Genus Castanea[1]

Castanea (Tournef., Inst., p. 584, t. 352) Miller, Dict., ed 7, p. 1 (1759); Gaertin., Fruct., I, p. 181; Chaum., Poir. of Ch. Fl. med., 11 t. 112 et 112 bis; Andanson, Fam. Pl., II, p. 375 (1763); A. DC. in Journ. of Bot. (1863), p. 182 et in Prodr., XVI, II, p. 113; Endlicher, Gen. Pl., p. 275 (1836-1840) p. p.; Nets in Gen. fl. germ. f. I, cum ic.; Baillon, Hist. Pl., VI, p. 257 (excl. sect. Castanopsis et Callaeocarpus); Bentham et Hooker, Gen., III, p. 409 (1880); Durand, Ind. gen. phaner., p. 381; K. Schineider, Ill. Handb. Laubh., I. p. 156 (1905); Dode in Bull. Soc. Dendr. Fr. (1908), p. 140; Bois, Pl. alim. II, p. 525; Lemee, Dict. gen. I, p. 867.

Castanea sect. II Eueastanea Engler et Prantl, Pflanzenfam., III, pt. I, p. 55 (1894); Dalla Torre et Harms, Gen. Siphon., p. 118, (1900-1907).

Castanea /sub-genus / {sous-genre. Eucastanea Koehne, Deutsche Dendrologie, p. 121 (1853); Aschers. et Graebn., Syn. Mitteleurop. Fl., IV, p. 440 (1911).

Fagus A. L. de Jussieu, Gen., p. 409, p. p. (1789) (2).

---

1. It is difficult to find the exact origin of the work Castanea which, more or less altered, is used to designate the chestnut tree in all the European languages; it became, in old German: kestina, chestinna; in Anglo-Saxon: cister or cyst-beam: in Scandanavian: kastanea; in Russian: kashtanus; in Polish: kasztan; in Lithuanian: kasztanas; in Spanish: castano; in Brittany: kistinen and the chestnut kistin (according to Leonidec); in Provencal: estagnie and the chestnut castagne; in Weish: castan-wydden (castan tree) the tree and sataen the nut.

   The name of Castanea niore or less modified is such to go back to the most ancient languages of southern Europe. According to Pline, the Greeks cculd have received the chestnut from Sardis, a city in Lydia.

According to Pictet, "The Inoo-European origins or the primitive aryas", Paris, 1859, p. 249, the origin of the work Castanea goes back to the Aryan epoch. In Persican kashtah (dry fruit), is connected to the Sankiit kashtat, from kashtlin; woody. Thus, quite probably the chestnut tree owes its name to its involucre and this name goes back at least to the primitive Aryan epoch. Kashtat became, in Armeniaa, kaskeri, for the chestnut tree and kask, for. the chestnut..

For Zrmbaldi, "Italian etoniological vocabulary", Citta di Castello, 1889, the Latin work Castanea comes from the Greek and perhaps from the Saúskrit kashtat. For De Candolle, it could not have eome, as was said, from Kastanda, a city in Thessaly, nor from Kastanus, a city of Pont, nor from several localities whose names recall the work Castanea, but it would be the names of these cities that had been given them because these were chestnut trees in their region.

As for the name "Marron" (cestnut in French), according to De Candolle, it was at first mostly local, proper to the neighborhood of Lyon, and might be of Italian origine (cf. Olivier de Serres, Th. agric, ed. Geniva, p. 614).

2. The chestnut tree, castanea of the Latins and pre-Linun botanists was gathered by A. L. De Jussieu and Linneus, to beech, in the genus Fagus.

axil some smali Bracts. Perianthe bell-shaped, with 6 deep lobes, oval-rounded on two rows, imbricate in estivation, scarcely puberulent. Diplostemonous or triplostemonous and roecium, formed of 6-18 (sometimes 20) stamen inserted on the slightly swolen tories, protruding out of it; thread-like fibers, free, white, curved in the bud; little anthers, ovoide or almost globular, a pale yellow, attached by the back, two-called, with 2 contiguous cells, parailel, dehiscent longitudinally; mucropulate or obtuse connective; rudionentary ovary, hairy or often not. Plowers ♀ situated at the base of the androgenous catkins, sessil, usually 3 (1-2-3), very close together (pl. I, f. 3 and 4), the central one situated a little lower than the two lateral ones, surrounded, except for the perianthus and the styles which are protruding out of it, by a common involucre (4), armed with more or less branchy prickles and scaly bracts, the latter appearing first and, even in the developed cupule, existing only on the lines of dehisence; the flowers surrounded by a bract and by 2 smaller lateral bracts. Each flower having an un-shaped perianthe armed at the top with 6 (8) short teeth, contracted blow the {limb / rim} into a tube, then dilated at the base and united to the lower ovary; often 6 (8) rudimentary stamen, enclosed; sometimes 3 shorter ones apigynous, sterile, very rarely fertile; short thread; lower ovary flask-shaped, densely hairy inside, with 6-9 incomplete cells at the top (this number without correlation to the number of styles), unequal, with sinuons walls, often being united two by two before rejoining the central columm; cells with two ovules; styles 7-9 (1), sometimes more, linear, prorruding out of the perianthe, subulate, rigid, armed at the base with slender hairs; stigmes only occupying the summet of the style,

4. According to Baillon, the bracts are those of the inflorescence in bunches. The prickles could be outgrowths of the same nature as the scales of the cupule of Quercus. In C. sativa there are originially 7 flowers belongin to 3 successive generations, those of the 3rd generation soon abort: when they are developed, they could be ♂.

