JOURNAL

OF THE

ARNOLD ARBORETUM

VOL. XXXVIII APRIL 1957 NUMBER 2

THE GENUS JUGLANS IN MEXICO AND CENTRAL AMERICA

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WALNUTS AND BUTTERNUTS, *nogal* or *nogales* in Latin America, well known important timber and nut trees belonging to the genus *Juglans*, of the Juglandaceae, occur in the New World from eastern Canada to Argentina and from the West Indies and Florida to California. The genus is missing in the modern flora from the northwestern states. In Central America walnuts have not been reported as native from Salvador, Nicaragua, Costa Rica, and Panama. The trees grow primarily in a humid, temperate climate, so that those which grow in the tropical latitudes are restricted to rather high altitudes with good rainfall, and those of arid regions are restricted to the canyons of streams. Consequently, the localities where *Juglans* occurs in Mexico and Central America are comparatively few and the trees are difficult to locate.

The species of Latin America are closely related to those of the United States and two of them occur in both Mexico and the United States. In the United States Sargent (1933) recognized six species, and gave an excellent treatment of these, with illustrations. Some authors recognize five species, others four. The writer recognizes five species: *J. cinerea* L. and *J. nigra* L. in the east, and *J. microcarpa* Berlandier (formerly called *J. rupestris* Engelmann ex Torrey), *J. major* (Torr.) Heller (included by many under *J. rupestris* as a variety), and *J. californica* S. Watson (including *J. hindsii* Rehd.) in the south and southwest. Of these species of the United States, *J. cinerea* clearly does not enter Mexico; *J. nigra* and *J. californica* approach the border of Mexico but have not been reported within that country; the other two species occur in north-central and northwestern Mexico.

The first species published for Mexico and Central America was *J. pyriformis*, described in 1850 by the Danish botanist F. Liebmann from the region of Mount Orizaba, near Coscomatepec, in the state of Vera Cruz, Mexico. The first treatment of *Juglans* of Latin America as a whole was that of Dode (1906–1909), who, in his comprehensive fully illustrated survey of the genus *Juglans* of the world, lists only two species for Mexico and Central America: *J. pyriformis* Liebm. and *J. mollis* Engelm. Standley, in his thorough treatment of the trees and shrubs of Mexico

in 1920, gave four species, the two above for eastern Mexico, and *J. rupestris* Engelm. ex Torrey and *J. major* (Torr.) Heller extending from Texas, New Mexico and Arizona into north-central and northwestern Mexico. Definite descriptions were not made of any species of the genus from Central America until Standley and Williams described *J. olanchana* from Honduras in 1950. Manning, in Standley & Steyermark's Flora of Guatemala (1952), described *J. guatemalensis* and *J. steyermarkii* from that country.

Since the time of Dode many collectors, primarily from the United States, have made trips to Mexico and Central America. In 1953 the writer and his wife made a trip of over 5000 miles in Mexico under the auspices of the American Philosophical Society, primarily to collect and study *Juglans* and *Carya*. As a result of these activities, we have acquired a much better idea of the species of *Juglans* in the area under consideration, and of the distribution of these species.

All species of *Juglans* of the new world, with one exception,[1] belong to the section Rhysocaryon of Dode, typified by *J. nigra*. Dode (1909, p. 166) gives a description of the section. It is characterized by having, (1) a secondary as well as a primary partition in the nut so that the lower part of the nut is 4-celled; (2) each staminate flower with a stalk, and with the floral receptacle round; (3) the husk persistent on the nut; (4) the nut surface ridged or striate in various ways, but never smooth or rugose; (5) the nut dehiscent only at germination; (6) the scales of the embryo of the seed and younger part of the seedling spiral, gradually increasing in size until the normal leaves are reached; (7) the embryos of the seeds with shoulders or lobes near the apex ("shoulder region of the embryo lobes concave" according to Scott, 1954), so the embryo is 5-lobed and the nut 5-celled near the apex; (8) the leaflets serrate; (9) the leaf-scar without a hairy fringe or "mustache," but with a definite notch, along its upper edge. Some of these features were not given by Dode, but have been added by Nagel (1914), Manning (1948), and Scott (1954).

The species of *Juglans* of the world, as well as those of the other genera of the family, arranged by sections, are listed by the writer in his paper on the staminate flowers of the family (Manning, 1948). Two species mentioned there were not published until 1952 and another of those listed will be described in this paper. *Juglans glabrata*, mentioned there, is here reduced to a variety.

All of the species of Mexico and Central America, as well as in the New World as a whole, are so closely related that it is difficult to distinguish them. The writer recognizes five species in Mexico, and two others in Central America, one of the latter represented by a variety in southern Mexico. Two taxa from western Mexico, here described as varieties, may, upon further study, prove to be distinct species.

[1] *Juglans cinerea*, the butternut, is a member of the section Trachyocaryon of Dode; the writer does not consider this section distinct from Dode's section Cardiocaryon of Asia, an opinion shared by Nagel, 1914, who, however, uses different sectional names.

Although Dode (1906–1909) did little work on the Mexican and Central American walnuts themselves, his contribution is the only comparatively recent world-wide study of the genus, and the only one on the *J. nigra* section. Furthermore, he studied intensively the species which occur in Texas, New Mexico, Arizona, and northern Mexico. Consequently we must examine carefully his criteria for distinguishing species. It should be pointed out, however, that most students of *Juglans* have ignored most of Dode's species, apparently because he based his new taxa on extremely variable features, so that almost every fruiting specimen constituted for him a new species. His treatment does bring out the amount of possible variation along certain lines.

The key of Dode (1909, pp. 166–168) to species of the section Rhysocaryon is based on nuts. He states that this key has only relative value, it presumably being necessary to use the key along with vegetative and floral features found in the descriptions. In this key he divides the species into three groups: A, nuts with ridges more or less sharp (*J. nigra*); B, nuts with ridges more or less obtuse (*J. pyriformis*, *J. elaeopyren*, etc.); C, nuts with striations (*J. mollis*, *J. torreyi*, *J. rupestris*, etc.). These features are important. They are, however, rather difficult to define, and there are wide variations within the species.

Additional but more unreliable features used by Dode in his key are the shapes of nuts, the compression of nuts, the wings of nuts, the size, shape, and number of lacunae (cavities in the outer wall of the nut as observed in a cross-section through almost the exact center of the nut, at least as used by Dode), and the height of dorsal or secondary partition (high, medium, low). On these additional features Dode has divided what most authors consider one species, *J. nigra,* into six species, and what most authors consider one or at most two species (*J. microcarpa* or *J. rupestris*, and *J. major*) into six species.

We can study *Juglans nigra*, the basic taxon for the section, as a criterion for many of these characters.

Certainly there is a decided variation in shape of nuts from tree to tree of *J. nigra*, from subglobose to depressed to elongate, these variations recognized by all American botanists as belonging to one species. Most nuts of *J. nigra* are compressed parallel to the primary partition, but the amount of compression varies.

The wings or dorsal lips of the nut along the suture, resembling those of the nuts of *J. regia*, seem to be variations on individual trees and of no value for specific distinctions in this section.

The writer has made an intensive study of the lacunae of the nuts of *J. nigra* and finds that the number and shapes of lacunae vary, not only in the nuts of trees side by side, but also from level to level of the same nut (typically 8 near the base of the nut, 4 elongate ones in the middle because of the fusion of these in pairs, then 8 toward the apex, with suppression of lacunae and intermediate conditions in different nuts). Scott (1954) has illustrations of consecutive cross sections of one nut of *J. major*, which is similar to, but somewhat less complicated than, *J. nigra*.

There is a possibility that the presence or absence of primary wall lacunae (at each end of the primary partition) may be distinctive, but more study of this feature is required.

The height of the dorsal partition, as seen in a carefully made longitudinal section of the nut along the secondary partition or, better yet, the section seen along the half of the nut following the natural dehiscence at germination, has been used by Dode in separating various species. It is true that the dorsal partition is high in all nuts of *J. nigra* observed by the writer, but the difference in height in the nuts of different species is so slight in the Latin American species, or else the variation is so great, that this feature is difficult to use.

There are other fruit features (husk and nut) not given by Dode in his key, though some of these are given in his descriptions. The writer has found the pyriform condition of the fruit (fruit with a basal or apical projecting neck or both) extremely unreliable, with fruits varying in trees side by side. The thickness of the husk is an uncertain feature, as very few fruits have been collected in the fully mature stage, with dependable notes, and the husk shrinks in drying. All Latin American fruits seem to have a husk thinner than that found in *J. nigra*. In some species, such as *J. pyriformis* and *J. olanchana*, the husk is conspicuously verrucose due to the presence of large, open, flat-topped warts. In other species, as in *J. nigra*, the warts are more numerous, smaller, raised, but not open and only give the fruit a rough appearance. In still other species the warts are very inconspicuous, partly because of the presence of numerous hairs. Strangely enough, Dode did not use the size of the fruit and nuts as criteria in his key. Although this feature must be used with caution because of the overlapping extremes due to variations on individual trees and to climatic conditions, it is important.

The length of the pistillate spike and the type of hairiness of the individual pistillate flowers are of some value.

In the staminate inflorescences the length of the catkin is in some cases useful. The position of the bract of the individual flower of the median, not basal, flowers along the catkin, seems to be important. This bract may be located: (1) at the base of the pedicel, therefore along the rachis of the catkin; (2) at the middle of the pedicel; (3) at the apex of the pedicel, hence at the base of the floral receptacle; or (4) essentially at the apex of the flower on its dorsal side just back of the two bracteoles (see illustration in Manning, 1948, *figs. 10, 11*). The term "at back of flower" is sometimes misleading and should be used only for position 4, the common condition in most species. In many cases, as explained by Manning (1948, p. 619), the position of the bract changes from the lower flowers to the median flowers of a catkin, so the lower flowers must not be used. The number of stamens seems to be a reliable feature, but there are cases where the number is higher than normal in individual flowers or plants.

In the leaves the number of leaflets is fairly constant for a species, though there may be a difference between the leaves on rapid and slow

growth. The base of the leaflet is a very important feature, whether truncate or rounded as opposed to cuneate or narrowed in some way toward the base. This feature is obscured by the oblique condition of many leaflets, and does not show well on poorly pressed specimens. In some species the leaflets are decidedly stalked.

Hairiness of twig, rachis, upper surface of leaflet, and especially of the lower surface of the leaflet are important, each species having a definite limit of hairiness. It is necessary to define terms used for pubescence. There are two basic types of hairs: solitary, gland-tipped, multicellular pale or colored hairs, and pointed, non-glandular, one-celled pale hairs. On the rachis the former may be extremely short, consisting of essentially stalked glands so that the rachis having these numerous hairs may appear glabrous unless a strong lens is used, and the rachis may be described as minutely puberulent or even glabrate; or the hairs may be medium in length so that the hairs are evident but not conspicuous without a lens, and the rachis may be described as pubescent; or the hairs may be long and conspicu-

MAP 1. Distribution of the taxa which are treated in this paper. The dots indicate localities recorded in this paper, except where distributions overlap; some of these localities are indicated by "X"; the "X" for *J. mollis* is near Monterrey, just below "2".

ous, so that the rachis may be described as villous or even hirsute. Students, of course, will vary in their interpretation, and young leaves with undeveloped hairs will be misleading. The pointed hairs, common on the lower surfaces of the leaflets, may be solitary, in pairs, or in fascicles of three or more, these, of course, representing a branched condition of one true hair. To a certain extent all young leaves of *Juglans* may have fascicled hairs on the lower surfaces of the leaflets, but only in certain species are the leaflets fascicled-hairy, or tomentose, at maturity. In *J. mollis*, and frequently also in *J. hirsuta*, the permanent fascicle of hairs seems to be growing out of a short, yellow, glandular, basal cell. Some of the fascicled hairs present on young leaves, on the rachis or lower leaflet surface, are extremely short, and are evanescent types, which must be distinguished from the permanent type, if possible.

