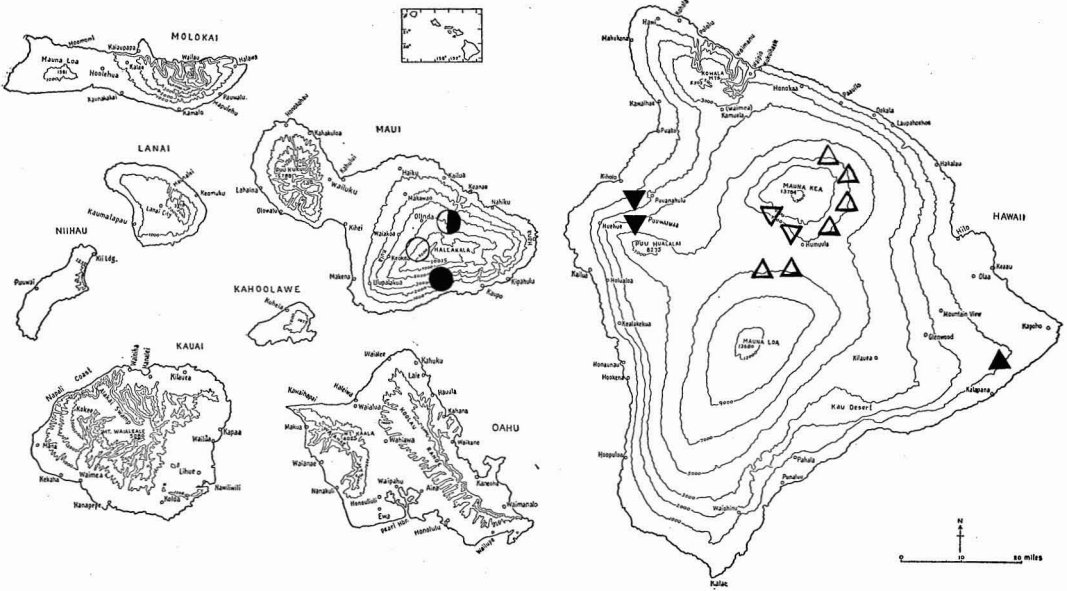


FIG. 7. Map of distribution of *Sophora chrysophylla* ssp. *glabrata*. Solid erect triangle represents var. *glabrata*, open erect triangles f. *ovata*, solid inverted triangles f. *puuwaawaaensis*, open inverted triangles f. *maunakeaensis*, open circle f. *maiuensis*, solid circle f. *lualailuaensis*, half-solid circle f. *olindaensis*.

HAWAIIAN ISLANDS ASSEMBLED

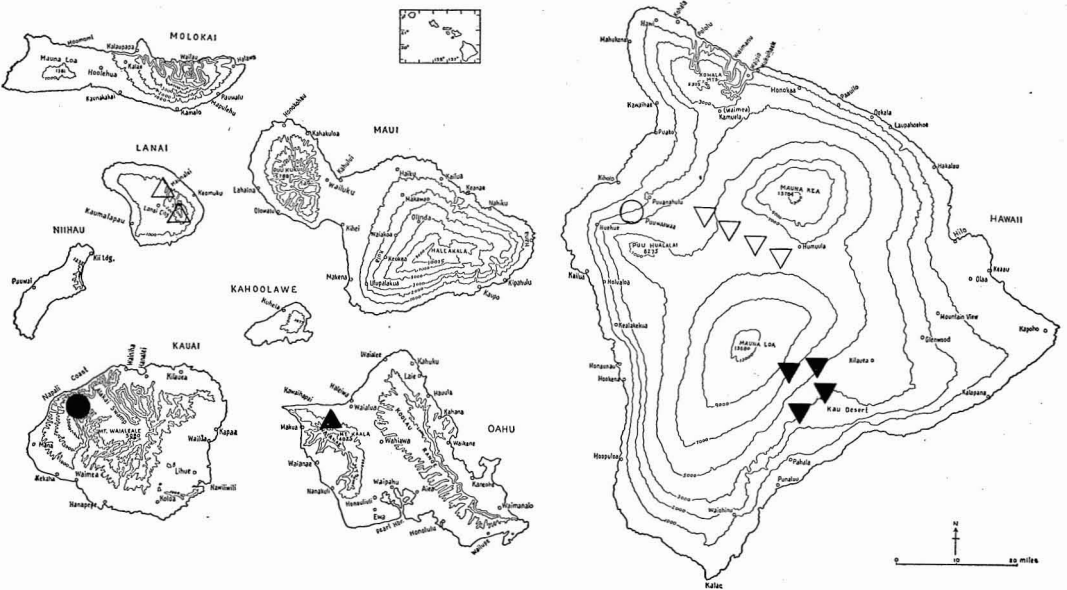


FIG. 8. Map of distribution of *Sophora chrysophylla* ssp. *glabrata*. Open erect triangles represent var. *lanaiensis*, solid erect triangles subvar. *grisea*, open inverted triangles f. *obtusa*, solid inverted triangles f. *maunaloaensis*, open circle f. *parva*, solid circle subvar. *ovatifoliolata*.

(1854: 459). He mentions that "the flowers are rather smaller."

10. *Sophora chrysophylla* ssp. *glabrata*
var. *lanaiensis*, var. nov.

Figs. 8, 9a, b

S. chrysophylla var. *glabrata* (Gray) Rock, sensu Rock, Hawaii Bd. Commrs. Agr. and Forestry, Div. Forestry, Bot. Bul. 5: 42-44, 1919.

Vexillo oblonge ovato, 9 mm. lato, 13 mm. longo.

Leaflets 4-11 mm. broad, 15-30 mm. long; calyx tube 7-8 mm. broad, 7-9 mm. high; the standard oblong-obovate, 9-13 mm. broad, 13-20 mm. long; the petals of the wing oblong-lanceolate, the base hastate, but

not symmetrical, the base 5-7 mm. wide, the petals 3-5 mm. broad, 17-21 mm. long; the petals of the keel oblong to oblong-lanceolate, the base obtuse on one side and hastate to cuneate on the other side, 5-8 mm. broad, 19-24 mm. long; the pods 1-5 seeded, the wings 0.5-1.5 mm. wide; seeds gray-black to red-brown.

TYPE: **Lanai**, "On the plateau leeward side, near Koele, back of Gibson Homestead, flowering and fruiting July 29, 1910, *Rock no. 8012*" (type: BISH; isotypes: G, NY, US) (st. lv. bd. fl. fr.).

SPECIMENS EXAMINED: **Lanai**—mountains of eastern end, June, 1913, *Forbes 234L* (st. lv. bd. fl. fr.); Kaluanui, Apr. 16, 1919, *Munro* (BISH, NY) (st. lv. bd. fl.); ravine in lower plain, Sept. 21, 1916, *A. S. Hitchcock 14,673* (US) (st. lv. bd. fl.).