1. According to Toguini, Bickrche di morfolopia atomia s.fiore feminile e sul fruto dil Castagno in Atti dell' Ist Bot. Uni. di Pavia, p. 1 (1894) and Vulcoq, I& Châtaigner, p. 12, the number of styles could go up to 16. I have never observed such a high number.

as in each cell, appearing rather late, attached to the internal angle (2), standing side by side, descending, half-inverted; single {tegmen / tegument}; developed nucellus (3); micropyl growing above, situated a little above the hilum. Cupule (pl. I f. 5) incieasing in size with age, almost spherical, always symetrical, the pedicel being situated diametrically under the styles in bundles, pubescent, of almost woody consistency, dehiscent with maturity in 4 (sometimes 2) valves, covered with stiff prickles, subulate (4), tasseled, a little divergent, at first green, then brown, disposed on 4 equal surfaces having nearly the form of an isocloese triangle with a high summit, separated from one another with 4 lines without prickles, armed with bracts. In the closed cupule, one can see 4 lines forming a cross; sometimes the cupule is only opened in 2 valves, but, even in this case, the 2 or 4 lines of bracts, without prickles, are obvious. Teh existence of these lines wfthout prickles dces not appear to have been recognized. Fruits (chestnut) ripening in one season, 1-3 in the cupule, rarely more, indehiscent, ovoid-pointed or, when there are more than one in the cupule, deformed by compression, the lateral flats on one side, the median on two, tapered at the top into a tube (torch) surmounted by the perianthe and the remaining styles; seed vessel chestnut colored, {torch / grestly / cartilaginous,} leatherlike, elastic, thin, dry, shiny, furrowed, longitudinally on the ventral side, provided with fine streaks comparable to the meridians of a sphere, armed at the base with a large scar, pale, often flattened, lusterless and more or less rough, at first 6-9 cells, but, following the rupture of the placentas and abortion,

---

2. When the 2 ovules are developed in the same cell, one is always larger than the other.
3. Van Gieghem has classified this genus in the {thick nucellus / Crassenucellees} {invested by a single covering / unitegminaceous} (cf. Van Tieghen in Journ, de Eot. (1848), p. 212).
4. The prickles are usually so crowded that their disposition in lines, as it exists in the genus Castanopsis, only appears when they are completely shaved off.

only containing one at maturity, sometimes two, rarely three or more (1) fertile seeds end by filling the entire cavity of the pericarp, breaking the walls and displacing the central column. Seed carrying at the top the (2-11) aborted ovules, triangular-ovoid, ordinarly furrowed on the ventral face, veined radically from the rootlet to the micropyle; central raphe; pale brown testa, veined, rather fragile when it has arrived at a certain degree of dessication; adult embryo deprived of albumen, the endosperm always thin, transparent, occupying the central part of the seed, then entirely absorbed by the embryo, the latter (fat, thick, upright, pulpy, white yellowish exterior; cotylendous not oriented (2), very thick, pulpy occupying almost the whole seed, at first concave-triangular or (cuculate, hood-shaped, then developing with the vestiges of the endosperm between them, next becoming thicker, mealy, more pulpy., more wrinkled on the exterior and interior, ondulate-ruminate, being separable from one another with difficulty when they are still hard, separating and leaving between them a sort of lenticulave (lens-shaped) chamber in the diminishing of turgescence; superior rootlet enclosed, small, sunken between the colytedons; circular hilum, often irregular, basilar.

Value and Stability of the Characterestics in the Genus Castanea

The species of the genus Castanea are closer to one another than those of the genus Castanopsis. More minute observations are necessary to distinguish among them. For a rather long time, many botanists did not distinguish the Japanese chestnut from the American C. sativa.

1. Gaertner, De fructib, I, p. 181, appears the first to have observed in the fruit the existance of more than one seed.
2. The regularity of orientation of the cotylendous noticed by LeMonnier, Recherches sur la nervation delagraine in Ann. Sc. nat., 5 ser., XVI, p. 264, is not observed. According to Tognine, the plann of the petiole of the cotifedons is slightly oblique in relation to the synetric plan of the seed.

Castanophorum Necker, Elem. Bot., III, p. 257 (1790)

Trees or more rarely shrubs with furrowed bark, armed with lenticels often wider than they are tall(1). Axiilary buds (2), alternating, disposed on the shoots in two rows, armed with two pairs of scales scarecely inbricate, those of the inferior lateral pair each formed of two united stipules, the inferior scale drv, brown, the second a little longer, often greenish, each following scale corresponding to a stipule with or without the rudiment of leaves, the pairs of stipules following covering each a young leaf, increasin? in size with age, becoming oval-oblong, marking when they fall the branches with a narrow annual scar. Peticolate leaves often disposed thus 2/5, alternating, decidious, not spaced out, simple, oval or oval-oblong, penniveined, with edges always armed with teeth sometimes developed and tapering to a fine point, folded in the bud following the midrib and the lateral vein(3), leaving, after their fall, a slightly raised scar, semioval. Stipules 2, ordinarily-decaying, oval or linear-lanceolate, scarions or (gramineous / herbaceous, enveloping the leaf in the bud, leaving after their fall, a scar on each side of the foliar scar. Inflorescence in a false foliate panicle. Moxoecious flowers with erect catkins, unisexual and bisexual.. Cylendrical (ears / heads ♂, erect, appearing at the axil of the (lower / inferior (spikes leaves of the year, dropping off early, the (upper / superior catkins of the false panicle ordinarily androgenous, ♂ at the top, ♀ at the base. Flowers ♂ by 3-7, in contricted clusters (pl. I, f. 1 and 2), at the

