

THUJOPSIS

Thujopsis, Siebold et Zuccarini, *Fl. Jap.* ii. 32 (1842).

Thuya, Bentham et Hooker, *Gen. Pl.* iii. 427 (1880).

Cupressus, Masters, *Journ. Linn. Soc. (Bot.)*, xxx. 19 (1893) and xxxi. 363 (1896).

THIS genus is considered by many authorities to be merely a section of *Cupressus* or of *Thuya*. The foliage and cones, however, are remarkably distinct, and justify its retention as a separate genus.

Evergreen trees, belonging to the tribe Cupressineæ of the order Coniferæ, with reddish bark scaling off in longitudinal shreds. Branches in false whorls or scattered, giving off secondary branches, which terminate in very flattened branch-systems, disposed in horizontal planes. These resemble in their general arrangement those of *Thuya* and *Chamæcyparis*, and are mostly tripinnate, all the axes being covered with small coriaceous leaves, adnate in part of their length, and arranged in four ranks in decussate pairs. The leaves on the main and ultimate axes differ only in size.

The ventral and dorsal leaves are flattened and ovate or spatulate, with rounded apices; the lateral leaves are carinate, more or less spreading, with a slightly acute apex, which is bent inwards. The dorsal flat leaves are shining green, and marked with a central ridge, which is often hollowed in the middle line. The ventral flat leaves have a central green ridge, with a concavity white with stomata on each side. The lateral leaves, green on the dorsal side, exhibit a single stomatic concavity on their ventral side.

Flowers monœcious, solitary, and terminal, the male and female flowers borne on separate lateral branchlets as in *Thuya*. Male flowers cylindrical, $\frac{1}{4}$ inch long, with six decussate pairs of stamens. Female flowers with five ovules on each scale. Cones globular, almost erect, with eight clavate, woody scales, in decussate pairs from a central axis, the upper pair abortive. Seeds three to five on a scale, laterally winged, the wing not notched at the summit.

The seedling¹ resembles that of *Thuya plicata*, but has broader and very blunt cotyledons, with shorter and broader primary leaves.

¹ See Tubeuf, *Samen, Früchte, u. Keimlinge*, 103, fig. 143 (1891).

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THUJOPSIS DOLABRATA

Thujopsis dolabrata, Siebold et Zuccarini, *Fl. Jap.* ii. 34, tt. 119, 120 (1842); Franchet et Savatier, *Enum. Pl. Jap.* i. 469 (1875); Shirasawa, *Icon. Essences Forest. Jap.*, text 27, t. xi. 18-34 (1900).

Thuja dolabrata, Linnæus, *Suppl. Pl. System*, 420 (1781); Masters, *Jour. Linn. Soc. (Bot.)*, xviii. 486 (1881), and *Gard. Chron.* xviii. 556, fig. 95 (1882); Kent, in Veitch's *Man. Conif.* 236 (1900).

The species has been described in detail above.

Two well-marked geographical forms occur, both confined to the main island of Japan:—

1. Var. *australis* (*var. nova*). A small tree 40 to 50 feet in height, or a shrub growing as underwood in the dense shade of forests. As a tree it has a slender trunk, with drooping branches and a narrow pyramidal top. Branchlets very flat and only slightly overlapping, the lateral leaves ending in acute points bent inwards. Cones broadly ovoid, with scales thickened at the apex, which is prolonged externally into a blunt triangular process. This is the form which is known in cultivation in Europe, and described and figured in the works cited above.

2. Var. *Hondai*, Makino.¹ A larger tree, attaining 100 feet in height, with a stem of over 3 feet in diameter. The branch-systems are more densely ramified, the branchlets being placed close together and overlapping one another by their edges more than is the case in the preceding variety. The leaves also are smaller, whiter underneath, and crowded more closely on the shoots; those of the lateral ranks being usually blunt and not curved inwards at the apex. The cones are globular, with scales not thickened at the apex, which is devoid of the process so conspicuous in the other form, or merely shows it as an obsolete transverse minute mucro. The seeds appear to be more broadly winged, the wings being more scarious in texture.