Hawaiian Islands, no locality—*Mann and Brigham 352* (BISH, G, NY, US) (fragments: st. lv. bd. fl.).

This variety, which was considered by many botanists to be the same as Gray's var. *glabrata* of Puna, Hawaii, is now separated from that variety and named for its occurrence on the island of Lanai.

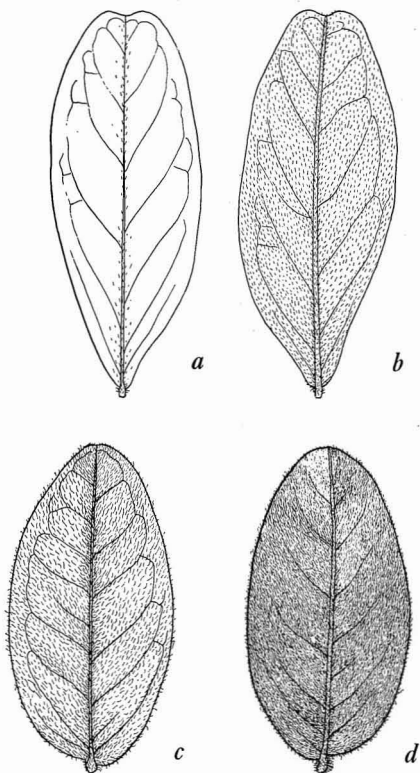


FIG. 9. Leaflet of var. *lanaiensis*, Rock 8012: a, upper surface, $\times 2$; b, lower surface, $\times 2$. Leaflet of f. *ovata*, Chock et al. 592: c, upper surface, $\times 1.5$; d, lower surface, $\times 1.5$.

11. *Sophora chrysophylla* ssp. *glabrata*
var. *ovata*, var. nov.

Foliolis oblonge obovatis vel oblongis vel oblonge ovatis, basi cuneatis; vexillo ovato, apice retuso, basi obtuso.

Leaflets oblong-obovate to oblong to oblong-ovate, the base cuneate; rachis-petiole up to 17 cm. long; calyx tube 8-15 mm. broad, 4-12 mm. high; the standard ovate, the apex retuse, the base obtuse, 13.5-23 mm. broad, 13-18 mm. long; seeds golden brown.

12. *Sophora chrysophylla* ssp. *glabrata*
var. *ovata* subvar. *ovata*, subvar. nov.

Rhachide cum petiolo longitudine quam 12 cm. breviori; foliolis 3-23 mm. latis, 10-50 mm. longis; petalis alarum oblongis vel ellip-

ticus; petalis carinae oblonge ovatis vel ellipticis.

Rachis-petiole length up to 12 cm.; leaflets 3–23 mm. broad, 10–50 mm. long; the petals of the wing oblong or elliptic, the apex obtuse, the margin sometimes irregularly indented toward the base; the petals of the keel oblong-ovate to elliptic, the margin sometimes irregularly indented toward the base.

13. *Sophora chrysophylla* ssp. *glabrata*
var. *ovata* subvar. *ovata* f. *ovata*, forma
nov.

Figs. 7, 9c, d

Petalis alarum ellipticis, apice obtusis, basi truncatis; petalis carinae ovatis, apice obtusis, basi truncatis.

The standard 15–18 mm. broad, 14–16 mm. long; the petals of the wing elliptic, the base truncate, margin entire, 6–9.5 mm. broad, 14–18 mm. long; the petals of the keel oblong-ovate, the apex obtuse, the base truncate, the margin entire.

TYPE: **Hawaii**, Mauna Kea, southeast slope, 6.9 miles northeast of Humuula, Mauna Kea contour road, 7,000 feet, Aug. 31, 1952, *Chock et al.* 592 (BISH) (st. lv. bd. fl. fr.).

SPECIMENS EXAMINED: **Hawaii**, Mauna Kea, east slope, Mauna Kea contour road, near Laumaia, 6,700–9,000 feet, Aug. 31, 1952—*Chock et al.* 594 (st. lv. bd. fr.); *Chock et al.* 611 (st. lv. bd. fl. fr.); *Chock et al.* 615 (st. lv. fr.); *Chock et al.* 618 (st. lv. fr.); *Chock et al.* 620 (st. lv. bd. fl. fr.); *Chock et al.* 621 (st. lv. bd. fr.); Aug. 18, 1935, *Neal and Hartt* 866 (st. lv. bd. fl.). Mauna Loa, north slope, Hilo-Kona road, 8,000 feet, Sept. 3, 1952—*Chock et al.* 662 (st. lv. fr.); *Chock et al.* 664 (st. lv. fr.); *Chock et al.* 667 (st. lv. fr.); *Chock et al.* 670 (st. lv. bd. fl. fr.).

This form is named for the ovate standard petal.

14. *Sophora chrysophylla* ssp. *glabrata*
var. *ovata* subvar. *ovata* f. *puuwaawaa-*
ensis, forma nov.

Figs. 3c, 7, 10a, b

Foliolis subtus glabratis; petalis alarum carinaeque irregulariter indentatis, basi modice in latere uno hastatis, altero truncatis.

Leaflets glabrate, 5–14 mm. broad, 12–25 mm. long; calyx tube 8 mm. broad, 6–9 mm. high; the petals of the wing oblong, the base truncate on one side and moderately hastate on the other side, the margin sometimes irregularly indented toward the base, 4–5 mm. broad, 13–15 mm. long; the petals of the keel oblong-elliptic, the margin irregularly indented toward the base, 7–8 mm. broad, 15 mm. long; pods 3.8–12 cm. long, 9–13 mm. wide; seeds golden brown.

TYPE: **Hawaii**, North Kona District, Mamelahoa highway, 4.1 miles northeast of Puu Waawaa Ranch road, 2,300 feet, Sept. 10, 1952, *Chock et al.* 799 (BISH) (st. lv. bd. fl. fr.).

SPECIMENS EXAMINED: **Hawaii**, Puu Waawaa Ranch, 1,800 to 2,300 feet, Sept. 8, 1952—*Chock et al.* 783 (st. lv. bd. fl.); *Chock et al.*

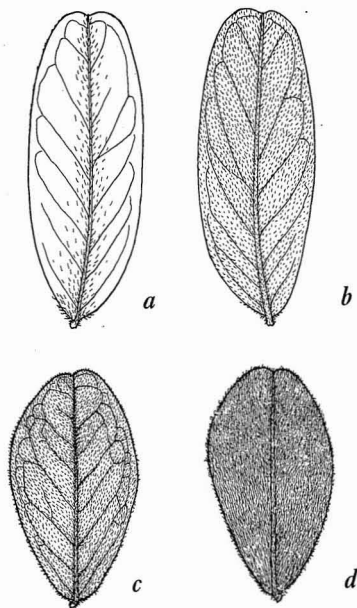


FIG. 10. Leaflet of f. *puuwaawaaensis*, Chock et al. 799: a, upper surface, $\times 2$; b, lower surface, $\times 2$. Leaflet of f. *maunakeaensis*, Chock et al. 578: c, upper surface, $\times 1$; d, lower surface, $\times 1$.