1. The lenticels are transversal or nearly round. This characteristic is in accordance with that which Wetmore observed in other groups (Wetmore, Organization and significance in Dicolyledous in Bot. Gag. LXXXII, p. 71, 113, 1926) When the rays in the genus Castanea are composeu of uniseriate rows, the lenticels are transversal, but they are ordinarilly longitudinal when the rays are composed of several series, as in Quercus.
2. Chestnut trees do not have a terminal bud, the extremity of the branch dies and falls in the middle of summer and leaves a small circuiar scar near the highest axillary bud which will lengthen the branch in the following season.
3. Cf. Henry in Nov. act. nat. cur., XXII, I, t. 28 and Doll, Zur Erklar. Laubkan. Anent., p. 25, f. 1 (1848).

Androgenous catkins. - The position of the androgenous catkins and, consequently, that of the cupules have a certain importance.

Flowers ♀. - The number of flowers carried by the catkin vary in the same species. In certain limits, it is the same case with the nuinber of styles, while this number is stable in the genus Castanopsis.

Cupule. - The cupule, which differs from that of the genus Castanopsis by the symetry of its developmeht, varies quite a lot in the same species, at least in the cultivated types. The C. sativa and crenata have cupules of a less stable form than the C. mollissima or Seguinii.

The prickes are much less variable than in the genus Castanopsis, however the prickles of C. mollissina are quite distinct from those of C. Seguinni and of C. sativa. In no species do the prickles reveal the cupule as in C. Ashei and C. paucispina.

In this genus, on the adult cupule, in the area of the lives of dehisance only,-- the prickles are replaced by braces. This characteristic does not vary according to species, as in the genus Castanopsis.

Fruit. - In the species that are not cuitivated and selected as fruit trees, the fruit varies little. In the cultivated species, however, the form and the size of th2 fruit, the presence or the absence of tomentum on the pericarp, the number of {anters / cracks} in the cupule, vary quite a lot in the same species. This can be seen especially in C. sativa and crenata.

The extent of the scar varies a little, but nevertheless permits the recognition of certain species, C. crenata for example. In the spontaneous forms and wirh small fruits of the Japanese chestnut, the scar a little larger than in the other species; in all the cultivated forms of C. crenata, the scar is very large and quite characteristic.

Fructiferous head. - The disposition of the fructiferous axis is rather stable.

Male catkins. - The disposition of the male catkins is also rather stable in this genus. The length of the catkins varies very much, in the same species, with the individuals. The placement. of the male flowers is, however, a rather good characteristic with C. alssifolia.

Leaves. - The nature, the texture of the leaves and above all the presence and the form of the captiate hairs give some very good characteristics. As for the presence or the absence of secretory hairs, I have observed great variations on the same individual; in C. sativa, the leaves carried on the {new wood? / wood} of the year, situated at the extremity of the fruit-bearing branches, being very tomentose below, in the adult stage, while, on the same tree, the leaves carried on the older wood and on the off-shoots were {smooth / glabrons} or almost glabrons on the under side.

Stipules. - The characteristics given by the form of the stipules are excellent, but it is necessary to compare the stipules taken on branches of the same {size / order}.

The large and rather persistent stipules of C. mollissima permit us to easily distinguish this species.

Anatomy - Branches

Epidermis. - The epidermis often has unicellular "regular'! hairs, isolated or in twos (pl. I, f. 23-27), or stellate hairs or glandular hairs with a multicellular head (pl. I. f. 18-22).

Peridermis. - The sub-epidermis peridermis appears very early, beginning in the first year (pl. I, f. 9 s.). It is sometimes rapidly formed of 6-8 layers of ceils.

The cells of cork are tangentially drawn out, radially flattened, a little elongated on the longitudinal section. Its layers are always more numerous than those of the {cork / phelloderm}.

The phelloderm cells in the young branches are a little elongated longitudinally and have thin walls. In the older branches, the ceils are more isodiametric, with thicker walls and are easily confused with the ceils of the primary cortex.

The {xough or dead bark / rhytidome} is formed around the eigth or twelfth year. It attains 2 to 3 cm thickness in old trees and forms small {plates / patches} of 3 to 5 mm.

Cortex. - The cells of the external cortex are tangentially elongated, often have their wails slightly thick and form a tight tissue sometimes containing mechanical cells and a few crystals.

The internal cortex is formed of cells with very thin walls, scarcely longated longitudinally, leaving meatuses between them, containing some crystals (pl. I, f.10) and sometimes some mechanical cells. These mechanical cells which appear to be lacking in several species, are rather small and short in a longitudinal section; their wails are usually not very thick and {channeled / canaliculate} (pl. III, f. 14).

Pericycle - The pericycle forms a ring of small fibers (pl. I, f. 9), longituidnally elongated, with narrow lumen and very {thick / large} mechanical cells, tangentially drawn out, not elongated longitudinally or scarcely at all, and having canaliculate walls.

The pericycle lasts a long time In the genus Castanea.

Phloem. - The primary vascular bundles are disposed in convex arks. The {riddled / screened} tubes are isolated or in twos, belonging to the "grapevine" type of H. Lecomte. They are terminated in walls quite obliquely faced and armed with several screens.

The callons plaques are developed.

Cells with crystals are disseminated in the phloem, without any apparent order, and are ordinarily more numerous near the fibers.