The shapes and measurements of leaflets are, as in all such cases, of importance within certain limits, but there is some variability. A terminal leaflet appears to be present in some leaves, but not in others. A careful examination of the apparent terminal leaflet will often reveal a small stub at its base, such as one finds frequently in *J. nigra* between the two uppermost leaflets; this may be the remains of a true terminal leaflet or of the other member of the uppermost pair of lateral leaflets, only one of which persists.

The color and stoutness of the twig (youngest growth) are undoubtedly of value, but to use these characters would require extensive field studies at different times of year. In almost all members of the Mexican and Central American species the terminal bud appears to be more slender (elongate?) than that of *J. nigra*.

The writer wishes to thank the American Philosophical Society for valuable assistance in collecting material in Mexico. He also wishes to thank the curators of the various herbaria for their generosity in lending specimens and sending photographs; especially Dr. O. Hagerup, Botanisk Museum, Copenhagen, Denmark; Dr. H. Humbert and Dr. J. F. Leroy, Muséum National d'Histoire Naturelle, Paris, France; Dr. M. Martinez and Dr. R. Llamas, Instituto de Biologia, Chapultepec, Mexico; Dr. C. Baehni, Conservatoire et Jardin Botaniques, Geneva, Switzerland; Sir Edward Salisbury, Royal Botanic Garden, Kew, England; and Dr. T. E. Hasselrot, Naturhistoriska Riksmuseet, Stockholm, Sweden.

In addition to the native species listed in the key and in the descriptions below, the Persian or English walnut, *J. regia* L., is cultivated in various regions of Latin America. There are no definite records of this species escaping from cultivation. This species has 7–9, entire, essentially glabrous leaflets, elongate, subsessile staminate flowers, glabrate somewhat irregularly dehiscent husk, and rugose nut shell with strong lips.

The following key to the native Mexican and Central American species and varieties of *Juglans* is not absolute, as there are occasional variations in individual features on certain trees or branches; a combination of characters as given in the descriptions must sometimes be used.

1. Mature leaflets about 1–1.5 cm. wide; fruit 1.2–2.2 cm. in diameter; nut 1–1.7 cm. in diameter; plants mostly of shrubby growth (leaflets 17–31, narrowly lanceolate, elongate, curved); nw. Nuevo León, Coahuila, and ne. Chihuahua. ..... 6. *J. microcarpa.*

1. Mature leaflets 2 cm. or more wide; fruit 2.3–5.5 cm. in diameter; nut 2–5 cm. in diameter; trees.

   2. Leaflets 9–15 (fruit not conspicuously verrucose; nut not sharply ridged).

      3. Leaflets and rachis both essentially glabrous (rachis with minute stalked glands visible with a strong lens); leaflets tapering at base; fruit glabrate; nut rather deeply furrowed; Mexico, Guerrero, Jalisco, Michoacan, Durango. ..... 4. *J. major* var. *glabrata.*

      3. Leaflets beneath and rachis both strongly fascicled-hairy or glandular-pubescent; fruit mostly pubescent; nut striate.

         4. Rachis whitish-pubescent; leaflets pubescent beneath with solitary hairs or rarely in part fascicled-hairy, not fascicled-hairy above, tapering at base; terminal leaflet mostly present; nut 1.8–2.8(–3) cm. in diameter; Chihuahua, Sonora, Sinaloa, Durango. ..... 4. *J. major.*

         4. Rachis fascicled-hairy or rarely brownish glandular-pubescent; leaflets fascicled-hairy beneath, and slightly so above, truncate at base, though often oblique; terminal leaflet mostly absent; nut 2.5–4.5 cm. in diameter; Nuevo León, San Luis Potosí, Hidalgo, Tamaulipas, Guanajuato, Puebla. ..... 3. *J. mollis.*

   2. Leaflets on larger leaves (16–)17–31; (fruit in some species conspicuously verrucose with open flat-topped warts; nut deeply furrowed or sharply ridged).

      3. Leaflets truncate at base, essentially sessile.

         4. Leaflets fascicled hairy beneath; nut sharply ridged, blackish; staminate catkins 6–10 cm. long; (leaflets 16–21); Nuevo León. ..... 2. *J. hirsuta.*

         4. Leaflets glabrate, or pubescent beneath with solitary or paired hairs; nut deeply furrowed with flat-topped broad or rarely narrow ridges, dark brown; staminate catkins 18–22 cm. long (unknown in *J. steyermarkii*).

            5. Leaflets (19–)21–31, lanceolate or oblong-lanceolate, glabrate beneath; lateral veins mostly leading directly to sinuses, and then sending a branch to the tooth; husk strongly verrucose with open, flat-topped warts, glabrous; Vera Cruz. ..... 1. *J. pyriformis.*

            5. Leaflets 16–18, ovate, strongly whitish-pubescent beneath; lateral veins mostly leading directly to the teeth; husk not strongly verrucose, pubescent; n. Guatemala. ..... 7. *J. steyermarkii.*

      3. Leaflets strongly tapering at base or decidedly stalked; (fruit strongly verrucose with open warts; leaflets 17–23; staminate catkins (15–) 18–30, the bract on the pedicel).

         4. Leaflets and rachis appearing glabrous (but with strong lens rachis appearing covered with stalked glands); leaflets inconspicuously lepidote, decidedly stalked; Guatemala and Honduras. ..... 6. *J. olanchana.*

4. Leaflets beneath strikingly fascicled-hairy, conspicuously lepidote under the hairs, subsessile; rachis whitish-villous; Colima and w. Jalisco. ..... 6. *J. olanchana* var. *standleyi*.

A list of collections is recorded for each species to validate the distribution. In each state the localities are arranged in general from north to south. Also recorded are the herbaria wherein the specimen may be found. Whenever staminate flowers, pistillate flowers, immature fruit, or mature fruit as well as leaves are present, indication is made by the abbreviations "stam.," "pist.," "im. fr.," or "fr." respectively; "fr. only" indicates that no leaves are present. When the material is sterile no symbol is given. The following are the herbaria and their abbreviations as used in this paper: AA — Arnold Arboretum; AMH — Amherst College; BH — Bailey Hortorium; BPI — fruit collection, Bureau of Plant Industry, U.S.D.A.; CAL — University of California; CM — Chicago Museum of Natural History; CU — Cornell University; GH — Gray Herbarium; ILL — University of Illinois; MICH — University of Michigan; MO — Missouri Botanical Garden; MS — Michigan State College; NC — University of North Carolina; NY — New York Botanical Garden; OKLA — University of Oklahoma; P — Philadelphia Academy of Sciences; REY — H. C. Reynolds; TENN — University of Tennessee; TEX — University of Texas; US — U. S. National Herbarium; USDA — U. S. Department of Agriculture; USFS — U. S. Forest Service; Y — Yale University; WEM — the writer's personal herbarium, Bucknell University; COP — Botanisk Museum, Copenhagen, Denmark; GEN — Conservatoire et Jardin Botaniques, Geneva, Switzerland; HON — Escuela Agricola Panamericana, Tegucigalpa, Honduras; K — Royal Botanic Garden, Kew, England; MEX — Instituto de Biologia, Chapultepec, Mexico; PAR — Muséum National d'Histoire Naturelle, Paris, France; ST — Naturhistoriska Riksmuseet, Botaniska Avdelningen, Stockholm, Sweden.

The vernacular name for all species of *Juglans* throughout Latin America is *nogal;* for small walnuts, such as *J. microcarpa*, as well as for hickories, the name is *nogalillo*. The nut is usually called *nuez*, or *nuez encarcelado*. There are undoubtedly other names, but most of these are not recorded. Martinez (1937) lists alphabetically the vernacular names of plants including walnuts in different states, but there is some uncertainty as to which species they apply.

1. **Juglans pyriformis** Liebmann, Vid. Med. Naturh. Copenhagen **1850**: 78–80. — Dode, Bull. Soc. Dendrol. France **1909**: 198–199. — Standley, Contrib. U. S. Nat. Herb. **23**: 165. 1920, pro parte.

Tree tall, deciduous; twigs quite stout, chocolate-brown to gray-brown, conspicuously lenticellate, glandular-pubescent on hairy-leaved plants, soon becoming glabrate, or glabrous or nearly so on glabrate-leaved branches; pith light brown; terminal bud elongate, slender, light brown; lateral buds superposed, brown and glabrate or some of them grayish-pubescent; leaves large, 40–60 cm. long, up to 30 cm. broad, unequally or sometimes equally pinnate; rachis brownish-villous or -pubescent on

some trees, minutely glandular-puberulent or with scattered minute appressed fascicled hairs on others, or even glabrous; leaflets 18–31, alternate, subopposite, or opposite, lanceolate or oblong-lanceolate, the principal ones 10–15 cm. long and 3–4.5 cm. wide (12 × 3; 15 × 4.5), sessile or subsessile, somewhat cordate to sub-truncate to rounded, rather oblique at the base, tapering to a long-acuminate tip, the margin slightly reflexed-falcate, serrulate, glabrous or apparently so on the upper surface (though on some specimens with minute scattered fascicles of hairs), on the lower surface brownish-pubescent on the main veins on leaves of some trees, on others nearly glabrous or sometimes with many scattered appressed fascicles of hairs on larger and some of the smaller ones; young leaflets densely dark-lepidote, especially on the lower surface, not tomentose, and usually without fascicled hairs, older leaflets inconspicuously lepidote with scattered minute dark glands; staminate catkins 18–22 cm. long (–37 cm. fide Dode), with rather large, distant flowers, the bract small (1 mm.), rounded, only slightly pubescent, at the apex of the pedicel (at base of the receptacle of the flower); stamens 43–58, the anthers glabrous; pistillate flowers unknown; fruit subglobose to pyriform-subglobose, 4.5–5 cm. long, 4.3–4.7 cm. in diameter, nearly glabrous, conspicuously verrucose with large open flat-topped grayish or light-brown warts; nut large, hard, thick-shelled, subglobose to depressed subglobose, compressed, 3.5–4 cm. long and 4 × 3.5 to 4.5 × 4 cm. in diameter, strongly longitudinally ridged, the ridges narrow but rounded at top (obtuse, fide Dode) to rather broad and flat, with sharp-angled edges, the furrows rather deep especially at the base of the nut, the whole often resembling a deep striate condition; dorsal partitions high; lacunae large, but otherwise much as in *J. nigra*.

VERNACULAR NAME: *Nogal*, though that name not recognized at Orizaba, where the tree was not well known.