784 (st. lv. fr.); *Chock et al.* 785 (st. lv. bd. fr.); *Chock et al.* 788 (st. lv. bd. fr.); Sept. 10, 1952, *Chock et al.* 798 (st. lv. bd. fl. fr.); Sept. 7, 1949, *Degener* 20,109 (F) (st. lv. bd. fr.); Huehue, Feb. 11, 1952, *Degener* 21,818 (F) (st. lv. bd. fl. fr.).

This form is named for its occurrence in the Puu Waawaa region on the island of Hawaii.

15. *Sophora chrysophylla* ssp. *glabrata*
var. *ovata* subvar. *ovata* f. *maunakeaensis*, forma nov.

Figs. 2a, 7, 10c, d

Foliolis subtus dense pubescentibus; petalis alarum integris, basi truncatis; petalis carinae irregulariter indentatis, basi truncatis.

Leaflets abundantly pubescent on the lower surface, 5–15 mm. broad, 10–34 mm. long; the petals of the wing elliptic, the base truncate, the margin entire, 7–7.5 mm. broad, 14.5–17.5 mm. long; the petals of the keel elliptic, the base truncate, the margin irregularly indented toward the base, 8–8.5 mm. broad, 16–19 mm. long; seeds golden brown.

TYPE: Hawaii, Mauna Kea, south slope, 3.1 miles north of Humuula, Humuula-Hale Pohaku road, Aug. 30, 1952, *Chock et al.* 578 (BISH) (st. lv. bd. fl. fr.).

SPECIMENS EXAMINED: Hawaii, Mauna Kea, south slope, Humuula-Hale Pohaku road, 8,000–10,000 feet, Aug. 30, 1952—*Chock et al.* 580 (st. lv. bd. fl.); near timberline, *Chock et al.* 577 (wood, st. lv. bd. fl. fr.); Sept. 2, 1949, *Degener & Murashige* 19,997 (F) (st. lv. bd. fl. fr.); Sept., 1949, *Degener* (F) (st. lv. fl.); Aug. 18, 1949, *Degener* 20,236 (F) (st. lv. bd. fl. fr.).

This form is named for its occurrence on the slopes of Mauna Kea on the island of Hawaii.

16. *Sophora chrysophylla* ssp. *glabrata*
var. *ovata* subvar. *mauiensis*, subvar. nov.

Rhachide cum petiolo minus quam 17 cm. longo; foliolis 5–12 mm. latis, 13–32 mm.

longis; petalis alarum carinaeque oblonge ellipticis.

Leaflets 5–12 mm. broad, 13–32 mm. long; rachis-petiole up to 17 cm. long; the standard ovate; the petals of the wing oblong-elliptic, the base cuneate on one side and hastate on the other side; the petals of the keel oblong-elliptic, the margin usually irregularly indented toward the base; seeds golden brown.

17. *Sophora chrysophylla* ssp. *glabrata*
var. *ovata* subvar. *mauiensis* f. *mauiensis*, forma nov.

Figs. 3a, 7, 11a, b

Vexillo ovato, 23 mm. lato, 18 mm. longo; petalis carinae basi oblique truncatis, apice acutis.

Rachis-petiole up to 9 cm. long; the petals of the wing 8.5 mm. broad, 18.5 mm. long, the apex obtuse; the petals of the keel 10

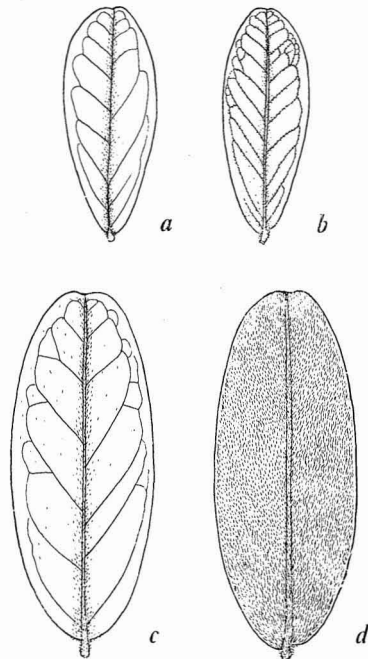


FIG. 11. Leaflet of f. *mauiensis*, Chock et al. 283: a, upper surface, $\times 1$; b, lower surface, $\times 1$. Leaflet of f. *lualailuaensis*, Forbes 1986M: c, upper surface, $\times 2$; d, lower surface, $\times 2$.

mm. broad, 20 mm. long, the apex acute, the base truncate-oblique.

TYPE: **Maui**, Haleakala, north-west-west slope, 0.8 miles from 8,000 feet level (road marker), Haleakala road, 8,450 feet altitude, Dec. 24, 1951, *Chock et al.* 283 (BISH) (st. lv. bd. fl. fr.).

SPECIMENS EXAMINED: **Maui**, Haleakala—between Olinda and Haleakala summit, June 15, 1927, *Degener and Wiebke* 2279 (NY, US) (st. lv. fr.); 1,666 M., Feb., 26, 1902, *J. G. Smith* (US) (st. fl.); 8,000 ft., April 1, 1947, *Alexander & Kellogg* 5285 (US) (st. lv. bd. fl.).

This form is named for its occurrence on Maui.

18. *Sophora chrysophylla* ssp. *glabrata*
var. *ovata* subvar. *mauiensis* f. *lualailuaensis*, forma nov.

Figs. 7, 11c, d

Vexillo ovato, 15 mm. lato, 13 mm. longo; petalis carinae basi truncatis apice obtusis.

Rachis-petiole up to 11 cm. long; the standard 15 mm. broad, 13 mm. long; the petals of the wing 7 mm. broad, 15 mm. long, the apex obtuse; the petals of the keel 8 mm. broad, 15 mm. long, the apex obtuse, the base truncate.

TYPE: **Maui**, cone of south side of Haleakala, cone near Lualailua Hills, Koheka-manawa [?], Mar. 17, 1920, *Forbes* 1986M (BISH) (st. lv. bd. fl.).

This form is named for its occurrence near the Lualailua Hills, Maui.

19. *Sophora chrysophylla* ssp. *glabrata*
var. *ovata* subvar. *mauiensis* f. *olindaensis*, forma nov.

Figs. 2b, 7, 12

Rhachide cum petiolo minus quam 17 cm. longo; petalis carinae oblonge ellipticis, apice obtusis, basi obtusis vel oblique truncatis.