The cells with crystals are usually in little longitudinal rows.

The phloem fibers appear rather early (pl. I, f. 11).

The rays are formed in a single series of cells rather large and almost equal.

Xylem. Vessels. - The vessels are single or double, joined together laterally or radially, sometimes separated by some rather flat parenchyma cells, with unequal cross-section, elongated radially, oval or irregular polygon, with walls of average-thickness. The burner of the vessels sometimes contains some tiloses in the perfect xylem (pl. I, f. 17).

The pitted vessels usually have some small, rounded pits in the contacts with the short parenchyma and some pits in the form of a horizontal or oblique line in the contacts with the bordered parenchyma.

When two vessels are sometimes in contact, the pits are numerous and form wide bordered lines.

Xylem fibers. - The fibers are very fine, with irregular sections, mostly polygonal; they have a clearly radial disposition, at least in the spring wood.

The wall of the fibers is uncolored, slightly thickened, armed, especially in the radial part, with oblique lines with a little circle at the center (pl. I, f. 16).

Short xylem parenchyma. - The short xylem parenchyma is abundant; it forms sinious tangential lines and rows that are sometimes crystaliferous.

The longitudinal section of the cells is rectangular; when this parenchyma is surrounded with fibers, it becomes very irregular nesr the vessels.

The transversal section of the cells is less irregular than that of the bordered parenchyma.

The horizontal walls and those in contact with similar cells are armed with numerous pits of irregular form. These pits are less numerous near the rays of the bordered parenchyma and of the vessels and very rare at the points of contact with the fibers.

Bordered parenchyma. - It is a parenchyma of irregular section, long and {spindle-shaped / fusiform, which formes several rows that are less numerous around the vessels. Its pits have the form of a horizontal line in the contacts with the vessels and the form of an oblique line in the contacts with similar cells. The rays and the short parenchyma. The thickness of the walls of this bordered parenchyma is nearly that of the fibers, but the transversal section of these cells is very irregular.

Rays. - The medularry rays are numerous (ordinarily 7-10 per mm.), very narrow, rectilinear in the radial sense, only slightly {deviating / warped by the largest vessels of the spring wood (pl. I, f. 13), formed of one, (rarely 2) row of cells. In the tangential cut they are formed of 4-26 (pi. I, f. 14) cells superimposed, ordinarily 10-15. The group of cells forming the rays have a fusiform tangential section, and are almost rectilinear or slightly arked following the direction of the neighboring cells.

The horizontal walls have less abundant pits, especiaily on the side of the parenchyma cells.

The vertical walls are rarely armed with pits in contact with the fibers, but in contact with the bordered parenchyma, the pits are rather large and slightly bordered. In contact with the vessels, the pits are large and irregular, especially in the spring wood. The walls are a little thicken around the pits.

The tangential walls are more or less curved or paralled and have rounded pits.

The lumen sometimes enclose several crystals or granulous concretions.

One usually observes two different kinds of cells in the rays; one kind that form the very short rays (3-4 cells) and the extremities of the rays, which ordinarily have rather thin walls, a more irregular form, and smaller pits; their section is oval, almost triangular at the extremity of the rays.

The other much more numerous cells from the greater part of the rays. Their walls are rather thick, their tangential section is rounded or squared with rounded corners, and their pits are larger.

Pith. - The pith is formed of polygonal cells ordinarily with thin walls. In a rather young shoot, a year old or less, the pith is greenish, rather firm and encloses simple and compound starch grains, a little chlorophyll and numerous crystals. Later the pith contains only amyl and is only amyiiferous tannin and tenniferous.

Leaf. - Petiole

The epidermis, rather rich in tannin, often has single "regular" hairs or double or triple and glandular hairs with multicellular (stem base).

Under the epidermis one finds some collenchyma, often with thick walls, formed of cells slightly elongated longitudinally, rich in tannin and, under this tissue, some parenchyma formed of cells with oval or rounded section, slightly elongated longitudinally, with thin walls, often containing crystals of ca oxylate, often arranged in rather long longitudinal lines, and rarely, only toward the extreme base of the petiole, some mechanical cells with very thick walls and elongated slightly longitudinally. These mechanical cells are much less numerous than in the genera Castanopsis and Pasania and do not mount into the petiole as in many species belonging to those genera.

The petiole has, at the stem, three (leaf bundles meristeles) formed of a variable number of vascular bundles (pl II, f. 3). These bundles, towards the base of the petiole, are arranged in a ring and assume the disposition shown in pl. III, f. 15. Higher up, the bundles ituated above the ark are curved inward on the inside, the two parts curved inward are separated from the ark and are united to form an internal vascular bundle, with (upper wood superior xylem). The ring is closed again and, at the summit of the petiole (characteristic of

Petit), one observes a vascular ring and well deveioped internal bundle (pl. II, f. 4), which is absent is very small leaves, according to Obaton (1).

The xylem is formed of vessels with a slightly large section (60µ in C. mollissina), covered with rays, spirals and pits, of xylem parenchyma, rays and fibers.

The xylem parenchyma has pitted walls, the longitudinal section of these cells is usually elongated longitudinally; its walls are thin, armed with less numerous pits, in contact with the fibers. The fibers are elongated with pitted walls.

These sometimes are some non-lignified xylem parenchyma, especially in the internal bundle and in the superior ark with inferior xylem, near the internal pith.

The phloem often contains some longitudinal lines of cells with crystals.