VERA CRUZ: Coscomatepec, Gulf of Coscomatepec, near Mt. Orizaba, *F. Liebmann 3776* fr. (TYPE-NUMBER — COP, CM, K, GEN). — Coscomatepec, in village, alt. about 4200 ft., *W. E. & M. S. Manning 53808* fr., *53809*, *53810* (WEM). — Orizaba, *Botteri 879* stam. (K, PAR). — Orizaba, mountain sides near town, *Witmer Stone 80* (P). — Santa Ana (about 10 miles north of Orizaba), *Borngeau 3032* fr. (PAR). — Trail up Cerro San Cristobal, Orizaba, alt. 4200 to 5000 ft., *W. E. & M. S. Manning 53736*, *53745*, *53773* fr., *53794*, *53796*, *53799* (WEM). — Cultivated in Alamda, Orizaba, *W. E. & M. S. Manning 53788* fr. (WEM). — East of San Andres Tuxtla, nw. of Catemaco, near Cerro Tapalcapan & C. Mastagaga, tropical evergreen forest, *Dressler & Q. Jones*, in 1953, nut only (WEM).

This species, the first to be described for Mexico, and the most distinctive, has not been well understood in the New World. This is probably because so few specimens have been collected — none between 1890 and 1953 — and because no specimens existed in the American herbaria until very recently. The description of Standley (1920) does not clearly indicate this species, as he lists a different number of leaflets and combines the features of various taxa. The writer fully understood the species

only when he had collected from trees in the Orizaba and Coscomatepec region 112 years after Liebmann was there.

Liebmann clearly distinguished this species from *J. nigra*. *Juglans pyriformis* has more numerous, narrower, more finely serrate, less hairy leaflets and lighter colored, less sharply ridged nuts with more prominently verrucose husks. The internal structure of the nut is not distinctive, though Liebmann thought that the lacunae were larger. Dode (1909) also stressed the surface of the nut.

This species differs from all other Mexican species in the larger number of narrow leaflets and in its conspicuously verrucose husk, though there is some overlapping in the number of leaflets. The staminate catkins are longer than those found in all other species except *J. olanchana* var. *standleyi*. The large nut is typically more deeply grooved than that of *J. mollis* and *J. major*. In the type-collection of *J. pyriformis* the narrow, rounded ridges approach those of *J. hirsuta*; the nut of the latter species has a few or several broad ridges, but there are always more of the narrow, sharp, broken ridges present in the darker nut. In general, the features appear to combine features found in *J. hirsuta*, *J. mollis*, and *J. major* var. *glabrata*, with the differences noted above. Discussion of the relationship between *J. pyriformis* and the Central American species will be found under *J. olanchana*.

There is a variation in the hairiness of the rachis which is quite striking, and the writer at first thought that the two conditions represented two different species. The trees at Coscomatepec, as far as collected, have brown-villous rachises; some of the trees near Orizaba have villous rachises, while others have glabrous rachises; all have nearly identical shapes of leaflets and nearly identical fruits where collected.

It is surprising that this species appears to grow in such a limited area: within a range of less than 125 miles. Part of this seemingly limited range is due to a lack of collecting. Until the collection of Dressler and Jones in 1953 the range had been 40 miles. The species is so closely related to *J. olanchana* of Guatemala and Honduras that it must occur somewhere in the mountains of the isthmus of Tehuantepec and northwest, an area not well known botanically. It is significant that *Engelhardtia mexicana*, a member of the Juglandaceae which occurs with *Juglans pyriformis* on the same slope of Cerro San Cristobal close to Orizaba (see Miranda, 1946, where he at first considered *E. orizabensis* a distinct species), has been collected by Dr. A. J. Sharp and Dr. E. Hernandez X. on the isthmus northeast of Juchitan and north of Niltepec, on the divide of the Sierra del Sur near the headwaters of the Rio Coatzacoalcos.

2. **Juglans hirsuta** Manning, sp. nov.* (Amer. Jour. Bot. 35: 616. 1948, nomen subnudum).

* **Juglans hirsuta** Manning, sp. nov. Ramuli glanduloso-pubescentes; gemmis terminalibus gracilibus; foliis paripinnatis; rhachi valde rufescente-glanduloso-hirsuta; foliolis 16–22, 2.5–6 cm. latis, ovato-lanceolatis, sessilibus, basi truncatis venis supra glanduloso-pubescentibus, subtus pilis plerumque fasciculatis; fructibus 3–4.7 cm. dia-

Juglans mexicana sensu Sargent, Trees and Shrubs **1**: 1–2, *pl. 1.* 1902, pro parte.

Juglans mollis sensu Dode, Bull. Soc. Dendrol. France **1909**: 197, pro parte. — sensu Standley, Contrib. U. S. Nat. Herb. **23**: 165. 1920, pro parte.

Large, rather spreading deciduous tree; young twigs reddish brown, glandular-pubescent or -hirsute, sometimes partly fascicled-hairy, becoming gray-brown the second season; pith light brown; terminal bud slender, elongate, grayish-tomentose; leaves large, equally or sometimes unequally pinnately compound, true terminal leaflet usually absent; rachis strongly glandular-villous or hirsute, the hairs brown, with a few scattered fascicled hairs, the latter more prominent on younger leaves; leaflets mostly 16–21, rarely 14–23, opposite or subopposite, sometimes alternate, medium, rather thick, somewhat rugose, ovate to ovate-lanceolate to oblong-lanceolate, 2.5–6 cm. wide and up to 15 cm. long, the apex abruptly long-acuminate, the margin finely to coarsely serrate, the teeth often incurved, somewhat blunt, the lateral veins mostly leading directly to the sinuses and then sending a branch to the tooth; the middle leaflets sessile or nearly so, truncate to rounded at the base, commonly oblique, the upper surface commonly glandular-pubescent on the principal veins or over the whole surface, not fascicled-hairy, sometimes becoming glabrate, the lower surface inconspicuously lepidote, strongly tomentose with whitish fascicled hairs mixed with brown glandular hairs and with solitary and paired sharp-pointed whitish hairs (on surface and veins), the midrib and frequently the strong lateral veins densely brownish glandular-hairy; staminate catkins 6–10 cm. long, the flowers not especially crowded, with short (1–1.5 mm. long) ovate-lanceolate whitish-tomentose bract located on the back of the flower, the perianth consisting of the bract, 2 bracteoles, and 4 or sometimes 6 sepals; stamens 20–34; pistillate flowers few, tomentose with frequent to numerous glandular hairs appearing through the fascicled ones; fruit medium to large, 3–4.7 cm. in diameter, globose to somewhat pyriform-subglobose or oval, strongly glandular-pubescent or villous, especially when young, not conspicuously verrucose-punctate because of hairs but at complete maturity very finely and densely minutely verrucose, not so prominently so as in *J. nigra*; nut dark reddish brown or mostly blackish, somewhat compressed, about as high as broad, (2.5–)3–4 cm. in diameter with numerous interlacing irregular flat-topped to rather narrow-topped ridges or frequently a mixture of the two, the furrows rather deep, in general appearing sharp-ridged, and strongly resembling the nut of *J. nigra*; dorsal partition rather high; secondary wall cavities prominent, varying from 4–8 at different levels, as in *J. nigra*, the primary wall cavities absent.

VERNACULAR NAMES: *nogal, nogal encarcelado.*

NUEVO LEON: Potrero, Alamo, 5 miles south of Villaldama, at mouth of canyon and in narrow canyon in the mountain along stream with *Platanus*, *W. E. & M. S. Manning 53354* fr., *53358* fr., *53359* fr., *53366* fr., *53368* fr., *53369* fr.,

metro, glanduloso-pubescentibus; nuce subfusca, 3–4 cm. diametro, extus rugosissima, rugis asperatis etiam subplanis.

53370 fr., *53371* fr., *53372* fr. (WEM). — Monterrey, canyons in Sierra Madre above city, alt. 2500 ft., *Canby, Sargent & Trelease 223* or *123a* stam., pist., fr. (AA, K, MO, US); *Pringle 10214* stam. (CAL, CM, COP, CU, GH, K, MEX, MO, MS, NY, P, ST, US); *Pringle 10374* fr. (TYPE-US; ISOTYPES-GH, MICH, Y); *Sargent*, in 1887, pist. (AA); unknown collector *18*, *"nogal encarcelado"*, fr. (P). — Monterrey, Sierra de la Silla, alt. 1700 ft., *Pringle 11178* fr. (CM, GH, K, MO, NY, US). — Monterrey, Canon Diente in Sierra Madre, *C. H. & M. T. Muller 63* fr. (AA, CM). — 3 miles west of Monterrey, Chipinque Mesa, base, alt. about 2000 ft., *W. E. & M. S. Manning 53336* fr. (WEM); same general locality, base to half way up to mesa, alt. 2000 to 3000 ft., *W. E. & M. S. Manning 53347*, *53341* (WEM). — 3 miles west of El Cercado (which is 2 miles south of Villa Santiago, 25 miles south of Monterrey), Hacienda Vista Hermosa, Horsetail Falls (Cola de Caballo), alt. about 2500 ft., *W. E. & M. S. Manning 53129a* fr., *53129b* fr. only, *53131* fr., *53132a*, *53132b*, *53132c*, *53132d*, *53132e* all fr. only (WEM); *A. Dyck*, Nov. 1954, fr. only (WEM); *Rowell & Barkley 16MS65* (TEX); *White 1633* (MICH); above Horsetail Falls, alt. 3000 to 4000 ft., *W. E. & M. S. Manning 53171a* fr., *53171b* fr. only (WEM). — Road from Linares to Galeana, along stream near base of canyon, alt. about 2000 ft., *W. E. & M. S. Manning 53187* (WEM).

Juglans hirsuta has been confused by various authors with *J. pyriformis*, *J. mollis* and *J. mexicana*, and yet it is probably more closely related to a very different species. The writer, at first confusing the Monterrey specimens collected by several botanists with *J. pyriformis*, and then with *J. mollis*, next decided that some of the specimens collected in the Jacala region of Hidalgo were conspecific with specimens from Monterrey because of the glandular-pubescent leaf rachises and fascicled-hairy lower leaflet-surfaces, though the nuts, where available, seemed somewhat different. Field studies by the writer of trees south of Monterrey, south of Galeana, and south of Jacala, showed at once that the nuts at Monterrey were quite different from those in the other regions. But abundant mature nuts of the Monterrey trees were not available until the fall of 1954 when, at the request of the writer, Miss Annabelle Dyck, of Monterrey, secured material from Horsetail Falls and sent it to the writer. These mature nuts are black, sharply ridged, and practically identical with those of *J. nigra*, although a few broad ridges are present on many of the nuts (this condition occasionally occurs on certain trees of *J. nigra*). It is possible that *J. hirsuta* may be a hybrid offspring of *J. nigra* and *J. mollis*, the ranges of which no longer overlap. Specimens collected by the writer at Potrero have small nuts similar to those of *J. hirsuta*, but the hairs on the rachises of the leaves of several of the trees are not as brown, and the fascicled hairs on the lower surfaces of the leaflets are rare. These trees, the leaves of which at first looked like those of *J. major*, are considered as variants of *J. hirsuta*, but they are similar to the small-fruited *J. nigra* of southern Texas. The features separating *J. hirsuta* from *J. nigra* are primarily vegetative ones: the striking brown-glandular hirsute leaf rachises, the fascicled hairs underneath the leaflets, the more nearly truncate leaflet-bases, the more slender terminal buds, and the less definitely verrucose husks of the fruits. The writer recognizes *J. hirsuta* until further studies

can be made in Texas and Nuevo León to settle the relationship between the two taxa.