This form has not yet been introduced. Elwes has brought home excellent specimens of it in fruit from the Uchimappe Forest, near Aomori, in the extreme north of Hondo. These differ in the characters given above from specimens of the ordinary form obtained by him in the forest of Atera, Kisogawa, and Yumoto (4000 to 5000 feet altitude) in Central Hondo. The smaller leaves, set more closely on densely ramified branchlets in this variety, may be due to the influence of dense shade. The difference in the cone is paralleled by what occurs in the fruit of the different geographical forms of *Cryptomeria japonica*. I am inclined to think that var. *Hondai* is not a distinct species; but as it is very different, from the point of view of cultivators, it may conveniently bear the name *Thujopsis Hondai*.

¹ *Tokyo Botanical Magazine*, 1901, xv. 104.

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Several horticultural varieties have been introduced, viz. :—

3. Var. *latevirens*, Masters, *Jour. Linn. Soc. (Bot.)*, xviii. 486.

Thujopsis latevirens, Lindley, *Gard. Chron.* 1862, p. 428.

Thujopsis dolabrata nana, Gordon, *Pinetum*, ed. 2, p. 399.

A dwarf shrub having no definite leader, with slender and much-ramified branchlets, and very small and bright green leaves. This variety often shows acicular leaves, spreading all round the shoot, and is apparently a fixed seedling form. It was introduced in 1861 from Japan by J. Gould Veitch.

4. Var. *variegata*. This only differs from the ordinary cultivated form in having the tips of many of the branchlets pale yellow or cream colour. It was introduced by Fortune in 1861.

DISTRIBUTION

Thujopsis dolabrata was discovered by Kaempfer,¹ who mentions it in his *Amœnitates Exoticæ*, p. 884, as "a kind of Finoki." His specimen is still preserved in the Natural History Museum at South Kensington, and was figured by Lambert² in his account of the species. Thunberg long afterwards (about 1776) sent specimens to Linnæus, who first gave a scientific description of the tree. Thunberg³ cites the locality as follows :—"Crescit in regionibus Oygawæ et Fakoniæ, inter Miaco et Iedo." (A. H.)

Thujopsis dolabrata in Japan is known under the name of *Hiba*, and is found in a wild state north of about lat. 35°, and in the southern part of this area is a mountain tree only, occurring in the forest of the Kisogawa district from about 3000 to 5000 feet. In the vicinity of Nikko it is common between about 4000 and 6000 feet according to Sargent, but I only saw it here near Lake Yumoto where it did not appear to attain such large dimensions as farther north. The variety found in the forests of Atera is distinct in its fruit from the northern form. The excellent figure on Plate xi. in Shirasawa's *Essences Forestières* appears to be taken from the southern variety.

The northern form has been described by Makino as var. *Hondai*, but the latter is not mentioned either by Goto or Shirasawa, nor is it recognised as specifically distinct in any of the Japanese collections which I saw. Though the tree usually occurs in mixture with *Tsuga* at Nikko, and with *Sciadopitys* at Atera, yet in the extreme north of Japan, on the hills north of Aomori, it is found in pure forest on hills of volcanic formation from near sea-level up to about 3000 feet. An excellent account of the forest of Uchimappe is given in *Forestry and Forest-Products of Japan*, where it is stated that the mountains are of Tertiary formation, and the under-lying rock composed of tufa, sandstone, and slate. Pieces of this rock which I brought home have been examined by Mr. Prior of the British Museum of Natural History, who considers that in all probability they represent a rather basic andesite or basalt, but owing to the weathered and decomposed state of the specimens, satisfactory sections could not be made. I visited this forest in the

¹ See Salisbury, *Jour. Science and Arts*, 1817, ii. 313.

² *Genus Pinus*, ed. 2, ii. tab. 68 (1842).