At the base of the petiole, the periderm is formed of cells with slightly thick walls, but not lignified. Higher up, the pexiderms are joined together while the three vascular systems form only one from it, and before the "Characteristic", one finds a peridermic ring whose fibers are elongated, with thick walls, sometimes pitted and with narrow lumen.

The internal pith, very large, relative to what it is ordinarily in the genus Castasopsis, is formed of cells with thinner lignified walls, very pitted, often *a* little elongated longitudinally and contains some simple crystals and crystals of ca oxalate.

Mid rib

The upper epidermis is formed of cells with the external wall slight' thick, convex, with rather thick secondary walls often pitted.

1. Obaton, Sur le manison das feailles des arbres in Rev. gin. Bot (1922), p. 264.

The cells of the lower epidermis are arranged in rather regular lines, their section is small, their external wall. is thin and convex or slightly thick, their secondary walles are often very thick.

Towards the base of the leaf, the midrib has a biconvex section and its structure is nearly that of the upper part of the petiole.

Under the upper epidermis, one finds some collenchyma and sometimes, on the upper side, some layers of parenchyma with thin walls.

On the underside, under the periderm, one observes some parenchyma and some slightly collenchyma-like external cortex. The cortical parenchyma is formed of cells that are more or less rounded, elongated longitudinally csntaining some crystals. These cells with crystals are often arranged in rows and are more abundant near the periderm.

The cortical cells with large lumen push back toward the outside, by their turgescence, the collenchyma-like cells under the epidermis.

The collenchyma is formed of cells with more or less oval sections, elongated tangentially and slightly longitudinally, often with slightly thick walls.

The periderm and the vascular system have the same arrangement as at the upper part of the petiole.

The internal vascular bundle, with superior xylem is often divided (pl. II, f. 5) and is sometimes armed with an ark well developed infra-phloem fibers. It sometimes contains phloem fibers.

In the upper part of the petiole, the internal ark disappears, terminates in the blind spot and there remains only the lower ark and the upper ark with superior xylem. The latter is ordinarily divided in two (pl. VI, f. 15) and in turn disappears at the summit of the leaf (pl. VI, f. 16). At this site one can still distinguish the periderm formed of fibers, with thick walls, and what remains of the internal pith, with much thinner walls.

Secondary Veins

Their section is usually biconvex (pl. II, f. 6). At the base of the vein there is ordinarily a vascular ring more or less discontinuous at the extremities. The periderm is sometimes more developed in its lower ark than in its upper ark. The fibers have more or less thick walls. Theis thickness quite variable. One sometimes finds side by side fibers with thick walls whose cumen is almost obliterated and others with rather thin walls.

This periderm is tied to the epidermises by some parenchyma that are very abundant on the lower side and lacking on the upper side and by some exterior collenchyna-like tissue often with slightly thick walls.

The internal pith, which is much larger than is the genera Castanopsis and Pasenia, is formed of cells with thin, lignified walls. Very rarely, there is a small internal phloem bundle. The xylem lacks elements with thick walls. The xylem parenchyma is abundant.

The epidermic cells often have their walls pitted (pl. V, f. 24).

Veinlets

The veinlets have a smooth / level / flat section, flat-convex, flat-concave or slightly biconvex. Their periderm Is often reduced to a few fibers; It is separated from the upper epidermis by some uncolored parenchyma or some fibers with thin walls and from the lower epidermis by some collenchyma with thin walls.

Parenchyma of *the* Leaf Blade

The thickness of the leaf blade in its parenchymatous part is not very great, it is often from 180-200 μ and does not exceed 250 μ. It is not as thick as certain leaves of Castanopsis and Pasania. The structure is two-sided; I have never observed an entirely palisade leaf blade, as in certain species belonging to the genus Quercus. The 2 epidermises are very different.

Upper epidermis. - The upper epidermis is formed of rather large cells, (pl. II, f. 8; pl. III, f. 5), usually not very tall, with (secondary lateral walls recti curoilinear, with ordinarv external walls, not having the thickness that they attain sometimes in several species of Castanopsig and Pasania, sometimes gelatingel within; the internal wall is sometimes very convex inside and the epidermic cells sometimes have *a* thin tangential position (pl. III, f. 20). This epidermis has not stomata. In youth, it sometimes has some "regular" hairs and even some glandular hairs in the adult stage (pl. II, f. 12-17).

Under the upper epidermis, one never observes a hypodermis, as it exists in certain species of the genera Castanopsis and Pasania.

Palisede and lacumar tissue. - Between the epidermises are found 1-2, rarely 3, palisade layers, of which the upper is the longest and a lacunar tissue equaling in volume the palisade tissue, more or less loose, formed of slightly (branching ramose cells, rather rich in crystals of caoxolate. The development of the palisade layers is moderate and does not indicate the same heliophile as in certain species of the genus Pasanica.

Lower epidermis. - The lower epidermis, with a thin external walls, is formed of cells with secondary walls recricurvilinear or undulated (pl. II, f. 9), always less rectilinear than those of the upper epidermis, not very thick, not very tall, with thin external walls, convex, never very thick, nor in papillas, as in several species of Castanopsis. This epidermis has stomata deprived of accessory cells (pl. V, f. 6), as in the Betulaceas and the Judlandaceas, often less tall than the epidermis and located in its external surface.

Hairs. - The lower epidermis can have some isolated "regular" hairs (pl. II, f. 29; pl. V, f. 3-10) or stellate hairs (pl. II, f. 30; pl. III, f. 23; pl. V, f. 11-13 and 27) with a single (coalescing stem concrescent base, and some almost sessile or long pedicellate glandular hairs, with ordinary head armed with

transversal and longitudinal partitions. These hairs, whose content is slightly colored by the tint orcanet, recall, in form, the pedicellate hairs with spheric head of Corylus Avellana.