The sharply ridged nuts of *J. hirsuta* are different from those of all other species of Mexico and Central America, although immature nuts are confusing. Some of the nuts of *J. pyriformis* have, however, rather narrow ridges with rounded tops. The leaves are typically different from those of *J. mollis*, averaging more numerous leaflets and having villous instead of fascicled-hairy rachises with many of the pointed hairs beneath the leaflets solitary or paired instead of mostly in fascicles. However, the rachises of the leaves of certain specimens of *J. mollis*, especially those from near Jacala, Hidalgo, have glandular hairs, as in *J. hirsuta*, and these hairs are only slightly shorter than those of *J. hirsuta*. Leaflets of *J. hirsuta* do not seem to have fascicled hairs on the upper surface such as are found in *J. mollis*; the constancy of this feature will have to be studied (see note under *J. mollis*).

The distinctions between *J. hirsuta* and *J. pyriformis* have been discussed under the latter species. *Pringle 11178* has leaves which closely resemble those of *J. pyriformis* in shape of leaflets, but the leaflets are fascicled-hairy beneath, the husk is not strongly verrucose, and the nut is the smallest of all of the collections of *J. hirsuta*, hence much smaller than in *J. pyriformis*.

Some Mexicans told the writer that the nuts of *J. hirsuta* are not used as food by the natives. Farmers above Horsetail Falls, however, stated that the nuts are occasionally used. The trees are local, the nuts are hard to crack, and so the use as food is not significant. Good varieties of *J. nigra*, however, would probably grow where *J. hirsuta* is native. Whether these trees could compete under cultivation with the pecan, which, incidentally, was planted as an orchard tree in the exact region under discussion, is questionable.

3. **Juglans mollis** Engelm. in Hemsley, Diagnoses plantarum novarum vel minus cognitarum mexicanarum et centrali-americanum. Pars 3: 54. 1880. — Dode, Bull. Soc. Dendrol. France 1909: 197, pro parte. — Standley, Contrib. U. S. Nat. Herb. 23: 165. 1920, pro parte.

Juglans mexicana S. Watson, Proc. Amer. Acad. Arts and Sciences 26: 152. 1891. — Sargent, Trees and Shrubs 1: 1, *pl. 1*. 1902, pro parte.

Medium-sized tree; young twigs densely fascicled-pubescent or partly brown-glandular pubescent, very rarely brown glandular-pubescent, becoming glabrate, mostly dark brown, the second year's growth gray-brown with scattered prominent lenticels; terminal bud slender, brown- or gray-tomentose; pith light brown; leaves alternate, equally or sometimes unequally pinnately compound, terminal leaflet, when present, with stub of other leaflet at its base; rachis, usually tomentose with numerous persistent spreading fascicled hairs, especially beneath, in rare cases becoming glabrate or, in trees of some regions, densely pubescent with short brown glandular hairs, the fascicled hairs few; leaflets 10–14, rarely 8–16, opposite or alternate, sessile or subsessile, broadly ovate to ovate, occasionally

ovate-lanceolate or elliptical-lanceolate, the larger ones 6 × 3, 8 × 3.5, 8.5 × 4, 10 × 4 or 15 × 5 cm. long and wide, truncate to rounded at the base, but frequently oblique, rather abruptly long-acuminate at the apex or tapering from the middle to the apex, finely or coarsely serrate, the upper surface glabrate, with minute appressed fascicled hairs along the midrib and principal side veins, lepidote on the lower surface with rather prominent golden glands and tomentose on the midrib, veins, and surface proper with fascicles of spreading hairs, each fascicle with a short yellowish glandular stalk, solitary pointed hairs apparently rare, the midrib fascicled-hairy or rarely in part brown-glandular pubescent; staminate catkins 8–10 (rarely 10–16, in *Salazar*) cm. long, slender, the flowers rather small, the individual floral bracts small, whitish tomentose, on the backs of the flowers; stamens 25–30 (rarely 87, in *Salazar*); pistillate flowers few, densely tomentose; fruit globose to subglobose, sometimes pyriform, the husk 3–4(–8?) mm. thick, at first usually covered with fascicled hairs, but in some cases with short brown-glandular hairs, becoming glabrate, usually very inconspicuously verrucose, 3–5 cm. in diameter, 3.5–5(–6, fide Sargent?) cm. long; nut globose to subglobose, somewhat compressed, 2.5–4.5 cm. in diameter, 2.8–4 cm. long, reddish brown, shallowly to deeply striate, that is, with broad flat to rounded longitudinal ridges, the grooves rather shallow, but strong, occasionally forked and interlacing, the nut very rarely with dorsal "lips" or "wings"; dorsal partition "rather low" to rather high; lacunae 8–4, depending upon the level, not especially large, the primary wall lacunae mostly absent, but present or indicated by dark areas in some of the larger nuts.

VERNACULAR NAMES: *nogal; nogal encarcelado; nuez meca* (fide Martinez).

NUEVO LEÓN: 3 miles west of Monterrey, near top of Chipinque Mesa, alt. about 4000 ft., *W. E. & M. S. Manning 53344, 53345* (WEM). — West of Galeana, at foot of Cerro Potosí, in arroyo near Ojo de Agua, alt. 5800 ft., *A. J. Sharp 45675* (TENN). — 15 mi. sw. of Galeana, Sierra Madre Oriental, *C. H. & M. T. Muller 428* stam., pist. (AA, CM, MEX, MICH, NY, US). — 15 mi. sw. of Galeana, Mesa de la Camisa, *C. H. & M. T. Muller 1156* im. fr. (AA, CM, MEX, MICH, NY, US). — near Tarey (e. of Pablillo, which is 20 mi. s. of Galeana), rainy area or fog belt, alt. about 7200 ft., *W. E. & M. S. Manning 53244, 53250* fr., *53268, 53331* (WEM). — Dulce Nombres and into Tamaulipas, just east of border, 24° N., 99.5°–100.5° W, Sierra Madre Oriental, *Meyer & Rogers 2642* im. fr. (MO, WEM). TAMAULIPAS: above Gomez Frias, Cerro del Tigre, Rancho del Cielo, alt. 1200m., *Sharp, Hernandez, Crum & Fox 50246* (NC, TENN, WEM). — SAN LUIS POTOSÍ: Mineral de Guadalcazar. *M. Villada* in 1892 (MEX). — Villar (40 mi, ne. of San Luis Potosí), alt. 5000 ft., *J. Graber 219* fr. (US). — San Luis Potosí (or Alvarez?, see *Carya illinoensis, Parry & Palmer 835 1/2*), *Parry & Palmer 835* fr. (TYPE-K; ISOTYPES-GH, MO, P, US). — *Alvarez, Palmer 68* fr. (AA, CM, GH, MEX, MO, NY, US, BPI, USDA). — San Jose Pass (near Villar?), *Pringle 3322* fr. (TYPE of *J. mexicana* Engelm.) (AA, AMH, CAL, CM, GH, MEX, MO, MS, NY, US, Y, GEN, K, BPI). — Minas de San Rafael, Sierra Tablon (near Cerritos?), *Purpus 5502* im. fr. (CAL, CM, GH, NY, US). — 16–18 mi. by road e. of Ciudad del Maiz, oak forest, alt. 3800 ft.,

W. E. & M. S. Manning 53424, 53432 fr., *53426* (WEM). — 23 m. e. of Ciudad del Maiz, oak forest, alt. 2200 ft., *W. E. & M. S. Manning 53440* (WEM). — 4 mi. w. of Pendencia (about 10 mi. ne. of Ciudad del Maiz), alt. 4600 ft., *Graber 206* fr. (US). GUANAJUATO: Palmillas, Río Palmillas, 25 km. ne. of San Luis de La Paz, *Little 11093* (USFS, WEM). HIDALGO: n. of Jacala, *Clark 7029* (OKLA). — 6–10 mi. n. of Jacala, alt. 4900–5400 ft., *W. E. & M. S. Manning 53582* fr., *53594* fr., *53595* fr., *53600* (WEM). — Jacala, alt. 4400 ft. *Chase 7624* fr. (CM, GH, ILL, MO, NY, USDA); *Lyonnel 1304* fr. (US). — 6–7 mi. s. of Jacala, Sierra Madre Oriental, alt. 5000–5400 ft., *Reynolds 6826* fr. (REY, WEM); *W. E. & M. S. Manning 53641, 53643* fr., *53645, 53646, 53647* fr., *53648* fr. (WEM). — 13 mi. s. of Jacala, alt. 6200 ft., *W. E. & M. S. Manning 53636* (WEM). — SW. of Jacala on road to Zimapán, district Jacala, alt. 1500 m., *Moore & Wood 3946* fr. (BH, WEM). — La Majada, on route 1, 229 or 222 km. n. of Mexico City (about 20–29 mi. s. of Jacala), alt. 6400 ft., *Sharp, Hernandez X., Crum & Fox 5020* (NC, TENN, WEM); *W. E. & M. S. Manning 53623, 53624* (WEM). — Between Zacualtipán and Olatla, Río Panotlán, on road to Metzitlán, alt. 1600–2000 m., *Moore 5328* fr. (BH, CAL, WEM), *3241* im. fr. (BH, GH), *2386* stam. (BH, GH). — NE. of Molango, slopes below Chalma on trail from Molango to Calnali, *Moore 3013* im. fr. (BH, GH). — Sierra de la Mesa (probably w. of Ixmiquilpan), *Rose, Painter & Rose 9095* fr. (GH, NY, US). PUEBLA: Zacapoaxtla, *J. Salazar*, in 1913, stam. (MEX, US).

This species has a wide distribution and has been well known in Mexico ever since it was first described. It is difficult to separate it sharply from some of the other species. *Juglans mollis* differs from *J. pyriformis* in having fewer, broader, more fascicled-hairy leaflets, shorter staminate catkins, less verrucose husk and less deeply grooved nuts. Vegetatively, trees of this species in certain regions are similar to *J. hirsuta*, as discussed under that species and below, but the nuts are different. The nuts of *J. mollis* are rather similar in external markings to those of *J. pyriformis*, *J. major*, and *J. olanchana* var. *standleyi*, though there are differences in size and depth of grooves. Because of the extent of variation no single feature will hold throughout but two or more must be used in combination. The distinctions in nuts and vegetative features are discussed under the other species and are given in part in the key to the species.

The fascicled-hairy lower surface of the leaflets is rather constant in the species. The rachises found on the type-specimen are strongly fascicled-hairy, and are similarly hairy on many specimens. In southern Nuevo León and in Hidalgo the rachises on some of the trees are strongly glandular-pubescent as in *J. hirsuta* and, as discussed under that species, it is difficult to distinguish the two species except where fruiting.

The rather moldy specimen collected on the Mesa de la Camissa, 15 miles southwest of Galeana (*Muller 1156*), called *J. mollis* by the writer largely because of its range, resembles *J. major* var. *glabrata* in being much less hairy throughout (leaflets, rachis, fruit) and having essentially tapering leaflet bases but probably represents an aberrant collection from abnormal branches of *J. mollis*; mature fruit is lacking.