³ *Flora Japonica*, 266 (1784), sub *Thuya dolabrata*, Linn

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company of Mr. Shirasawa in June, and after passing through the flat rice-fields which extend from the sea to the foot of the hills, entered the forest, which consists mainly of *Thujopsis* naturally reproduced, though here and there, trees of *Quercus glandulifera*, *Magnolia hypoleuca*, and other species occur, whilst *Cryptomeria* and *Cupressus obtusa* are planted in the valleys, and *Larix leptolepis* on those parts of the hills where the natural forest has been destroyed by fire. From observations taken at the meteorological observatory of Aomori, it appears that the climate of this part of Japan is cold in winter and the snowfall heavy, the thermometer falling in February to -15° Centigrade, and rising in September to 32.5° Centigrade; the average temperature for the whole year being 9° , and the average moisture 78 per cent. The average height of the trees here is about 70 to 80 feet, attaining in deep shady valleys 100 feet or perhaps more, and about 2 feet in diameter when closely grown, at the age of 150 to 180 years when it is considered ripe for felling.

The stems are often much curved at the butt from the pressure of the snow on the young seedlings, which require eight to ten years to get above its surface in winter, and these butts are usually cut separately and used for special purposes. The tree does not seem to have the power of reproducing itself from the stool, but produces abundant seed, which in dense shade germinates freely, though the growth of the seedlings is very slow at first.

The undergrowth of the forest is very different from what I saw in other parts of Japan, bamboo-grass (*Arundinaria Veitchii*) being much less prevalent, but in the damp places tall herbaceous plants were numerous, with *Aucuba*, *Skimmia*, and *Ilex*, and other evergreen shrubs on the drier ground, and many pretty liliaceous plants and orchids in places.

Goto says of this tree,¹ that it formed under the old regime, together with *Cupressus pisifera*, *C. obtusa*, *Thuja japonica*, and *Sciadopitys*, the so-called "Goboku" or Five Trees, which enjoyed careful protection at the hands of the feudal authorities; he also says that it is rarely planted, being regenerated naturally by seed, and that it forms extensive forests in a mixture with other conifers such as *Thuja japonica* and *Pinus parviflora*, in the mountains on the northern frontier of the province of Rikuchu, in Goyosan, and in the mountains of the Tone districts, Kozuké. It has lately come to be in great demand for railway sleepers.

Plate 60 (in Vol. I.) represents a dense growth of trees of this species in the forest of Uchimappe very similar to what I saw in the Kisogawa district at about 3000 feet. I am indebted to the Japanese Forest Department for the negative from which it was made.

The wood of *Thujopsis* is highly valued in those parts of Japan where it grows, on account of its great durability. This is proved by specimens shown at the St. Louis Exhibition, one of which had been used as a gate-post for eighty-three years, another as a plank in a fishing-boat for eighty-four years, others as railway sleepers in use for fourteen years. The wood has an aromatic smell, takes a fine lustrous polish when planed, and is yellowish white in colour, showing a fine grain, which makes selected planks from the butt length very ornamental. Exceptional

¹ *Forestry of Japan*, 18 (1900).

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cases occur in which the wood is curiously mottled and freckled. A ceiling and a screen made of such wood, which I saw in the Forestry Bureau at Aomori, were very beautiful.

The wood weighs about 30 lbs. per cubic foot, and is worth at Aomori from 40 to 50 yen per 100 cubic feet, or about 1s. per cubic foot. It is much valued not only for joinery and building purposes, but for foundations, ship and boat building, as it is stronger and more resinous than other woods of the same character.

The bark also, which is thin, tough, and durable, is much used for roofing and for partitions and walls of out-houses, fences, etc.

CULTIVATION

T. Lobb sent a plant from the Botanical Garden at Buitenzorg in Java, to Exeter in 1853, which died; and soon after, Capt. Fortescue, a cousin of Earl Fortescue, brought a plant from Japan which was planted at Castlehill in 1859. But this tree, as I learn from Mr. Pearson, the head gardener, has been dead for some time, though plants raised from its cuttings are still growing at Castlehill and elsewhere.