Rachis-petiole up to 17 cm. long; the petals of the wing 8 mm. broad, 20 mm. long, the apex acute, the base truncate; the petals of the keel 10 mm. broad, 22 mm. wide, the

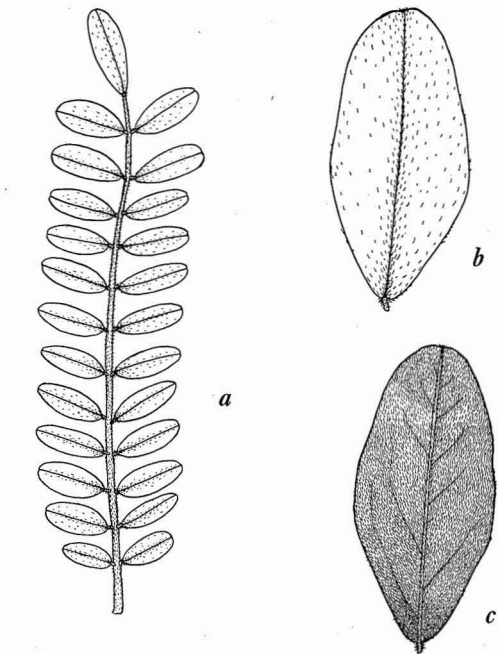


FIG. 12. *F. olindaensis*, Chock et al. 286: a, leaf, upper surface, $\times 0.5$; b, leaflet, upper surface, $\times 2$; c, leaflet, lower surface, $\times 2$.

apex obtuse, the base obtuse to truncate-oblique.

TYPE: **Maui**, Makawao, Olinda Pipe Line road, 4,600 feet, in wet gulch, tree 10 meters high with few leaves and large number of flowers, Dec. 25, 1951, *Chock et al.* 286 (BISH) (st. lv. bd. fl.).

SPECIMENS EXAMINED: Same locality, Dec. 25, 1951, *Chock et al.* 311 (st. lv. bd. fl.); same locality, June 27, 1927, *Degener* (NY) (st. lv. bd.).

This form grows in an area where the rainfall is over 200 inches a year, and is named for its occurrence in the Olinda region, Maui.

20. *Sophora chrysophylla* ssp. *glabrata*
var. *grisea* (*Degener and Sherff*), comb. nov.

Sophora grisea *Degener and Sherff*, in *Sherff, Bot. Leaflets*, 5: 24-25, 1951.

Leaflets broadly elliptic to oblong-ovate to oblong to oblong-ovate, abundantly pube-

scent, 3–22 mm. broad, 7–40 mm. long; petiolule 0.5–1.5 mm. long; rachis-petiole up to 16.5 cm. long; pedicels 5–25 mm. long; calyx tube 5–10 mm. broad, 6–11 mm. high; the standard ovate to oblong-ovate, the apex and base obtuse, 10.5–17 mm. broad, 12–17 mm. long; the petals of the wing 4.5–8 mm. broad, 13–19 mm. long, the base usually truncate; the petals of the keel 5–12 mm. broad, 14–20 mm. long, the base usually truncate; pods 2–14.5 cm. long, 7–15 mm. wide; seeds gray-black to golden brown.

21. *Sophora chrysophylla* ssp. *glabrata*
var. *grisea* subvar. *grisea* (Degener and Sherff), comb. nov.

Figs. 8, 13a, b

Sophora grisea Degener and Sherff, in Sherff, Bot. Leaflets 5: 24–25, 1951.

Leaflets usually broadly elliptic, 6–22 mm. broad; 14–40 mm. long; rachis-petiole up to 11 cm. long; calyx tube 9.5 mm. broad, 7 mm. high; the standard oblong-ovate, 10.5–12 mm. broad, 15–17 mm. long; the petals of the wing oblong-lanceolate, 4–5 mm. broad, 14 mm. long; the petals of the keel oblong to

oblong-ovate, 5–8 mm. broad, 15–17 mm. long; pods 7 mm. wide, including the wings, which are 1–15 mm.; seeds gray-black.

TYPE: Oahu, Waianae Mts., DuPont trail, Oct. 23, 1949, *Degener and Greenwell* (F, type; BISH, fragment of type) (st. lv. fr.).

SPECIMENS EXAMINED: Oahu—Waianae Mts., Makaha valley, Feb. 12–19, 1909, *Forbes* (st. lv. fl.); *Remy*, ex. herb. A. Gray (NY) (st. lv. bd. fl.); Dec. 4, 1951, *Degener* (F) (st. lv.); DuPont trail, 2,500 ft., Sept. 9, 1950, *Hatheway, et al.*, 349 (F) (st. lv. fl.).

This taxon was named by Degener and Sherff in allusion to the seed color.

22. *Sophora chrysophylla* ssp. *glabrata*
var. *grisea* subvar. *obtusa*, subvar. nov.

Foliolis oblongis vel oblonge obovatis, basi cuneatis; vexillo ovato, apice obtuso.

Leaflets oblong-obovate to oblong to oblong-ovate, the base cuneate; the standard ovate, the apex obtuse, 12–15 mm. broad, 12–17 mm. long; the petals of the wing with the apex obtuse; the petals of the keel 6–8 mm. broad, 14–17.5 mm. long; seeds golden brown.

23. *Sophora chrysophylla* ssp. *glabrata*
var. *grisea* subvar. *obtusa* f. *obtusa*, forma nov.

Figs. 2e, 3e, 8, 13c, d

Petalis alarum ellipticis, apice obtusis, basi modice sagittatis; petalis carinae oblongis, apice obtusis, basi obtusis in latere uno, in altero modice sagittatis.

Leaflets oblong-obovate, 5–15 mm. broad, 10–34 mm. long; rachis-petiole up to 13 cm. long; the petals of the wing elliptic, the apex obtuse, the base moderately sagittate, 7.5 mm. wide, 13 mm. long; the petals of the keel oblong, the apex obtuse, the base obtuse on one side and moderately sagittate on the other side, 6 mm. broad, 14 mm. long.

TYPE: Hawaii, Mauna Kea—Mauna Loa Saddle, Waikii, 10.4 miles west of Pohakuloa, 5,500 feet, Aug. 30, 1952, *Chock, et al.*, 584 (BISH) (st. lv. bd. fl. fr.).