The original description of *J. mexicana* by Engelmann — "foliage as in *J. nigra*, but with the pubescence of *J. cinerea* —," i.e., with glandular-

villous rachis and fascicled-hairy lower leaflet-surface, suggests *J. hirsuta*, not *J. mollis*. However, although the specimens of *Pringle 3322* (the type-collection of *J. mexicana*) in some herbaria have glandular-pubescent rachises, such as occur in *J. hirsuta* (also in *J. cinerea* and *J. nigra*), specimens in some other herbaria have fascicled-hairy rachises, and in others glabrate ones. The nut is clearly that of *J. mollis*, not *J. hirsuta*, though the lips on the nut are unusual for any species. This collection is the one illustrated by Dode for *J. mollis* (1909, p. 175). Sargent (1902), in his description and excellent illustration of *J. mexicana*, combines collections of *J. hirsuta* and *J. mollis*; in general, the flowers are *J. hirsuta* (*Pringle 10214*, Sargent), and the fruit is *J. mollis* (*Pringle 3322*); the figure of the leaves with the unusual leaflet-bases was made from an atypical specimen of *Pringle 3322*.

Two collections by the writer (*53250* and *53645*), presumably variants of *J. mollis* because all other trees in the region are that species, do not have fascicled hairs on the upper surfaces of the leaflets.

A collection of nuts at the Arnold Arboretum, marked *J. mexicana*, presumably sent by Newton Pierce, of U.S.D.A., who was stationed in California, are *J. mollis*, though two nuts do not belong to that species and may have been mixed in the herbarium from a collection from Colombia. Unfortunately the source in Mexico is not given.

The writer has not recorded *J. mollis* from Durango. However, certain specimens called by the writer *J. major* forma *stellata*, especially *Palmer 448* and *476*, appear similar to *J. mollis* in leaflet-base and hairiness; the rachis is glandular-pubescent as in *J. major* or certain trees of *J. mollis*. The nut is smaller than in *J. mollis*, and has surface markings closer to *J. major*. The trees of this region need further study.

Juglans mollis and *J. hirsuta* both grow in Nuevo León, but not together. The latter appears to grow at lower elevations (or possibly in different habitats: stream valleys instead of mountain fog belts). Thus at Chipinque Mesa, near Monterrey, *J. hirsuta* grows at the foot of the mesa at about 1800 ft. elevation and *J. mollis*, several miles away by winding road, grows near the top of the mesa at about 4000 ft. elevation, at the most northerly point in the range of the species. Unfortunately the trees of the latter collected by the writer were not fruiting, and the identification is not positive. A similar situation occurs with respect to the Linares (*J. hirsuta*) and Pablillo (*J. mollis*) collections.

4. **Juglans major** (Torr.) Heller, Muhlenbergia 1: 50. 1900. — Standley, Contrib. U. S. Nat. Herb. 23: 165. 1920. — Johnston, Jour. Arnold Arb. 25: 436. 1944.

Juglans rupestris Engelm. ex Torr. β *major* Torr. in Sitgreaves, Rep. Zuni & Colo. 171, *pl. 16*. 1853. — Sudworth, Poplars, Principal Tree Willows and Walnuts of the Rocky Mountain Region, U.S.D.A. Tech. Bul. 420: 102. 1934.

Juglans elaeopyren Dode, Bull. de l'Herb. Boissier, II. 7: 247–284, *figs. 1–3*. 1907.

Juglans neomexicana Dode, Bull. Soc. Dendrol. France **1909**: 191. 1909.
Juglans arizonica Dode, loc. cit. 193.
Juglans torreyi Dode, loc. cit. 195.
Juglans microcarpa Berl. var. *major* (Torr.) Benson in Benson & Darrow, Trees and Shrubs of Southwestern Deserts, ed. 2, 110. 1954.

Small or large tree, sometimes with several trunks; young twigs light to dark brown, finely whitish glandular-pubescent or -puberulent, the second year's growth slender, usually ashy gray or sometimes yellowish brown, with rather prominent lenticels; terminal bud slender; leaves unequally or sometimes equally pinnately compound, the terminal leaflet usually present; rachis usually finely whitish glandular-pubescent, rarely glabrate, very rarely (on special branches: young growth?) glabrous; leaflets 9–15, rarely to 17, opposite or alternate, subsessile or short-stalked, oblong-lanceolate to ovate, the larger ones usually 2–3.4 cm. wide (or rarely 1.5–1.9 cm.), and 6–11.5 (rarely –13) cm. long, typically tapering at the base, characteristically oblique, acuminate at the apex, commonly tapering from the middle of the leaflet to the apex, definitely serrate, but varying from finely to coarsely serrate; youngest leaflets mostly glandular-puberulent, very rarely fascicled-hairy, the mature ones usually lightly puberulent above and densely whitish glandular-pubescent beneath as well as densely golden-glandular (lepidote), varying to partly fascicled-hairy (forma *stellata* below), very rarely glabrate; staminate catkins 7–17 cm. long, slender, the individual floral bracts small, whitish-tomentose, on the backs of the flowers; sepals, in addition to the bract and two bracteoles, 4–8; stamens 30–50; pistillate flowers solitary or few, glandular-pubescent; fruit globose to rather oval, the husk rather thin, finely glandular-pubescent, inconspicuously verrucose, usually 2.3–3 (rarely 1.9) cm. in diameter; nut 1.8–2.8 cm. in diameter, subglobose, slightly compressed, longitudinally striate, sometimes rather deeply so; dorsal partition varying from low to rather high, the lacunae 8–4, depending upon the level, typically well developed for the size of the nut, rarely reduced to barely more than a canal.

VERNACULAR NAMES: *nogal; nogal silvestre.*

SONORA: 5 mi. s. of Naco, San Jose Mts., alt. 6000 ft., *Wolf 2518* fr. (GH); *Mearns 1049* (NY). — Matiti (or Mababi, 10 mi. sw. of Fronteras), *Thurber 409* fr. (GH, NY). — 9 mi. e. of Imuris in canyon of Magdalena river, alt. 3100 ft., *Ferris 8778* stam., fr. (MICH, US). — NE. of Colonia Morelos, Cañon de la Mescalera, Sierra de la Caballera, alt. 4900 ft., *White 4704* (GH, NY). — Colonia Oaxaca (about 25 mi. n. of Bavispe, on Rio Bavispe), *White 464* (GH, MICH). — La Angostura, Cañon de los Otates, *White 3527* (GH, MICH, USDA). — NW. of Bavispe, Cañon International, *White 3496* (GH, MICH, USDA). — W. of Bavispe, Cañon de Bavispe, *White 2994* (GH, MICH, USDA). — Bavispe, Cañon de los Metates, *White 2824* (GH, MICH). — Bavispe, Río Bavispe, *White 2875* fr. (GH, MICH). — Santa Rosa Cañon (between Bavispe and S. Miguelito), *White 499* (MICH). — W. of Magdalena, Aqua Nuevo Arroya, El Alamo, *Kennedy 7040* fr. (CAL, CM, US). — Horconcitos, Rio Huachinera, n. of Huachinera, *White 2971* (GH, MICH, USDA). — La Chumata (a mine, e. of Sierra de San Antonio, probably in the vicinity of Banamichi), alt. 3400 ft., *Brown*, in 1905 (AA). — Between Granados and Bacadehuachi, Aguaje de

Bacatejaca, *White 2925* (GH, MICH). — Curohui, Río Mayo, *Gentry 3642* im. fr. (CM). CHIHUAHUA: Municipio de Janos, Carretas, border of Chihuahua and Sonora, alt. 4800 ft., *White 2616* (GH, MICH, USDA). — Casas Grandes, *Goldman 427* im. fr. (GH, US). — St. Diego, *Hartman 588* stam. (AA, GH, K, P). — W. of Chihuahua, mouth of Majalca Cañon, *Le Sueur 448* fr. (CAL, CM); *Le Sueur*, in June 1936, fr. (GH). — Chihuahua, alt. 1300 m., *Palmer 141* stam., pist., fr. (GH, K, MO, NY, ST). — Chihuahua, canyon near city, *Pringle 1596* stam., pist. (CAL, K, MEX, MS). — 7.5 mi. e. of Victoria, road from Jaco to Mestenas, *Stewart & Johnston 1999* fr. (GH). SINALOA: Quebrado de Platano, Sierra Monterrey, deep moist canyon in oak forest, alt. 3000 ft., *Gentry 5908* (USDA). DURANGO: Nombre de Dios, alt. 6500 ft., *W. E. & M. S. Manning 531291, 531293, 531294, 531296* fr., *531297* (WEM).

Sargent (1933) described the staminate catkins as 20–25 cm. (8–10 inches) long; the writer has examined specimens from Mexico and the United States and finds that the catkins are 7–17 cm. long as given in the description above.

Dode (1909, pp. 191–195) in his descriptions of *J. arizonica*, *J. neomexicana*, *J. elaeopyren*, and *J. torreyi* gave the number of leaflets as 8–24, 8–20, and 10–20, numbers intermediate between *J. major* and *J. microcarpa*. Studies by the writer of the isotypes of these species in the American herbaria show that the number of leaflets is 11–13 in *J. neomexicana* and *J. elaeopyren*. Isotypes of *J. arizonica* so far have not been located in the United States but most specimens of *J. major* from Arizona have 15 or fewer leaflets. *Juglans torreyi* is based on plants cultivated in France. It should also be noted that all fruits located of the isotypes of Dode's species have only immature fruits, and it is difficult to see how Dode could have described the structure of the nuts from specimens such as these.

Dode discarded the name *Juglans major* (Torr.) Heller, because in the description of the species Heller included both *J. rupestris* var. *major* Torr. and *J. californica* S. Wats. The name *J. major* (Torr.) Heller is, however, based definitely on *J. rupestris* β *major* Torr. which in turn is based on material from Arizona and New Mexico. Hence, the name *J. major* should be retained.

The writer is dividing *J. major* into two main races, the northern race being the well known typical taxon, ranging from Arizona and New Mexico to Sinaloa and Durango, and a southern race, the variety *glabrata* described below with larger, glabrate leaves and larger fruits.

The detailed description given above is for the typical species, based upon Mexican specimens, and the deviations within this taxon, considerable in extent, will be discussed first.

At the beginning should be mentioned the variation in hairiness on the lower surfaces of the leaflets. This is sufficient to make the basis for the description of a new form:

4a. **Juglans major** forma **stellata** Manning, forma nova.*

* A *J. majore* differt foliolis subtus pilis saepe fasciculatis.

A plant differing from the species in having many of the hairs on the lower surfaces of the leaflets fascicled, so that these surfaces appear somewhat tomentose. The leaflets of this form are more frequently subtruncate at the base than in the species proper.

Several sheets of specimens intermediate between the species and forma *stellata*, with a few fascicled hairs, are listed under *J. major* itself.

This form approaches *J. mollis* somewhat in leaflet structure, but the leaflets are usually smaller, the fascicled hairs usually shorter, the short, glandular hairs on the lower leaflet-surface more common, the hairs on the rachis usually paler and typically not fascicled, and the fruit and nut smaller. The leaves of this form are similar in some ways to those of *J. hirsuta*.