The structure hardly varies from one species to another, except in the form and the presence of capitate hairs on the adult leaf.

In the genus Castanea, one does not observe hairs like the fingers of a glove as in Pasania, nor the scaly hairs of Castanopsis and several rare Pasania. The capitate hairs, almost sessile or long pedicellate of Castanea, are lacking in the closely related genera. Although certain authors have claimed that it is impossible to distinguish the leaves of Castanea from those of certain Quercus (Q. castaneoofolia, Q. Libani, etc.), the examination of the glandular hairs will render the distinction extremely simple. The glandular hairs of Castanea are not formed in the genus Quercus.

Edges of the Leaf Blade

The edge of the leaf blade is often rather thick. The epidermis is formed of cells that are usually much smaller than those of the leaf blade. It has an ordinary external wall, convex; this wall is never as thick as in the genus Castanopsis.

The sub-epidermis collenchyma with scarcely thick walls, often replaced by some aquiferous parenchyma with rather thin walls, is comprised of 3-5 layers of cells that are often slightly large (pl. III, f. 11, 13, 19; pl. V, f. 7 and 22). I have never observed any cartilagenous collenchyma with very thick walls, as in certain Castanopsis.

Ordinarily there are no fibious bundles right at the edge of the leaf, thick the near-by veins of the edge have only 2 large sclerified ards.

Teeth

The teeth are thin (C. alnifolia) or rather wide (C. sativa, C. dentata). In the first case (pl. V, f. 23), they are not transverse for the greater part

of their length except by the midrib, with xylem often reduced to a few vessels.

In the second case (pl. 11, f. 10), the teeth are transverse by a midrib and 2 small secondary veins, the first is formed of a vascular ark armed with 2 arks of fibers with thin walls united to the epidermises by some collenchyma with thin or thick walls. Teh secondary veins are usually reduced to xylem and sometimes armed with a little support tissue.

Sometimes there is only one big vascular bundle with two groups of trachids forming the flanges (C. mollissima) (pl. IV, f. 28).

At the edge of the leaf 'blade, the epidermis is formed of little cells with extremely convex walls. The upper epidermis sometimes serves as a water reserve. The lower epidermis has some stomata and sometimes glandular hairs and regular hairs. Under it is found a Little equiferous parenchyma with thin walls or some colienchyma (C. dentatę).

Under the single palisede layer a lacunar tissue exists.

Tannins in the Chestnut Tree

Tannins are abundant in almost all the organs and in much of the tissue of the chestnut tree. The tannin of the leaves, the xylem and the cortex is the same according to Freudenberg and Walpuski (1). The fruits are less rich in tannin than those of the oak.

The tannin substances can be considered as compounds of the nature of glucosides in which the esterification was produced between an aromatic oxacid of the fundamental gallic type and a sugar, usually glucose. The acids are often of the fundamental gallic acid type. They can be indirectly derived from quercitol and inositol. These tannic substances represent, in the glucoside stage, waste substances that t'he plant easily destroys by carburization..

1. Freudenburg and Wapluski in Ber. Deutsch. Chem. Ges. LIV, p. 1695-1700 (1921).

Tannin is a protoplasmic poisin because it coagulates the albuonin very much. We have seen that it appears in the germinanion of seeds. It can not be regarded as a reserve substance.

The xylem has a more elevated coefficient of absorption for tamin than for gallic acid, but it is difficult to accept that the easier elimination of the tamic substances, at the giucoside stage, by the absorbing action of the xylem cellulose, could be the cause of this formation. For one thing, the tamin is not an initimate part of the xylem, since it is easily surrendered / given up in water; for another, the destination of the tamic substances in the non-xylem tissues would be unexplainable.

For DeDominicis (2), the principal reason for the formation of tamic glucosides is ther oxidizability which is greater than that of the phenol-carbonic acids frcm which thye are derived. Tannin burns much more easily than gallic acid. It is important for plants that are nearly deprived of glandular organs to easily eliminate rather toxic products.

There is a sort of equilibrium between the tannin that is formed in certain organs and that which the combustion destroys. In the case of peripheral tissues, like the cortex, exposed to the action of atmospheric oxygen and the variable influence of external agents, the equilibrium also varies. Thus it is that the oxidation of tannin increases with the elevation of temperature and summer warmth.

Michel-Durant (3) has studied not only in the plantlet as we have already seen, but also in the adult chestnut tree, the influence of light on the formation of tannins.

The stems contain only a little less tannin in the light than in darkness.

---

2. DeDominicus in Le stangioni sperimentali agrarie italiane, V, L11, p. 305-331.
3. Michel-Durand, Influence de la lumiere sur la formation des tannins in C. R. (1925), p. 1171.

If one considers leaves that grew in darkness, one seen that the proportion of soluble tamins in water is much greater than in the leaves that grew in sunlight. The reverse takes place with tannins that are soluble in acetone 1.

In summary, the tannins soluble in water are more abundant in light in the tigella and the roots, less abundant in the leaves; there is almost no difference in the stem.

On the contrary, the tannins soluble in acetone are always found in greater quantity in the organs exposed to the light.

Plants developed in darkness and coming from seed, only contain trees of tannin in their cotyledons, and prepare tannins in their aerial or subterranian organs, about 14% of the dry weight in the stem and 23% in the leaves.