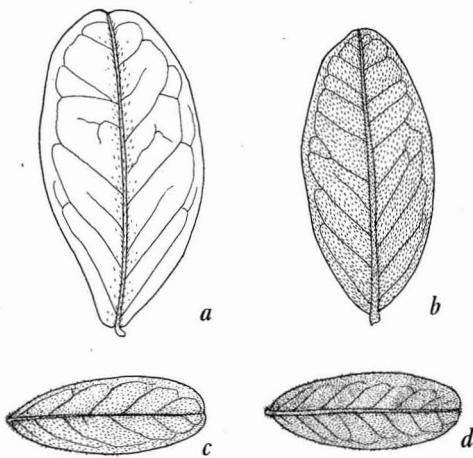


FIG. 13. Leaflet of subvar. *grisea*: a, upper surface, $\times 1$, Degener and Greenwell (October 23, 1949); b, lower surface, $\times 1$, Forbes (February 12–19, 1909). Leaflet of f. *obtusa*, Chock et al. 584: c, upper surface, $\times 1$; d, lower surface, $\times 1$.

SPECIMENS EXAMINED: **Hawaii**, Mauna Kea—Mauna Loa Saddle—Waikii, Aug. 30, 1952, *Chock, et al.*, 582 (st. lv. bd. fr.); same locality, *Chock, et al.*, 583 (st. lv. bd. fr.); Pohakuloa, Bd. of Agr. & For. camp, 6,000 feet, Sept. 1, 1952, *Chock, et al.*, 625 (st. lv. fr.).

This form is named for the obtuse apex of the standard petal.

24. *Sophora chrysophylla* ssp. *glabrata*
var. *grisea* subvar. *obtusa* f. *maunaloaensis*, forma nov.

Figs. 8, 14a, b

Petalis alarum oblongis, apice obtusis, basi

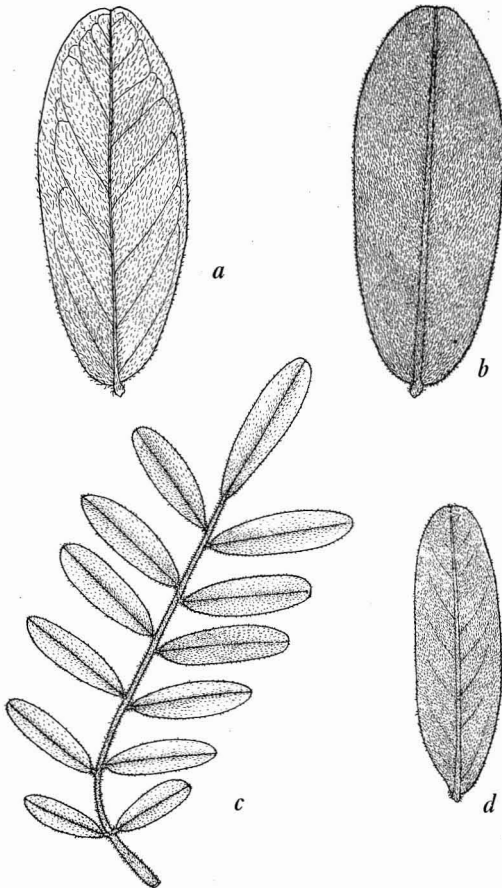


FIG. 14. Leaflet of f. *maunaloaensis*, Chock et al. 726: a, upper surface, $\times 1$; b, lower surface, $\times 1$. Leaf and leaflet of f. *parva*, Chock et al. 782: c, leaf, upper surface, $\times 1$; d, leaflet, lower surface, $\times 2$.

truncatis; petalis carinae oblonge ellipticis, apice acutis, basi subsagittatis.

Leaflets oblong-obovate, 5–16 mm. broad, 10–41 mm. long; rachis-petiole up to 13 cm. long; the petals of the wing oblong, 7–8 mm. broad, 19 mm. long; the petals of the keel oblong-elliptic, the apex acute, the base subsagittate, 8 mm. broad, 16 mm. long; seeds golden brown.

TYPE: **Hawaii**, Hawaii Natl. Park, Feb., 1952, *Hubbard* (BISH) (st. lv. bd. fl. fr.).

SPECIMENS EXAMINED: **Hawaii**, Mauna Loa, southeast slopes, Hawaii Natl. Park, Mauna Loa—Kilauea section road, Sept. 5, 1952—6,700 feet, *Chock, et al.*, 726 (st. lv. fr.); same locality, *Chock, et al.*, 727 (st. lv. fr.); same locality, *Chock, et al.*, 728 (st. lv. bd. fr.); 4,400 feet, *Chock, et al.*, 730 (st. lv. bd. fr.); same locality, *Chock, et al.*, 733 (st. lv. bd. fr.).

Hawaii, Hawaii Natl. Park, Mauna Loa—Kilauea section—in kipuka 8.5 miles along Kau road from Volcano House, July 22, 1926, *Degener* 9848 (NY) (st. lv. fl. fr.); Sept., 1908, *Forbes, et al.*, (BISH, NY) (st. lv. fr.); lava "oasis" beyond Bird Park, Dec. 26, 1922, *Degener* (NY) (st. lv. fr.); 7 miles west of Volcano House along Kau road, July 21, 1926, *Degener* 9844 (NY) (st. lv. fr.); Kilauea (drawn for *Plants of Hawaii Natl. Park*, plate 47), Aug., 1929, *Degener* (NY) (st. lv. bd. fr.); on trail to rest house (Mauna Loa), 7,000 ft., Sept. 13, 1916, *A. S. Hitchcock* 14,634 (US) (st. lv. bd. fl.); east of Kilauea-iki, July 17, 1926, *Degener* 9845 (US) (st. lv. bd.); Bird Park, 4,000 ft., Dec. 22, 1931, *St. John, et al.*, 11,261 (BISH, US) (st. lv. bd. fl.).

This form is named for its occurrence on the eastern slopes of Mauna Loa in Hawaii National Park.

25. *Sophora chrysophylla* ssp. *glabrata*
var. *grisea* subvar. *obtusa* f. *parva*,
forma nov.

Figs. 8, 14c, d

Foliolis glabratis; petalis alarum oblongis, apice obtusis, basi in latere uno cuneatis, in

altero modice hastatis; petalis carinae oblongis, apice acutis, basi oblique truncatis.

Leaflets glabrate, 3–11 mm. broad, 7–20 mm. long; rachis-petiole length up to 7 cm.; the petals of the wing oblong, the apex obtuse, the base truncate or cuneate on one side and moderately hastate on the other side, 4.5–5 mm. broad, 14 mm. long; the petals of the keel oblong, the apex acute, the base truncate-oblique, 6.5–7 mm. broad, 16.5–17.5 mm. long; pods 2–4 cm. long, the wings 1.5–2.5 mm. wide, 1–4 seeded, usually 2 seeded.

TYPE: Hawaii, North Kona District, Puu Waawaa Ranch, junction of Mamalahoa highway and Puu Waawaa ranch road, 2,300 ft., Sept. 8, 1952, *Chock, et al.*, 782 (BISH) (st. lv. bd. fl.).