In 1861 Mr. J. G. Veitch and R. Fortune sent seeds from Japan to the Chelsea and Ascot Nurseries, from which plants were raised and generally distributed, so that the tree is now common in England.

From what I have said of its habitat in Japan it is clear that though this tree is hardy as regards frost in winter, it requires conditions which are rarely found in England to bring it to any size, and, as a matter of fact, it has not yet become a tree anywhere except in Devonshire and Cornwall, though perhaps if seeds from North Japan are obtained the results might be better.

Though no doubt it has ripened seeds elsewhere, I have never obtained any which germinated, except from a tree planted about 1881 by Queen Alexandra in the Earl of Northbrook's grounds at Stratton Park, Hants, which I gathered in October 1900. One of these grew, and is now a healthy plant about 9 inches high. It seems to suffer less from spring frost than many Japanese and Himalayan conifers.

The finest tree that I have seen in England is at Killerton, which in 1902 measured 35 feet 6 inches in height and 2 feet 4 inches in girth. It is growing on a slope facing south-west in a peculiar soil, which Sir C. T. D. Acland describes as "Trap, soft below the surface, but hard after exposure. This trap overlies red sandstone, but is rather darker and more porous." This soil evidently suits most conifers admirably, as I have seen no other collection which contains so many fine specimens as this.

At Boconnoc, at Carclew, and at other places in Cornwall there are trees approaching this in height, but we have not seen any specimen above 15 to 20 feet in other parts of England, though as a bushy shrub 12 feet high it exists in most modern gardens. In Scotland it seems hardy in the west and in Perthshire, whilst at Castlewellan in Ireland it has attained 30 feet in height. At Powerscourt and Kilmacurragh, Wicklow, there are trees with the lower branches layering and forming numerous independent stems.

(H. J. E.)

ÆSCULUS

Æsculus, Linnæus, *Gen. Pl.* 109 (1737); Bentham et Hooker, *Gen. Pl.* i. 398 (1862).
Pavia, Boerhave, *ex* Miller, *Gard. Dict.* ed. 6 (1752).

DECIDUOUS trees and shrubs, belonging to the natural order Sapindaceæ, some authorities, however, making the genus the type of a distinct order Hippocastaneæ. Leaves in opposite decussate pairs, without stipules, stalked, digitately compound; leaflets five to nine, serrate in margin, pinnately veined. Branchlets stout, terete, with large triangular leaf-scars. Buds large, of numerous decussately opposite scales which are homologous with leaf-bases, the outer deciduous, dry or resinous, the inner accrescent and often brightly coloured.

Flowers in large terminal racemes or panicles, appearing later than the leaves, of two kinds, hermaphrodite and staminate, on the same plant; placed in the axils of minute caducous bracts on stout jointed pedicels. Calyx imbricate in bud, five- or two-lobed, the lobes unequal, united with an hypogynous annular disc in the hermaphrodite flowers. Petals four to five, imbricate in bud, alternate with the calyx lobes and inserted on the disc. Stamens five to eight, usually seven, inserted on the inner margin of the disc, unequal in length; filaments filiform; anthers two-celled, sometimes glandular at the apex. Ovary three-celled, rudimentary in the staminate flowers, each cell containing two ovules. Style slender, elongated, generally curved. Fruit a capsule; prickly, roughened, or smooth; coriaceous; three-celled, three-seeded, and three-valved, or by abortion one- to two-celled and one- to two-seeded, the remains of the abortive cells and seeds usually remaining visible. Seeds without albumen, rounded or flattened by mutual pressure; seed-coat brown and coriaceous, marked by a large whitish hilum. Cotyledons thick and fleshy, unequal, cohering together by their contiguous faces, remaining in the seed-coat during germination.