In general, individuals taken out of the influence of light are poorer in tannin than the green plants growing in the light, especially in the subterranian organs.

The genera Castanea and Castanopsis, Pasania and Quercus very probably have the genus Dryophyllum for a common ancester. It preceded them in Europe and is found especially in the cretacious flora of Aix-La-Chapelle. Debey called its leaves "querciforme" (1).

The Castanea differe morphologically from the Castanopsis, but which are almost Castanopsis with dissiluous leaves, originated in the mouth; one finds them very often in the arctic flora.

The genus Castanea has been observed from the Cretaceous period and the lower Ecocene period into the Pliocene and the Quarternailly (2), represented by leaves and fruits, the latter less well preserved.

---

1. Derbey, Sur les feidles querciforme des sable d'Aix-la Chapelle, Bruxelles (1881).
2. Zittel, tr. Barions, Traité de paleontologic, p. 419 (1891.)

In the lower Erccene period Gelinden, that of Sepanne and the rather large and very hard sandstone near Soissons, on findes some species that already have certain characteristics of Castanea and belong, strictly speaking to them: the Castanea sepannunsis and Saportae Watelet, the Dryophyllum centricellense Watelet; the D. palaeocastanea Sap. and especially the Dryophyllum Dewalquei Sap. and Marion which, according to Saporata (3), certainly appears to be the ancestial type of the chqstnut tree, with leaves of more leather-like cariaceous, probably indecidious, like those of Castanopsis.

Krausel noticed some leaves of Castanea in the Tertiary period of Selesia (4).

There exists also, in England, in the Eeosene, from the deposits of Bournemouth, a Castanea related to the type of C. pumila of the kicene of American.

In the fossils of the Arctic flora in northern Greenland and in Alaska, one finds towards the middle of the Tertiary, in the Ecosene, the ancestors of our chestnuts, Castanea Ungeri Heer. This species shows many affinities with C. pumila of America. Dr. Cowentz observed some flowers of chestnuts in the amber of Samland. Other leaves, found in the deposit of Atanckerdluk, further recall C. sativa.

It is towards the lower Miocene that these forms appear in the center of Europe.

The C. palacopumila And., of the Oligoiene, is found at Armissan, in the neighborhood of Naibonne, in slabs of limestone resting on marls with lignite and of the Miocene of Thalein, in Transylvania. It is associate with C. pumila and our C. sativa.

---

3. Saporta, Origine paliontologique des arbres (1888), p. 155.
4. Krausel in Jahrb. Preuss. Ged. Lanies, LX, p. 363-433 (1920).

C. Jacki Wurth has been observed in the Tertiary, near Constance, and specimen of Castanea fossils in Italy and in Greece (1).

At this time, there existed in Auveigne at Menat, a chestnut close to C. sativa, perhaps C. sativa. A leaf tound in the Pliocene of Cantal, at Cheylade, has been attributed, by Lauient and Maaty, to C. sativa, arid classified, by Maury, in the Iucertae, closely related to C. Kubinyi.

According to Loviaile, E. Larry possessed a piece of chestnut tree fossil found near Marathon (Charente). Lalande had collected, in the sandstone Triassic (du trias) at Saulieres near Donzenac (Correge), *a* piece of fossil chestnut tree. At the Brive Museum, there is a piece of a chestnut tree fossil that came from Vic-sur-Cere (Cantal).

C. munzebergensis Ett., from the Miocine of Netteravic, is close to C. sativa (Zittel.)

The Tertiary form recalling C. sativa the most, is certainly C. kubinyi Kov., from the recent Miocine of Hungary, observed also in Italy, whose leaves have cuspidate teeth, like our present species. C. kubinya Kov. and Uogeri Heer were found in the Tertiary terrains of southern France, in Croatia, in Styric, in Hungary and in Transylvania. Cavara noticed them on the northern slopes at the Apenuines, in Endis, in the Piemont, in several sites in northern Italy, near the gulf of Spezia, in Tuscary, near Sienna, at Poggibonsi and near Anione.

In the Tertiary of Colorado (Middle Rock), is found a kind of fossil, C. intermedia Lesq., very close to C. pumila.

Finally, fossils belonging to this genus have been observed in Asia a little to the north of the present location of C. crenata and that of C. mollissima.

1. Fax, Die fossile Flora von Ueskub in Mazedonion in Engler, Bot. Jahrb., LVII, p. 302 (1921).

In the distant past the genus Castanea existed in regions of America from which it has disappeared, it is found in Europe as far as Arctic zone, and in Asia, a little further north of the area that is occupied by the living species (2).

The present distribution of the genus is a remainder of that which existed in the Tertiary. The genus Castanea that is found at present in northern America., in Europe, is northern Africa, in Japan, and in China comes from species whose area of dispersal was much larger in the Tertiary epoch than is the area of the living species (3).

Towards the end of the Miocine, all of Europe, except the northern part had a climate nearly equal and mild, as is shown by the presence in abundance only only of chestnuts, but of many other trees (oak, elm, Ancr etc.) from Italy up to the arctic region.

Later, with the return of colder climate, the genus Castanea become more southern. It remained in the regions where the ice age did not destroy it and has since regained, in the historic age, other countries, especially in the north. Cultivation has very much extended the area of our C. sativa, to such a point that is is quite difficult to know the locations in the Mediterannean basin where it is really spontaneous.

Key to the Species of the Genus Castanea

A. Fruits ordinarily 3 to a bure, the central median one at least: as wide as tall, or wider than tall not counting without the "torch"); pericarp terminated at the summet in an obvious "torch" (sect. Eucastanon Dode).

   a) Trees; cupule from 3-10 cm. in diameter; fruit terminated in an eiongated "torch".