SPECIMENS EXAMINED: Hawaii, Puu Waawaa Ranch—2,300 ft., Sept. 8, 1952, *Chock, et al.*, 775 (st. lv. bd. fr.); 3 miles west of Puu Waawaa, 3,000 ft., June 21–23, 1948, *Wilbur and Webster* 1887 (st. lv. fl.).

This form is named in allusion to its small size in habit, the narrow wings of the pods, and the small leaflets.

26. *Sophora chrysophylla* ssp. *glabrata* var. *grisea* subvar. *ovatifoliolata*, subvar. nov.

Figs. 8, 15a, b

Foliolis oblonge ovatis.

Leaflets ovate-oblong, the few larger leaflets being oblong to obovate-oblong, 6–17 mm. broad, 15–38 mm. long; calyx tube 9.5 mm. broad, 11 mm. high; the standard ovate, 17 mm. broad, 17 mm. long; the petals of the wing ovate-oblong, 8 mm. broad, 19 mm. long; the petals of the keel elliptic, the apex obtuse, 12 mm. broad, 20 mm. long; the wings of the pods under 2 mm. wide; seeds orange-brown.

TYPE: Kauai, Na Pali-Kona Forest Reserve, Kokee Terr. Park, 4,000 feet, near Kalalau Lookout, in rain forest, specimen from 2–3 trees (7 m. x 5 cm.), Dec. 24, 1952, *St. John, et al.*, 24,879 (BISH) (st. lv. bd. fl. fr.).

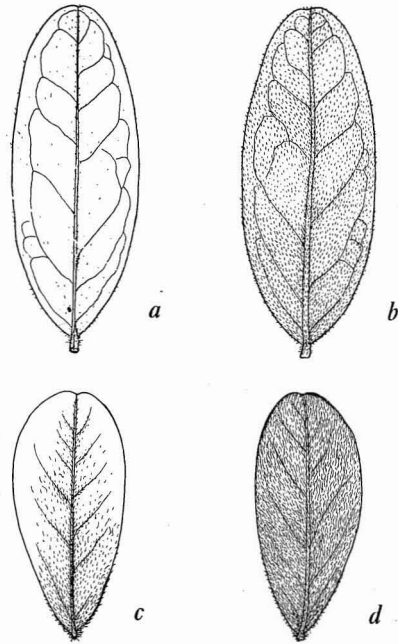


FIG. 15. Leaflet of subvar. *ovatifoliolata*, St. John et al. 24,879: a, upper surface, $\times 1.5$; b, lower surface, $\times 1.5$. Leaflet of var. *circularis*, Chock et al. 612: c, upper surface, $\times 1$; d, lower surface, $\times 1$.

SPECIMENS EXAMINED: Kauai, Kokee Terr. Park—same locality as type, Nov., 1951, *Souza* (st. lv. bd. fr.); same locality, July 4, 1926, *Degener* 9847 (NY) (st. lv.); same locality, *Degener and Greenwell*, 21,513 (F) (lv. fl. bd.); Kaunuohua ridge, northeast of Pohakuwaawaa, Jan. 12, 1952, *Degener and Greenwell* 21,745 (F) (st. lv. bd. fl.); Kapiwai trail, Jan. 11, 1952, *Degener and Greenwell* 21,742 (F) (st. lv. bd. fl.); Nualolo trail, 2,000–3,750 feet, Dec. 28, 1930, *St. John, et al.*, 10,810 (st. lv. bd. fl.); Waimea Drainage Basin, west side, Nualolo trail, July 3 to Aug. 18, 1917, *Forbes* 965K (st. lv.); road to Halemanu hill, 3,700 feet, Sept. 7, 1953, *Chock* 1194 (st. lv. fr.); same locality, *Chock* 1196 (st. lv.).

A large number of seedlings were observed near Halemanu hill, with several scrubby trees 2 meters high. This subvariety is named in allusion to the ovate leaflets.

27. *Sophora chrysophylla* ssp. *circularis*,
ssp. nov.

Figs. 1, 19

Vexillo circulari.

Shrub to tree, 4–5 meters high; leaflets oblong-obovate, 6–14 mm. broad, 13–37 mm. long, abundantly pubescent to glabrate; petiolule 1–1.5 mm.; rachis-petiole up to 12 cm. long; pedicels 6–13 mm. long; the standard circular, the apex retuse, the base obtuse, the breadth and length the same, 13–18 mm.; the petals of the wing with the apex obtuse, the base hastate on one side and truncate on the other side; pods 4–11 cm. long, 7–17 mm. wide, 1–7 seeded; seeds orange-brown or golden brown.

KEY TO SUBSPECIES *circularis*

- A. Rachis-petiole maximum length 12 cm.; pubescence on the lower surface of the leaflets abundant; wing petals elliptic. 28. var. *circularis*
- A. Rachis-petiole maximum length 7 cm.; lower surface of leaflets glabrate; wing petals oblong-lanceolate. 29. var. *kauensis*

28. *Sophora chrysophylla* ssp. *circularis*
var. *circularis*, var. nov.

Figs. 2*d*, 3*d*, 15*c*, *d*, 19

Rhachide cum petiolo minus quam 12 cm. longo; foliolis subtus dense pubescentibus; petalis alarum ellipticis.

The lower surface of the leaflets abundant strigose-pubescent; rachis-petiole up to 12 cm. long; calyx tube 12 mm. broad, 10 mm. high; the petals of the keel elliptic, the apex obtuse, the base cuneate on one side and truncate on the other side, the margin irregularly indented toward the base, 9 mm. broad, 19 mm. long; pods 3 seeded, the wings 3 mm. wide; seeds golden brown, 5 mm. wide, 7–8 mm. long, 4 mm. thick.

TYPE: **Hawaii**, Mauna Kea, east slope, 15.9 miles northeast of Humuula, Mauna Kea

contour road, 6,700 feet, Aug. 31, 1952, Chock, et al., 612 (BISH) (st. lv. bd. fl. fr.).

This variety is named for the circular petal.

29. *Sophora chrysophylla* ssp. *circularis*
var. *kauensis*, var. nov.

Figs. 1*c*, 2*c*, 3*b*, 16*a*, *b*, 19

Rhachide cum petiolo minus quam 7 cm. longo; foliolis subtus glabratis; petalis alarum oblonge lanceolatis.