About twelve species of *Æsculus*¹ are known to occur in the wild state. They are natives of North America, Europe, and Asia. The genus was formerly divided into two sections, *Pavia*, with smooth fruit, and *Hippocastanum*, with spiny fruit; but this division is not a natural one. The following synopsis groups the species under sections, which are more natural, being dependent on the characters of the flowers and buds:—

I. HIPPOCASTANUM. Buds viscid. Calyx irregularly campanulate, four- to five-

¹ The two Mexican species, which have tri-foliolate leaves, are now separated as a distinct genus, *Billia*.

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lobed. Petals four or five, claws not longer than the calyx; stamens exerted. This section includes all the old-world species.

1. *Æsculus Hippocastanum*, Linnæus. Greece.
2. *Æsculus indica*, Colebrooke. Afghanistan, north-western Himalaya.
3. *Æsculus punduana*, Wallich, *List* 1189 (1828). Sikkim, western Duars, Khasia Hills, Upper Burma, Tenasserim, Siam, Tonking. Large tree. Leaflets six to seven, very large, thinly coriaceous, stalked, acuminate, serrate. Panicles 12 to 15 inches or more, flowers white or yellow. Fruit brown, smooth.

Not introduced and not likely to be hardy.

4. *Æsculus chinensis*, Bunge, *Enum. Pl. Chin. Bor.* 10 (1835). Northern and Central China. A tree, 40 to 50 feet high. Leaflets five to seven, large, stalked, obovate-oblong, rounded at the base, abruptly acuminate at the apex, finely serrate, shining above, glabrescent below except for pubescence along the nerves, petioles pubescent. Panicles, 8 inches long, pubescent. Flowers small, white; sepals shortly and unequally five-lobed, pubescent. Petals four, minute. Filaments glabrous. Fruit¹ pear-shaped or globular, small ($\frac{3}{4}$ inch diameter), one-celled, three-valved, brown, covered with warts, not spiny.

This species has been much confused with the next, from which it differs in every way. The flowers, though small, are numerous in the large panicle, and the foliage is very handsome. It is common enough in the mountains of central China, in Shansi, and in the hills to the west of Peking; and when introduced is likely to prove hardy in England.

5. *Æsculus turbinata*, Blume. Japan.

II. PAVIA. Buds not resinous. Calyx tubular, five-toothed. Petals four, yellow or scarlet.

6. *Æsculus glabra*, Willdenow. North America.
7. *Æsculus octandra*, Marshall. North America.
8. *Æsculus Pavia*, Linnæus, *Sp. Pl.* 344 (1753); *Bot. Reg.* t. 993 (1826). Middle United States. A shrub. Leaves with slender grooved petioles, the edges of the grooves jagged. Leaflets five, obovate, acute at the base, acuminate at the apex, finely serrate without cilia, slightly pubescent beneath. Flowers in loose panicles, 4 to 7 inches long. Petals red, meeting at the tips; upper pair longer, with claws about three times as long as the small spathulate limb; lateral pair shorter, with claws as long as the calyx, and rounded limb equalling the claw in length; margin of petals beset with minute dark glands. Stamens as long as the upper pair of petals. Fruit brown, without spines.

This species, though only a shrub, is mentioned here at some length, as it closely resembles *Æsculus octandra*, and moreover enters into such important hybrids as *Æsculus carnea*, *versicolor*, etc. All its hybrids may be recognised by the red colour of the flowers and the glandular margin of the petals. It is readily distinguished from *Æsculus octandra* by its smaller leaves and peculiar petioles. In winter it shows the following characters:—Twigs slender, glabrous, shining, with numerous lenticels.

¹ Cf. Hance in *Journ. Bot.* viii. 312 (1870).

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Leaf-scars obovate or crescentic on slightly prominent cushions, with three groups of bundle-dots; opposite scars joined by a linear ridge. Terminal buds long oval or fusiform, pointed; scales numerous, the upper rounded, the lower pointed at the apex and keeled on the back, minutely ciliate in margin. Pith wide, circular, green.