SONORA: 1 mi. w. of El Tigre, La Matancita, alt. 4250 ft., *White 4161* (GH, MICH). — 8 mi. from Cucurpe, fork of road to El Tigre, *Wiggins 7161* fr. (AA, US). CHIHUAHUA: 3 mi. w. Ciudad Camargo, alt. 4000 ft., *White 2284* fr. (GH, MEX, MICH, USDA). — Beyond village of Cocomorachic, Río Papagochic, District Guerrero, *Mexia 2633* im. fr. (TYPE-AA; ISOTYPES-CAL, CM, GEN, GH, K, MICH, NY, P, ST). DURANGO: Tejamen (s. of Santiago Papasquiaro), *Palmer 476* fr. (CAL, CM, COP, GH, MO, NY, US). — Santiago Papasquiaro, *Palmer 448* fr. (AA, CAL, CM, COP, K, NY, ST, US); *Nelson 4670* (GH, US).

In addition to the deviation described above there are other critical variations in rachis, leaflets, and fruit in the typical species.

The rachises on a very few specimens are glabrate or nearly glabrous, instead of pubescent. It is significant that in *White 2616* and *3527* the rachises and the leaflets are essentially glabrous in specimens in some herbaria, strongly pubescent in specimens of the same number in other herbaria.

The leaflet is usually very short-stalked, and oblique with tapering base, but sometimes the stalk is well developed, and sometimes the bases appear almost truncate above an extremely short stalk (leaflet subsessile) or above a well developed stalk. The teeth are definite but range from coarse to rather fine, though the leaflets are never revolute along the margin as *J. microcarpa*. The larger leaflets in *White 3496*, *Thurber 409*, *Kennedy 7040*, *Stewart & Johnston 1999*, *Le Sueur* in June 1936, are small and narrow, 1.5–1.9 cm. in width on the specimens observed by the writer.

The number of leaflets in Mexican collections appears to be rather constant, 9–15, rarely 17. For this reason *J. major* var. *stewartii* Johnston has been transferred to *J. microcarpa*, as discussed under that species.

In the shape of the fruit and nut (subglobose) and the lacunae of the nut (well developed), the Mexican collections appear to be rather constant where fruit is present but, since *J. elaeopyren* Dode with oval fruit and nuts has been described from Arizona, one may expect this variation from Mexico (see also *J. major* var. *glabrata* below). Dode describes the lacunae of the nut of *J. arizonica* (nuts not located by the writer) as

reduced to a canal, as in *J. microcarpa*, an unusual condition for *J. major* if fully substantiated.

The size of the fruit and nut varies within rather broad limits. Thus *Palmer 448*, *476*, *Mearns 1049*, *Wolf 2518*, and *Stewart & Johnston 1999* have fruits less than 2.2 cm. in diameter, with nuts 1.5–1.9 cm. in diameter. Some of these collections, especially the first two, have fruits of two sizes, indicating the possibility that some of the small fruits might represent abnormal collections or immature fruits. *Stewart & Johnston 1999* is listed by Johnston (1944) under *J. microcarpa,* and although the leaflets are rather long drawn out and the bases not clearly oblique, the leaflets are 14(16?) in number. The extreme on the larger size of fruit in the northern race is represented by a collection by *C. R. Biederman* from Garces, Arizona, found in the fruit collection of Arnold Arboretum. The nuts are 3.1 cm. in diameter.

In general, in the typical *Juglans major* the leaflets are 9–15, relatively narrow, whitish-pubescent beneath, as is the rachis; the nuts are relatively small (but larger than in *J. microcarpa*), striate or longitudinally ridged, with rather large lacunae as seen in cross-section of the nut.

From southern Durango to Guerrero there are trees present in scattered localities in the mountains similar to the northern race of *J. major* in having 11–15 leaflets, these short-stalked, lanceolate to ovate-lanceolate, with tapering leaflet-bases, and staminate catkins 8–16 cm. long, but differing in certain important features. This taxon, the southern race of the species, is here described as a new variety:

4b. **Juglans major** (Torr.) Heller var. **glabrata** Manning, var. nov.*

Juglans pyriformis Liebm. sensu Standley, Contrib. U. S. Nat. Herb. **23**: 165. 1920, pro parte.

Juglans glabrata Manning, Amer. Jour. Bot. **35**: 616. 1948, nomen subnudum.

Trees of this variety differ from typical *J. major* in having the leaflets and leaves commonly larger, the twig, the rachis and the leaflets appearing glabrous, the stamens 60–75, the fruit and nut larger, and the pith frequently not chambered.

Leaves 30–45 cm. long, and up to 25 cm. wide, the rachis appearing glabrous, but under a strong lens minutely and densely puberulent with extremely short-stalked brown glands, and with scattered evanescent small appressed fascicled hairs in addition to the typical sessile yellow glands, rarely completely glabrous; leaflets 2.3–3.4 cm. wide, 8–11.5 cm. long, occasionally 5.5 × 15 cm., the margin finely serrate, the lateral veins 13–22 pairs, some of them ending in the teeth, the youngest leaflets (1 cm. wide) drying dark, the lower surface grayish tomentose, soon becoming glabrate, the older leaflets with scattered, minute, brown, appressed, evanescent fascicled hairs (appearing to the naked eye as pinpoints) on the largest veins, appearing glabrous except under a very

* A *J. majore* differt foliolis et foliis plerumque majoribus, rhachi et foliolis glabris, staminibus 60–75, fructu et nuce majore.

strong lens, not at all tomentose, the fascicled hairs without glandular bases, the surface lepidote with many pale glands, rarely completely free of hairs; upper surface of mature leaflets glabrous or with scattered minute appressed fascicles of hairs along the veins; sepals of staminate flowers, in addition to bract and two bracteoles, commonly 6–8, or even 14; young pistillate flowers whitish-tomentose; immature fruit pyriform, densely to lightly fascicled hairy, the hairs minute, evanescent, to rather glabrate, about 2 flowers on each peduncle, the peduncle proper 2 cm. long, peduncle and rachis together 2.5–3 cm. long; mature fruit about 3.6 cm. in diameter, 4 cm. long, with thin husk, wrinkled when dry, very inconspicuously verrucose, subglobose to broadly ovate, with some scattered glandular pubescence; nut dark brown, subglobose to ovate, 3–3.4 cm. in diameter, 3–4 cm. long, with broad, flat-topped to rounded fairly high to shallow broken ridges, the general appearance essentially strongly longitudinally striate; secondary partition rather high, the primary wall lacunae absent.

VERNACULAR NAMES: *nogal; nogal de Uriqui* (Jalisco, fide Martinez).

DURANGO: San Ramon (80 mi. w. of Tepehuanes, nw. Durango), *Palmer 104* im. fr. (GH, K, NY, US). — Sianori, alt. 800 m., *Ortega 5350* stam. (K, MEX, US). JALISCO: Guadalajara, *Rose & Hough 4805* im. fr. (US). MICHOACAN: Coalcomán, Sierra Naranjillo, alt. 1350 m., *Hinton 13759* stam. (GH, US). MEXICO: Naranjo, district Temascaltepec, *Hinton 3807* stam., pist. (K, NY, ST, US). — Luvianos, district Temascaltepec, *Hinton 3973* im. fr. (TYPE-AA, K, US). GUERRERO: Acamixtla, n. of Taxco, *Martinez* in 1942 fr. (WEM). — 7 mi. ne. of Taxco, ravine by stream, alt. 6000 ft., *W. E. & M. S. Manning 531005* fr., *531020*, *531021*, *531023* fr. (WEM). — Chilapa, *Hernandez X. X3167* fr. only (WEM).

This variety may, upon further study, prove to be a distinct species. The writer was unable to locate trees of this taxon in the Guadalajara region. Nuts from the original collection at Guadalajara were planted in California, and fruiting trees are now found at Davis and Riverside. These trees are used as the source of understock for buddings of *J. regia*; they are reported to be subevergreen there, being without leaves for less than a month. In Taxco, wood presumably of this taxon is used locally to make fine furniture.

This taxon is similar to *J. mollis* in having 11–15 leaflets and rather large fruits. The bases of the leaflets are typically tapering in *J. major* var. *glabrata*, and rounded or truncate in *J. mollis*, but as the leaflets are commonly oblique in most species this distinction is not always evident. The lower surface of the leaflets is glabrate or with a few appressed fascicled hairs in *J. major* var. *glabrata* and tomentose in *J. mollis*. The rachis of *J. mollis* is much hairier, with either fascicled hairs or brown, glandular ones. The nuts of *J. major* var. *glabrata* are typically more deeply grooved than in *J. mollis*. As mentioned under *J. mollis*, *Muller 1156* from Nuevo León may be *J. major* var. *glabrata*; this would represent a tremendous extension of range.

The differences between *J. major* forma *stellata* and the members of the northern race of *J. major* closest to *J. mollis,* are given under the description of that form.

The true distinctions between *J. major* and *J. microcarpa* have always been problematic and many authors consider *J. major* a variety of *J. microcarpa* (or of *J. rupestris*) since they seem to intergrade in their features. One reason for this in the United States may be that *J. microcarpa* and *J. nigra* may hybridize in certain regions, such as Oklahoma, and the resulting hybrids appear to be *J. major.*

Sudworth (1934) gave in his key (prepared by W. A. Dayton) the main distinctions separating *J. rupestris* and var. *major.* In addition, Johnston (1944, p. 437) states that the leaflets of *J. major* are evidently short-petiolulate, with the bases of the leaflets strongly oblique, with one side of the blade decurrent on the petiolule for at least a millimeter, while the curved, more elongate leaflets of *J. microcarpa* are subsessile with the blade decurrent only very obscurely, if at all. The writer agrees with Johnston, in general, but believes there is some deviation in both species. Scott (1954, Plate 15, figs. 17, 18, 20, 21) illustrates the seeds of *J. major* and *J. microcarpa* as quite different and he believes that these features will always separate the two species. Preliminary observations by the writer, however, indicate that the embryo of *J. major* as figured by Scott is not typical of the species and that most of the seeds are closer to the illustration of *J. microcarpa.* Consequently, Scott's distinction does not hold. This feature, however, is worth further study. Scott made his study by filling the seed-cavities of the nut with soft metal, after which he removed the woody pericarp with strong sulphuric acid, leaving a metallic cast of the seed. The writer has cut nuts in half, then painted the seed cavity with latex, and finally removed the mold of the upper half of the seed.

Since the writer's key to the species brings out only one or two distinctions between *J. microcarpa* and *J. major,* species which grow not far from each other and which are often confused, Sudworth's key is repeated here with some changes and additions. This key applies primarily to the northern race of *J. major,* as this taxon is closer to *J. microcarpa* than the southern race.