The lower surface of the leaflets glabrate; rachis-petiole up to 7 cm. long; calyx tube 8 mm. broad, 8 mm. high; the petals of the wing oblong-lanceolate, 5.5 mm. broad, 14 mm. long; the petals of the keel oblong-elliptic, the apex acute, the base cuneate on one side and hastate on the other side, 8.5 mm. broad, 17 mm. long; pods 1–7 seeded;

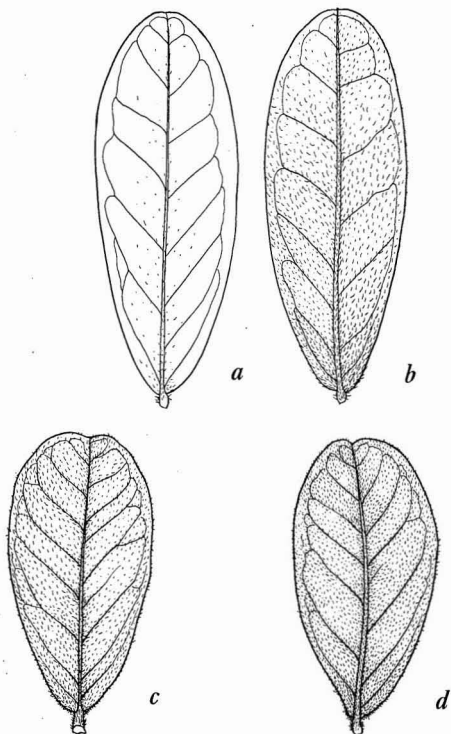


FIG. 16. Leaflet of var. *kauensis*, Chock et al. 749: *a*, upper surface, $\times 2$; *b*, lower surface, $\times 2$. Unifoliate leaf of var. *unifoliata*, Roçk 13,011: *c*, upper surface, $\times 1$; *d*, lower surface, $\times 1$.

seeds orange-brown, 3–4 mm. wide, 5 mm. long, 2.5–3.5 mm. thick.

TYPE: **Hawaii**, Kau District, Mamalahoa highway, 4.5 miles west of Kahuku Ranch entrance, 1,900 feet, Sept. 6, 1952, *Chock, et al.*, 749 (BISH) (wood, st. lv. bd. fl. fr.).

SPECIMENS EXAMINED: **Hawaii**, near 1907 lava flow, Feb. 14, 1952, *Degener* 21,820 (F) (st. lv. bd. fl. fr.).

This variety is named for its occurrence in the Kau District on the island of Hawaii.

30. *Sophora chrysophylla* ssp. *unifoliata* (Rock), comb. nov.

Figs. 1*b*, 19

Sophora chrysophylla var. *unifoliata* Rock, Hawaii Bd. Commrs. Agr. and Forestry, Div. Forestry, Bot. Bul. 5: 44, 1919.

Edwardsia unifoliata (Rock) Degener, Flora Hawaiiensis, family 169c, 1932.

Sophora unifoliata (Rock) Degener and Sherff, in Sherff, Bot. Leaflets 5: 24, 1951.

Shrub to tree, 3.5–8 meters high, leaves alternate, unifoliolate to pinnate; leaflets oblong-obovate, 6–19 mm. broad, 12–49 mm. long; petiolule 1 mm.; rachis-petiole (of pinnate leaves) up to 8.5 cm. long; pedicels 5–18 mm.; calyx tube 7–10 mm. broad, 4–8 mm. high; the standard elliptic, 10–16 mm. broad, 13–20 mm. long; the petals of the wing oblong-lanceolate, the apex obtuse, the base hastate, 3–5 mm. broad, 12.5–21 mm. long; the petals of the keel oblong to oblong-lanceolate, 3–6.5 mm. broad, 8–25 mm. long; no fruits on specimens.

KEY TO SUBSPECIES *unifoliata*

A. Leaves typically unifoliolate to trifoliolate, petiole 2 mm.; margin of keel sometimes irregularly indented. . . 31. var. **unifoliata**

A. Leaves typically pinnate (5–21 leaflets), but sometimes unifoliolate to trifoliolate, petiole over 2 mm.; margin of keel always entire. B

B. Leaves always pinnate (5–21 leaflets), never unifoliolate, bifoliolate, or trifoliolate; leaflets 6–9 mm. broad, 12–26 mm. long; keel oblong-lanceolate, apex acute 33. var. **kanaioensis**

B. Leaves pinnate (5–11 leaflets), but sometimes unifoliolate, bifoliolate or trifoliolate; leaflets 6–14 mm. broad, 18–49 mm. long; keel oblong, apex obtuse. 32. var. **elliptica**

31. *Sophora chrysophylla* ssp. *unifoliata* var. *unifoliata* Rock, Hawaii Bd. Commrs. Agr. and Forestry, Div. Forestry, Bot. Bul. 5: 44, 1919.

Figs. 16*c*, 19

Edwardsia unifoliata (Rock) Degener, Flora Hawaiiensis, family 169c, 1932.

Sophora unifoliata (Rock) Degener and Sherff, in Sherff, Bot. Leaflets 5: 24, 1951.

Leaves alternate, usually unifoliolate, but sometimes bifoliolate or trifoliolate; petiole up to 2 mm.; the petals of the keel oblong, the apex obtuse, the base cuneate on one side and truncate on the other side, the margin irregularly indented toward the base.

TYPE: **Hawaii**, Puu Waawaa, 2,000 feet, Aug., 1917, *Rock* 13,011 (BISH) (st. lv. bd. fl.).

SPECIMENS EXAMINED: **Hawaii**, Puu Waawaa—1913, *Young* 12,648 (st. lv. bd.); 900 m., wood sample no. phloem 180, Dec. 1, 1926, *MacDaniels* (st. lv. fl.); *Meebold* (*Degener's*) 10,138 (st. lv. bd. fl.).

Meebold's specimen shows a double pistil on all of the flowers, while Rock's type specimen does not show such an abnormality. The one flower on MacDaniels' specimen showed a development toward a double pistil, since there was a longitudinal depression.

Fruits were found in an envelope on the sheet of Young's specimen, which probably do not belong to this particular collection, since Rock (1919: 44) states, "no pods seen." The envelope on this sheet appears to be of recent origin, and later collectors failed to find any pods.

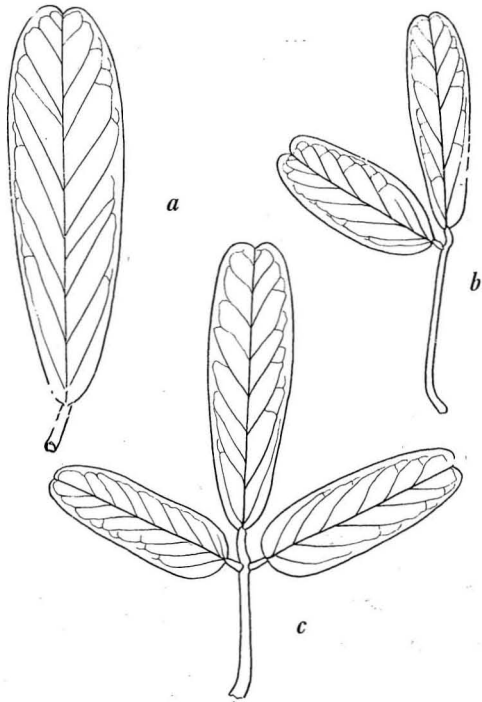


FIG. 17. Leaves of var. *elliptica*, Degener et al. 19,327: *a*, unifoliate leaf, $\times 1$; *b*, bifoliate leaf, $\times 1$; *c*, trifoliate leaf, $\times 1$.