9. *Æsculus austrina*, Small, *Bull. Torrey Bot. Club*, 1901, xxviii. 359; Sargent, *Man. Trees N. America*, 647 (1905); *Æsculus Pavia*, β *discolor*, Torrey and Gray, *Fl. N. Amer.* i. 252 (1838), in part. A small tree, attaining 30 feet in height, occurring in Tennessee, S. Missouri, E. Texas, and north-western Alabama. This resembles the last species. The leaflets, however, are usually more irregularly but finely serrate, and pale tomentose beneath. Panicles pubescent, 6 to 8 inches long. Petals bright red, meeting at the tips, unequal, oblong-obovate, rounded at the apex, glandular, those of the upper pair about half as wide as those of the lateral pair, with claws much longer than the calyx. Stamens longer than the petals. Fruit brown, slightly pitted. Not introduced.

III. MACROTHYRSUS. Buds not viscid. Calyx five-toothed. Petals four to five, white, claws longer than the calyx. Stamens exserted, very long.

10. *Æsculus parviflora*, Walter, *Flora Caroliniana*, 128 (1788). South-eastern North America. A shrub. Leaflets five to seven, elliptical or oblong-ovate, densely grey-tomentose beneath, finely serrate. Panicles erect, 8 to 10 inches long, slender, narrow. Flowers white, faintly tinged with pink. The long and thread-like stamens are pinkish white and very conspicuous.

This is a valuable shrub, as it flowers late, in July or August, some five or six weeks later than any of the other species except *californica*. Occasionally it forms a short single trunk, but generally it sends up a crowd of stems from the ground. It is figured in *Gard. Chron.* 1877, viii. fig. 129; and is often known in gardens as *Pavia macrostachya*, Loiseleur, or *Æsculus macrostachya*, Michaux. See *Bot. Mag.* t. 2118 (1820), where it is stated that the species was introduced by Mr. John Fraser in 1785. Canon Ellacombe reported in 1877¹ that he had at Bitton a specimen, which was at least forty years old, but that it remained a bush, not exceeding 8 or 10 feet in height.

IV. CALOTHYRSUS. Buds viscid. Calyx two-lipped or five-lobed. Petals four, pink or white, claws not longer than the calyx. Stamens exserted.

11. *Æsculus californica*, Nuttall. California.

12. *Æsculus Parryi*, A. Gray, *Proc. Amer. Acad.* xvii. 200 (1881); Sargent, *Garden and Forest*, 1890, p. 356, fig. 47. Lower California. A small shrub, resembling the preceding species; but differing in the five-lobed calyx, and in the leaflets, which are small, obovate and hoary pubescent beneath. It has not been introduced.

V. HYBRIDS. The most important is *Æsculus carnea*, Hayne, which is a cross between the common horse-chestnut and *A. Pavia*. This is described fully below.

¹ *Gard. Chron.* 1877, viii. 691.

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Æsculus plantierensis, André, a supposed hybrid between *Æsculus carnea* and *Æsculus Hippocastanum*, will be mentioned under the former species. *Æsculus versicolor*, Dippel, a hybrid between *Æsculus Pavia* and *Æsculus octandra*, will be treated under the latter species.

The following key to the species in cultivation is based on the characters of the leaves and buds. In Plate 61 the leaves of all these species are shown; and in Plate 62 are represented the twigs and buds of six species, *viz.*, *Hippocastanum*, *carnea*, *indica*, *glabra*, *octandra*, and *californica*:—

A. *Leaflets sessile or nearly so; buds very viscid.*

1. *Æsculus Hippocastanum.*

Petioles glabrescent. Leaflets obtusely and irregularly serrate.

2. *Æsculus turbinata.*

Petioles pubescent, especially towards their tips. Leaflets regularly and crenately serrate.

B. *Leaflets stalked.*

**Buds viscid.*

3. *Æsculus indica.*

Leaflets finely and sharply serrate, pale beneath. Buds very viscid.

4. *Æsculus carnea.*

Leaflets obtusely and irregularly serrate. Buds only slightly viscid, the brown scales having a dark-coloured margin.