1. Leaflets 17–23, rarely to 31, lanceolate, mostly narrowly so, about 1–1.5 cm. broad, usually falcate, finely serrate or nearly entire, subsessile, mostly rounded at the base, long tapering at the apex; fruit 12–20 mm. in diameter; nut 10–17 mm. in diameter, the lacunae of the wall much reduced; stamens about 20–30; much-branched, round-headed shrub or small tree, ranging from Texas to western Oklahoma and southeastern New Mexico into nw. Nuevo León, Coahuila, and ne. Chihuahua. ..... *J. microcarpa.*

1. Leaflets 9–15, rarely 17, oblong-lanceolate to ovate, 1.7–3.4 cm. broad, acuminate, usually coarsely serrate but sometimes finely serrate, usually short-stalked, strongly oblique, with one side of the blade decurrent on the stalk for at least a millimeter; fruit mostly 23–35 mm. thick; nut 18–30 mm. in diameter, the lacunae of the wall prominent; stamens about 30–50;

medium-sized tree, occasionally 50–60 feet high, with well-defined trunk and narrow crown, ranging from central and southern New Mexico and Arizona to Chihuahua, Sonora, Sinaloa, and Durango. ..... *J. major.*

The range of typical *J. major* is shown in the key above. Details of the range in the United States will be found in Sargent (1933), Sudworth (1934), and Benson (1944). The distribution as shown on the map in Sudworth is not accurate for Mexico. The distributions in Mexico of *J. major*, its one variety and one form is shown on Map 1 of this paper.

5. **Juglans microcarpa** Berlandier in Berl. & Choval, Diario Viage Comision de Limites baja Mier y Teran 276. 1850; Johnston, Jour. Arnold Arb. **25**: 436. 1944.

Juglans nana Engelm. Proc. Amer. Assoc. Adv. Sci. **5**: 226. 1851.

Juglans rupestris Engelm. ex Torr. in Sitgreaves, Rep. Exped. Zuni & Colorado Rivers 171, *t. 15.* 1853; Dode, Bull. Soc. Dendrol. France **1909**: 189. 1909; Standley, Contrib. U. S. Nat. Herb. **23**: 165. 1920; Sudworth, Poplars, Principal Tree Willows and Walnuts of the Rocky Mountain Region, U.S.D.A. Tech. Bull. **420**: 98. 1934.

Juglans subrupestris Dode, Bull. Soc. Dendrol. France **1909**: 191. 1909.

Much-branched, round-headed shrub or small tree; young twigs slender, orange-red and strongly lenticellate, finely whitish glandular-pubescent or -puberulent during their first winter, the second year slender, ashy gray, often puberulent; terminal bud slender; leaves moderate or small, usually unequally pinnately compound; rachis usually finely whitish-puberulent; leaflets usually 19–23, rarely 17 or more, opposite or alternate, subsessile, lanceolate or narrowly lanceolate, usually 1–1.5 cm. wide (or to 1.9 cm. in var. *stewartii*), and 5–8(–11?) cm. long, typically rounded at the base, but occasionally oblique, acuminate and long-tapering at the apex, usually falcate, finely serrate or frequently revolute and almost entire, finely pubescent beneath or rarely glabrate; staminate catkins 7–11 cm. long, very slender, the individual floral bracts small, whitish-tomentose, on the backs of the flowers; stamens 20–30; pistillate flowers solitary or few, whitish- or reddish-puberulent; fruit globose or subglobose, pubescent or puberulent, 1.2–2.1 cm. in diameter; nut 1–1.7 cm. in diameter, subglobose, longitudinally ridged or striate, sometimes with definite dorsal lips; dorsal partition rather low, lacunae typically reduced to canals or almost points.

VERNACULAR NAMES: *nogal; nogalillo.*

NUEVO LEON: Lampazos, Rancho Resendez, *Mary T. Edwards 420* fr. (CAL, MEX). COAHUILA: Cañon de San Enrique, east side of Sierra de la Encantado, nw. Coahuila, *Stewart 1390.* — Cañon del Indio Felipe, Sierra Hechiceros, close to Chihuahuan border, lat. 28° 33′, *Stewart 134A* (GH). — 6 mi. e. of El Tule, 24 km. n. of Castillon, and close to Chihuahuan border, southern foothills of igneous Sierra Hechiceros, *Stewart 482* fr. (GH). — Sabinas, *Nelson 6787* (or *6187?*) fr. (COP, ST, US). — Musquiz, Hacienda Mariposa, near Puerto Santa Ana, *Wynd & Muller 283* (GH, ILL, K, MEX, US). — Musquiz, Flores Pasture, Hac. Mariposa, *Marsh 313* fr. (GH). — Vicinity of La Noria, Sierra del Pino, *Johnston & Muller 509* fr. (GH). — Municipio de Castanos,

cañon Bocatoche, *Muller 3120* fr. (CAL, GH, USDA, WEM). — 9 mi n. of Hipolito, *Johnston 7229* fr. (GH). — Guadeloupe, *Aguirre* in 1942, pist. (NY, WEM).

This species is the smallest in stature and has the smallest fruit of any known walnut. It is easily distinguished from all other species of *Juglans* of Mexico, with the possible exception of *J. major*, by the narrow leaflets and small fruit. The differences between *J. microcarpa* and *J. major* are discussed above under the latter species and in the key given there is the range of the species in Mexico and the United States. The distribution in Mexico as shown on the map in Sudworth (1934) is not accurate.

In northwestern Coahuila and northeastern Chihuahua there are shrubs or trees intermediate in certain respects between *J. microcarpa* and *J. major*. This taxon, possibly a hybrid race, has been called *J. major* var. *stewartii* by Johnston, but because the number of leaflets is within the range of *J. microcarpa*, this variety is here transferred to that species:

5a. **Juglans microcarpa** Berlandier var. **stewartii** (Johnston) Manning, comb. nov.

Juglans major (Torr.) Heller var. *stewartii* Johnston, Jour. Arnold Arb. 25: 437. 1944.

COAHUILA: Sierra Hechiceros, Cañon del Indio Felipe, nw. Coahuila, *Johnston & Muller 1358* fr. (TYPE-GH); *Stewart 134* fr. (GH). — CHIHUAHUA: Cañon de la Madera, southeastern flank of Sierra Rica, north of Rancho de la Madera, oak pinon belt, (west of Manuel Benavides or San Carlos), tree or shrub, *Stewart 2557* (GH).

This variety has the number of leaflets 17–21 (or to 32 in *Stewart 2557*), these with long drawn out tips, as in *J. microcarpa*, but the leaflets are frequently broader (1.1–1.9 cm. wide), usually with an oblique base; the fruits average larger (1.8–2.5 cm. in diameter). In the single, probably atypical specimen of *Stewart 134* there are only 17 leaflets, but the other collections given above have higher numbers. The writer believes that *Muller 7968*, from Chisos Mts., Brewster Co., Big Bend National Park, Texas belongs to this variety; in the nuts of this specimen the lacunae are rather large.

Johnston (1944), in discussing the variety, states "A plant agreeing with the western *J. major* in its arborescent habit, large fruits, and oblique leaflet-bases, and resembling *J. microcarpa* in its numerous elongate leaflets."

6. **Juglans olanchana** Standley & Williams, Ceiba 1: 76. 1950.

Juglans guatemalensis Manning, Amer. Jour. Bot. 35: 616. 1948, nomen subnudum; in Standley & Steyermark, Flora of Guatemala, Fieldiana: Botany 24(3): 356. 1952.

Medium-sized or large tree, the bark dark and deeply furrowed; twigs dark brown, appearing glabrate, but minutely glandular-puberulent, the lenticels prominent; leaves large, mostly 45–65 cm. long and 30–35 cm.

wide, the terminal leaflet usually present; leaflets large, distant, chiefly 17–21, each 14–17 cm. long and 5–6 cm. wide, decidedly stalked, the stalk 2–4 mm. long; leaflets finely to strongly serrate, oblong-elliptic to ovate, obliquely truncate or rounded at the base above the stalk, commonly cuneate on the lower side, long-acuminate at apex, the lowest leaflets frequently small; lower surfaces of leaflets glabrate, with only a few stalked glands and a few minute fascicled hairs on midrib and a few on larger lateral nerves, inconspicuously lepidote, young leaflets with whitish pointed hairs on the smallest veins; very young leaflets drying green, with almost no fascicled hairs beneath; upper surface of leaflets glabrate; rachis glabrous or glabrate, but under a strong lens appearing densely puberulent with minute stalked glands; staminate catkins (15–)22–30 cm. long, the bracts, small, 1 mm. long, obtuse, short-hairy, essentially on the catkin-rachis at the base of the flower-stalk throughout the catkin; flower-stalk well developed, 4–5 mm. long; the bracteole-sepal ring frequently with 8 organs; stamens 61–102; pistillate flowers and immature fruits unknown; peduncle and rachis of fruiting spike together 8 cm. long; mature fruit large, subglobose-pyriform, 4.3–4.5(–5.5) cm. thick and 4.7–4.8(–5.8) cm. long, to essentially glabrous, shining greenish brown, strongly and conspicuously white punctate-verrucose (warty), with the punctations open and lenticel-like, not wrinkled in drying, the husk thick; nut reddish brown, subglobose, slightly flattened, 3.4–4.5 cm. thick and 3.2–4.2 cm. long, strongly ridged, the ridges broad, flat-topped, interrupted, rather rounded in cross-section, the furrows comparatively shallow except at the depressed base of the nut, where the ridges are sharp and the furrows deep; primary wall cavities usually well developed at all levels, frequently united with tertiary wall cavities, and at the very base of the nut uniting also with secondary wall cavities; secondary wall-cavity ridges strongly projecting into the loculus at the one-celled level and at least in one collection at the 2-celled level; secondary septa rather low.

VERNACULAR NAMES: *nogal; nuez.*

GUATEMALA: Alta Verapaz: Tucuru, *Popenoe 265a* nuts only (AA, BPI). Baja Verapaz: Finca Chejel, *Popenoe 180a* nuts only (AA, BPI). Quiche: Finca San Francisco, Cotzal, alt. 3800 ft., *Skutch 1866* fr. (AA: TYPE of *J. guatemalensis*; CM, NY). Huehuetenango: 5 mi. se. of Barillas, Sierra de los Cuchumatane, cafetal of Finca Soledad, alt. 1150 m., *Steyermark 49544* fr. (CM, WEM). — Above Democracia on trail towards Jutal, alt. 1000 m., *Steyermark 51072* (CM). Guatemala: Antigua, cultivated in finca, Standley, in 1939, nuts only (CM). — Guatemala, cultivated, *Lewis 1125* stam. (CM); *Morales 624* stam. (US).

HONDURAS: Olancho: Catacamas, common in moist forest along rio de Catacamas, alt. 450 m., *Standley 18159* fr. (TYPE-CM, HON). — *Standley 18149* stam. (CM, HON). Morazan: Mont. de la Flor., Rio Guarabuqui, *Molina A-3009* fr. (CM). — Along river, alt. 2600 ft., *C. & W. Von Hagen 1271* (CM, NY).

SALVADOR: cultivated: San Salvador, *Standley 22637* (GH, NY, US). — *Calderon 1528* stam. (GH, US). — Finca San Nicolas, *Calderon 1570* im. fr. (US). — Playa Santiago de Maria, Dept. Usulutan, alt. 150 m., *Carlson 656* (CM). —

Dept. Sonsonate, brush slope south of headquarters of Hacienda Las Tablas, near Rio Acachapa, Balsam Range, alt. 660 m., *Tucker 1364* fr. (CAL, GEN, NY).

NICARAGUA: cultivated: Dept. Managua, vicinity of Casa Colorado near El Crucero & summit of Sierra de Managua, planted in hedge of finca, *Standley 8209* (CM).