32. *Sophora chrysophylla* ssp. *unifoliata*
var. *elliptica*, var. nov.

Figs. 1*b*, 17, 18*a*, *b*, 19

Foliis unifoliolatis vel pinnatis; petalis carinae oblongis, apice obtusis.

Leaves pinnate, but sometimes unifoliate, bifoliate or trifoliate, 6–14 mm. broad, 18–49 mm. long; the standard with the apex retuse, the base cuneate, 16 mm. broad, 20 mm. long; the petals of the wing 5 mm. broad, 21 mm. long; the petals of the keel oblong, the apex obtuse, the base cuneate on one side and hastate on the other side.

TYPE: **Maui**, Hokukano, Dec. 27, 1948, Degener, Bertram, Clay 19,327 (type, BISH; isotype, F) (st. lv. bd. fl.).

This variety has pinnate, unifoliate, bifoliate, and trifoliate leaves, and represents a transitional stage between var. *uni-*

foliata and the more common *mamane*. It is named for the elliptic standard petal.

33. *Sophora chrysophylla* ssp. *unifoliata*
var. *kanaioensis*, var. nov.

Figs. 18*c*, *d*, 19

Foliis pinnatis; vexillo oblonge elliptico; petalis carinae oblonge lanceolatis, apice acutis.

Leaves alternate, always pinnate; leaflets oblong to oblong-obovate, 6–9 mm. broad, 16–26 mm. long; rachis-petiole up to 5 cm. long; calyx tube prominently nerved; corolla orange (according to Forbes' label); the

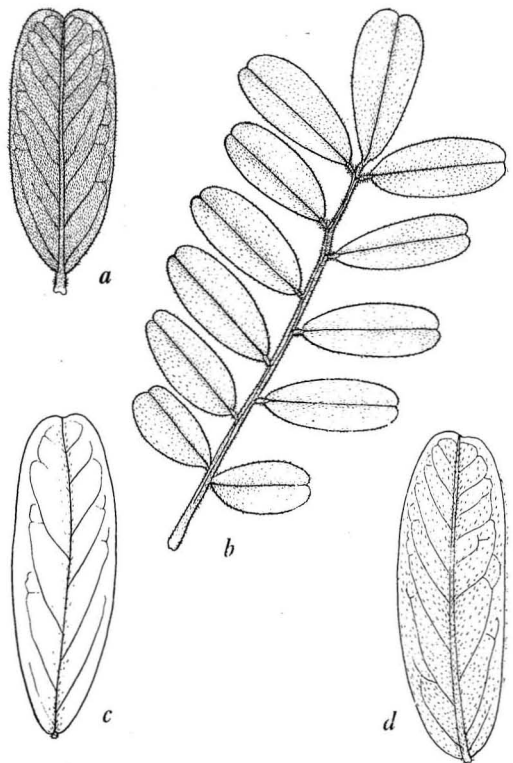


FIG. 18. Pinnate leaf of var. *elliptica*, Degener et al. 19,327: *a*, leaflet, lower surface, $\times 2$; *b*, pinnate leaf, upper surface, $\times 1$. Leaflet of var. *kanaioensis*, Forbes 1807M: *c*, upper surface, $\times 2$; *d*, lower surface, $\times 2$.

standard oblong-elliptic, the apex retuse, the base obtuse, 12 mm. broad, 18 mm. long; the petals of the wing 3 mm. broad, 20 mm. long, the base 4 mm.; the petals of the keel oblong-lanceolate, the apex acute, the base hastate.

TYPE: **Maui**, Kanaio, Mar. 2, 1920, *Forbes 1807M* (BISH) (st. lv. bd. fl.).

SPECIMENS EXAMINED: **Maui**, Kanaio, Feb. 27, 1952, *Degener 21,976* (F) (st. lv. bd. fl. fr.).

This form is named in allusion to its occurrence near Kanaio on the island of Maui.

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HAWAIIAN ISLANDS ASSEMBLED

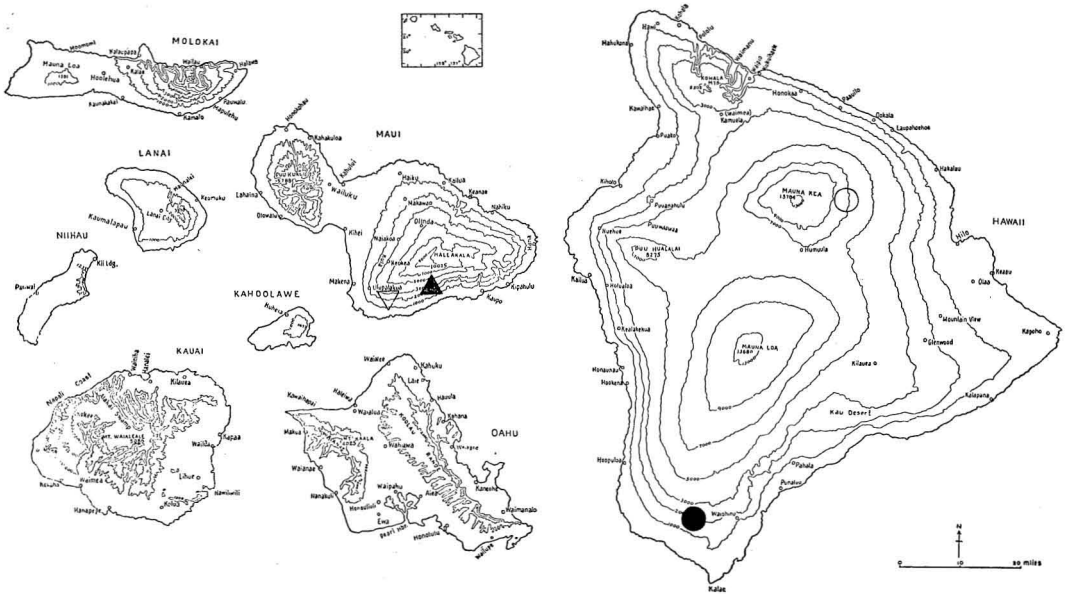


FIG. 19. Map of distribution of *Sophora chrysophylla*: ssp. *circularis*—open circle represents var. *circularis*, solid circle var. *kauensis*; ssp. *unifoliata*—open erect triangle represents var. *unifoliata*, solid erect triangle var. *elliptica*, open inverted triangle var. *kanaioensis*.

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