5. *Æsculus californica.*

Leaflets shallowly and crenately serrate, pale beneath. Buds viscid, glistening with white resin.

** *Buds not viscid.*

6. *Æsculus parviflora.*

Leaflets densely grey-tomentose beneath, finely serrate in margin. Buds minutely pubescent.

7. *Æsculus octandra.*

Leaflets pubescent beneath, broadly lanceolate, shortly acuminate, with twenty or more pairs of nerves in the terminal leaflet; margin finely serrate but not usually ciliate. Petioles without jagged marginal ridges.

8. *Æsculus glabra.*

Leaflets glabrous beneath, except for a slight pubescence along the midrib and tufts in the axils, long-acuminate, with about fifteen pairs of nerves in the terminal leaflet, finely serrate with ciliate tufts in the bases of the serrations. Petioles with smooth marginal ridges.

9. *Æsculus Pavia.*

Leaflets slightly pubescent beneath, narrowly lanceolate, finely serrate but not ciliate in margin. Petioles flattened on the upper side, with marginal sharp ridges, usually jagged.

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ÆSCULUS HIPPOCASTANUM, COMMON HORSE-CHESTNUT

Æsculus Hippocastanum, Linnæus, *Sp. Pl.* 344 (1753); Loudon, *Arb. et Frut. Brit.* i. 462, iv. 2543 (1838); *Gard. Chron.* 1881, xvi. 556, figs. 103, 104.

A large tree, attaining in England a height of over 100 feet and a girth of 15 or even 20 feet. Bark smooth and dark brown in young trees, becoming greyish and fissured longitudinally in old trees, at the same time scaling off in thin plates. Leaves palmately compound, digitate, on a long stalk widened at its insertion. Leaflets five to seven, sessile, obovate, cuneate at the base, abruptly acuminate at the apex, unequally and coarsely serrate; green above; beneath pale, tomentose at first, but ultimately glabrous, except for small tufts of hairs in the axils of the veins and a few scattered hairs over the surface; middle leaflet the largest, with twenty-four or more pairs of nerves, lower pair smallest; venation pinnate; petiole glabrous. The leaflets as they emerge from the bud are at first erect, but soon bend downwards on their stalks. When nearly full grown they rise up and become horizontal. In autumn they turn yellow or brownish and fall early, each leaflet disarticulating separately from the petiole.

Flowers in large upright pyramidal panicles, the primary branches of which are racemose, the lateral branches cymose. Upper flowers staminate and opening first; lower flowers hermaphrodite. Calyx greenish, five-toothed. Petals four to five, crumpled at the edge, white, with yellow spots at the base, which ultimately become pink. Stamens seven, longer than the petals, the filaments bent down when the flower opens and the stigma protrudes, later moving up on a level with the style. Fruits few on each panicle, large, globular, green, with stout, thick conical spines, three-valved, usually one-seeded, occasionally two- to three-seeded. Seed large, shining-brown, with a broad whitish hilum. Cotyledons two, large, fleshy, distinct below, blended into one mass above.

SEEDLING¹

The cotyledons are large and fleshy and remain in the seed, which frequently germinates on the surface of the soil or only slightly buried beneath it. The cotyledons have long petioles ($\frac{3}{4}$ -1 inch), which are broad and flattened, with a concavity on their inner surface. The caulicle, very variable in length (1 to 4 inches), is stout, brownish, pubescent, and ends in a stout tap-root, which gives off numerous branching fibres. The young stem is stout, terete, brownish, striated and marked with numerous lenticels, puberulent or glabrous; it has no scale-leaves, differing in this respect from the young stem of the oak. In other respects the germination of the oak and of the horse-chestnut are almost identical. At a varying height

¹ Cf. Lubbock, *Seedlings*, i. 356 (1892), where it is stated that the seed is carried a considerable height above ground during germination owing to the great length of the caulicle. So far as I have observed, the seed does not change its position during germination.