The description above seems to differ radically from the original description by Standley & Williams of *J. olanchana*. Their description reads, in part: "folia magna, 10–12-foliolata, petiolata, rhachi dense puberula; — amenta mascula — 13–17 cm. longa." The writer has studied the two sheets cited by these authors, and believes that the leaflets, some of which have fallen off, are more numerous than stated in the description; the difference in the description of the pubescence is merely a matter of interpretation.

As stated in the Flora of Guatemala, "The collections of Popenoe and of Standley (in Guatemala) are represented only by nuts, and there is some uncertainty about the identification; the collection of Steyermark has the internal cavities absent at the end of the primary partition in the nut. This may be the species reported by Rene Guerin (as *nogal, Juglans nigra*), in Catalogue des products presentes par la Republique de Guatemala a l'exposition universalle de Paris, 1900, from Coban, Alta Verapaz; Cuilapa, Santa Rosa; Chimaltenango, Zacapa, and Chiquimula."

This native walnut (*J. olanchana*) of Guatemala and Honduras has been called for many years *Juglans pyriformis* and is undoubtedly closely related to it. The fruit of *J. olanchana* is quite similar to the fruit of *J. pyriformis,* but the leaves are entirely different, with the leaflets mostly 17–21, strongly stalked, frequently cuneate at least on the lower side at the base, as opposed to leaflets 19–31, sessile, truncate. The cross section of the nut of *J. olanchana* resembles that illustrated by Dode (1909) for *J. peruviana* (*J. boliviana*, according to the writer).

The identification of *Steyermark 51072* is uncertain, as the young leaves have 17–25 leaflets, which are slightly more hairy than in typical *J. olanchana* with colorless pointed hairs beneath.

Certain specimens cultivated in Salvador (i.e. *Calderon 1570*) are quite different from what the writer considers typical *J. olanchana* and closely resemble *J. major* var. *glabrata* in having smaller leaves, fewer (13–15), narrower (2.5–3.5 cm. wide by 8–11.5 cm. long) leaflets whose bases are strongly cuneate on both sides. In *Calderon 1528*, which has about 19 leaflets but small and narrow as in *Calderon 1570*, the staminate catkin is only 9 cm. long. *C. & W. Von Hagen 1271*, from Honduras, is similar to these specimens, although it should be noted that *Molina A3009*, from the same general region, has leaves characteristic of *J. olanchana*. Mature fruits are lacking on these specimens. Whether these atypical specimens are variants of *J. olanchana,* poorly collected specimens of *J. olanchana* (such as young shoots), true *J. major* var. *glabrata*, or a different species is uncertain. These plants need further study. It should be pointed out that Standley & Calderon, in Lista Preliminar de las Plantas de El Salva-

dor, in 1935, stated that *Juglans pyriformis* Liebm., *nogal*, planted in many places in Salvador, was introduced from Mexico. The writer believes that all walnuts in Salvador and Nicaragua have been planted, and most specimens from these countries are so marked; no statement, however, is made on the labels of *Carlson 656* and *Tucker 1364*.

Skutch states, in a note concerning his specimen, that near Cotzal "there were a number of huge trees standing in the cleared lands near the river, 175 feet high. From the size and appearance of the trees, coupled with what I heard of the relatively recent date of the clearing, I had no doubt that they were relics of what must have been an extraordinarily magnificent forest. They were associated with a sycamore which here also seemed to be near the southern limit of its range." Popenoe, concerning his No. *180a* states that "the tree, seen occasionally on mountain sides and along water courses, at elevations of 1500–4500 ft. . . . . is only moderately large, rarely reaching a greater height than 40–45 feet."

Record & Hess (1943) state that a wood, *Yale 300*, probably a walnut, called "Cedro Nogal" has been obtained in Copare, Honduras. In a recent letter William L. Stern, of the Yale School of Forestry, has informed the writer that *Yale 300* is called "Cedro Negro" and came from the Comya district, Dept. of Copan, Honduras. This wood was exhibited at the 1904 St. Louis Exposition.

Two collections from western Mexico are similar to *J. olanchana* in having large leaves with 17–20 large, lanceolate to oblong-lanceolate leaflets, staminate catkins 23–29 cm. long, the bracts of the large flowers short, located on the rachis or the very base of the pedicel, large light brown nuts strongly longitudinally furrowed with broad flat ridges. These are here described as a new variety:

6a. **Juglans olanchana** Williams & Standley var. **standleyi** Manning, var. nov.*

This differs from typical *J. olanchana* in having the twigs, rachis, and leaflets conspicuously hairy, and the leaflets essentially sessile or with a short broad stalk, tapering somewhat on both sides at the base but especially on the lower side.

Twigs densely glandular-villous with whitish hairs, gummy (fide Ynes Mexia); rachis stout, densely and strongly pale-brown glandular-villous; leaflets 12 cm. long and 4–4.5 cm. wide, conspicuously and densely finely whitish tomentose with fascicles of long hairs beneath, each fascicle lacking a bulbous base, with strong tufts of hairs at bases of side veins, very finely and remotely serrate, appearing nearly entire, possibly because of the subrevolute margin, lepidote under the hairs with golden glands, the midrib with glandular hairs; upper surface of leaflets with most of strong veins glandular-pubescent, some fascicled hairs being present toward base of midrib; pistillate flowers unknown; husk of fruit unknown; nuts subglobose, 3.2–3.5 cm. in diameter, 3.2 cm. long, somewhat compressed.

* A *J. olanchana* differt ramulis, rhachibus et foliolis conspicue pilosis, foliolis subsessilibus, basi angustatis.

COLIMA: San Antonio, *Reiche*, in 1913, stam. (MEX). JALISCO: San Sebastian, Sierra Madre Occidental (Sierra Madre del Sur?), *Ynes Mexia 1438* fr. (TYPE-NY; ISOTYPES–AA, CAL, CM, GH, GEN, MICH, MO, US, BPI).

Husks which might correlate this variety more fully with *J. olanchana* have not been collected. This taxon may prove, upon further study, to be a distinct species.

The hairs are somewhat similar to those of *J. mollis* or *J. hirsuta,* but are extraordinarily developed; the leaflet base, the length of the staminate catkin, the position of the staminate bract, and the nuts are quite different.

7. **Juglans steyermarkii** Manning in Standley & Steyermark, Flora of Guatemala, Fieldiana: Botany 24(3): 358. 1952; in Amer. Jour. Bot. 35: 616. 1948, nom. subnud.

Tree about 50 feet tall, the bark gray and furrowed; twigs densely glandular pubescent; terminal bud elongate, densely grayish tomentose; leaf-scar only slightly notched; leaves large, up to 60 cm. long and 30 cm. wide, the terminal leaflet usually absent; rachis conspicuously pubescent with reddish glandular hairs; leaflets large, distant, mostly 16–18, each 14–17 cm. long and 5–8 cm. wide, essentially sessile or very short-stalked, ovate or ovate-lanceolate, typically finely but rather remotely serrate with the serrations shallow and turned outward, and with most of the small veins terminating in the teeth rather than the sinus; upper surface of leaflets pubescent with minute glandular hairs, the lower surface pubescent with reddish glandular hairs on larger and smaller veins and especially on the midrib and with solitary or paired whitish pointed hairs on the surface and smaller veins; base of leaflet usually truncate to broadly rounded, the apex acute or abruptly acuminate, the lowest leaflet somewhat reduced; flowers unknown; nearly mature fruit wrinkled, subglobose-pyriform, truncate at the base, 4 cm. in diameter and 4.5 cm. high, strongly pubescent with reddish glandular hairs; punctations numerous, drying brown, very inconspicuous; husk not very thick; nut apparently deeply grooved, with rounded ridges, but nut immature; cavities present in the wall at each end of the primary partition.

VERNACULAR NAME: *nogal.*

GUATEMALA: Huehuetenango: Paso del Boqueron, along Rio Trapichillo, below La Libertad (west of Jacaltenango, almost on Mexican border), alt. 1200–1300 m., *Steyermark 51140* fr. (CM, WEM).

This species is completely different vegetatively from *J. olanchana*; the husk is different, also. Unfortunately the nut is immature, so that it is impossible to compare the nuts of the two Central American species.

Although *J. olanchana* has a fruit similar to that of *J. pyriformis* of eastern Mexico, it is similar to the species of western Mexico in its narrow leaflet bases and type of hairiness. *Juglans steyermarkii,* on the other hand, is similar vegetatively to the eastern Mexican species with truncate leaflet bases and brownish pubescent rachises. The differences

between *J. steyermarkii* and the eastern Mexican species are given in the main key to species.

Both *J. olanchana* and *J. steyermarkii* occur within a few miles of the border of Chiapas, Mexico, and it is very probable that one or both species may occur in that state of Mexico.

INTERRELATIONSHIPS OF SPECIES OF THE NEW WORLD

With the exception of *Juglans cinerea*, all species of the New World are closely related and have probably evolved from one or two common ancestors.

Juglans boliviana (C. DC.) Dode and *J. columbiensis* Dode, of South America, are similar in vegetative features to *J. olanchana* and *J. major* var. *glabrata*. *Juglans neotropica* Diels, of northern South America, has truncate leaflet-bases as in *J. mollis*. *Juglans australis* Griseb. of Argentina and Brazil is similar to *J. major*.

The one (two?) species of *Juglans* of the West Indies is similar vegetatively to *J. olanchana* and *J. pyriformis* but is also similar to *J. columbiensis* Dode of Venezuela.

The nuts of all species of Latin America are very similar, most of them having rather flat-topped ridges. It is almost impossible to identify positively any nut of this area by itself. Dode (1909) has natural-size drawings of the nuts of many species, showing for each nut the external appearance, a cross-section at the middle, and a longitudinal section along the dorsal partition. These illustrations include not only the Mexican species but also the species from South America and the West Indies. The Mexican species illustrated are *J. pyriformis* Liebm., *J. mollis* Engelm. (represented by *Pringle 3322* which is unusual in having dorsal lips), *J. major* (Torr.) Heller (as *J. arizonica* Dode, *J. neomexicana* Dode, *J. torreyi* Dode, *J. elaeopyren* Dode) and *J. microcarpa* Berlandier (as *J. rupestris* Engelm. and *J. subrupestris* Dode). The nuts of some species not illustrated by Dode, such as *J. hirsuta* Manning and an unnamed species of South America, with sharply ridged nuts, as in *J. nigra* L., are different.

The species of *Juglans* of South America and the West Indies will be treated by the writer in a later paper.

The species of *Juglans* of Central America probably gave rise to those of Mexico and the United States. There seem to have been three principal lines of evolution, an eastern, a western, and a central branching one. In the east *J. pyriformis* has arisen from *J. olanchana*, though the leaflet-bases are similar to those of *J. steyermarkii*. *Juglans olanchana* is represented in extreme western Mexico by its variety *standleyi*. In central Mexico *J. major* var. *glabrata* is similar in many ways to *J. olanchana* and has, in turn, evolved into the more eastern *J. mollis* and into the more western *J. major*, *J. microcarpa*, and *J. californica*. *Juglans mollis* has the truncate leaflet bases of *J. steyermarkii* and *J. pyriformis* and there may have been some cross breeding; *J. mollis* and *J. major* have fewer leaflets than typical *J. olanchana*. *Juglans hirsuta* seems to be a combination