2. Cf. Edward Berry in American Journal of Bot. (1929), p. 551.
3. Keclhach, Uber ein interglaciales Torflager in Diluvicum von Lauenburg on der Elbe, Berlin (1885).

α Adult leaves smooth or silky below, with ordinary teeth; thin stipules, dropping off early; smooth or suberulent buds; spikes of the bur rather hard, smooth and glabiescent; young cupules a little hairy or smooth; styles not very hairy; rsther tall trees.

\+ Fruits more or less tapered at the summit with ordinary scars; burs often situated at the extremity of the branches, armed with spikes; large leaves, sometimes silky underneath, rounded or tapered at the base; large trees do not carry fruit very early.

x Fruits tapered briefly at the summit; leaves not tapered at the base, or hardly, tomentose in youth, those on the extremities of the branches often silky-whitish below, lusterless above; avoid-rounded buds; young branches with numerous capitate hairs . . . . . **1.** C. sativa.

xx Fruits with lengthy tapers at the summit; leaves tapered at the base, hardly hairy in youth, very quickly smooth, green, very shingy above, with stronger teeth; pointed buds, smaller; young branches with rare capitate hairs . . . . . 2. C. dentata.

++ Fruits rounded or very briefly tapered at the summit, with a large scar; burs often very lateral on the branches, leaves often small, smooth and silky above in the adult stage, rounded or {heart-shaped / cordate} at the base; trees shorter, carrying fruit very early . . . . . **3.** C. crenata.

β Adult leaves (at least those at the extremity of the branches) very strongly white-tomentose below, very discolored, usually longer and wider, rounded or cordate at the base, with edges armed with large teeth; large stipules, lasting rather long; silky buds; spikes of the bur less hard, very pubescent; young cupules very densely tomentose; elongated styles, heavily haired . . . . . 4. C. mollissima.

b) Shrubs or little trees; burs from 2–4 cm in diameter, usually lateral, armed with smooth or almost smooth spikes, fruits terminating in a rather short torch.

α Spikes of the bur long, slender, very branching, not completely hiding the secondary wall, fruit from 11–16 mm. in diameter; leaves aboval-oblong . . . . . 5. C. Sequinii.

β Spikes of the bur short, stronger, more squat, completely hiding the secondary wall; fruit 8 mm. in diameter, oblong leaves . . . . . 6. C. Davidii.

B. Fruit 1 (rarely 2) to a bur, elongated, taller than wide.

a) Pericarp termined at the sunmit in an obvious torch; glandular or regular hairs at least on one side of the adult leaves; teeth of the leaves not {bristled / setaceous} – {lepag flat / appressed} (sect. Balanocostamone Dode).

Trees or bushes 2 m. tall or more, with straight trunks, are propogated from time to time by {sucker offshoots / scions}; fructiferous axis having 2–10 burs.

\+ Young branches from 1–2, 5 mm. in. diameter, brown or redish-brown, smooth or almost smooth; buds more or less pointed or obtuse.

x All the leaves armed on the lower side with a velvety tomentum, the shaded ones hardly tomentose below in C. Ashei.

□ Spikes of the mature bur numerous, very close together; leaves leaves exposed to the shade and those exposed to the sun are similar, pointed at the tip, the veins not very clost together, 9–12 per dm. of midrib . . . . . 7. C. pumila.

□□ Spikes of the ripe bur usually spaced, not very numerous, polymorphus leaves, the shaled ones aboval-obtuse, with veins close together, i6–22 per dm. of midrib; lanceolate leaves

on the young vigorous branches . . . . . 8. C. Ashei.

xx Vigorous leaves, lanceolate, white-pubescent below, the shaded ones aboval and smooth; bur with pubescent-grayish spikes, numerous and clost together, or not very numerous, in thick tufts . . . . . 9. C. floridana.

xxx All the leaves similar, lanceolate, pointed and smooth, a little {bluish-green / flaucous} below or green; bur with numerous spikes, close together, glabrescent . . . . . (x?). C. alabamensis.

++ Young branches from 2–4 mm. in diameter thick, smooth; after buds, smooth except at the extremity; spikes of the bur close together . . . . . C. ozarkinsis.

β Dwarfed shrubs (ordinariiy 30–60 cm.); subteranian stems, branches from 10–30 cm. tall, rarely 1 m. in C. almifolia; fruclifeious axis rarely having more than 2 {burs / cupules.

+ Bur armed with dense spikes, smooth, dark brown; fructiferous axis from 2–3 cm long, smooth; leaves of the sterile branch rounded at the apex, yellowish–green, shiny . . . . . 10. C. alnifolia.

++ Bur armed with spaced spikes, hariy, grayish brown; fructiferous axis from 1–1.5 cm. long, pubescent; leaves of the sterile branches pointed or obtuse, but not rounded at the apex, dark green lusterlus . . . . . 11. C. paucispina.

b) Pericarp not very protracted with a torch at the summit, glandular and regular hairs absent on the adult leaves, teeth of the leaves with points very erect, almost {bristled / setaceous} (sect. Hypocastanea Dode) . . . . . 12. C. Henryi.

Anatomy

A. Glandular hairs with heads armed with walls that are usually horizontal and vertical.

a) Glandular hairs rare on the lower side of the adult leaves; head sometimes as wide as tall; teeth of the leaves traversed by 3 vascular bundles.

Young branches armed with numerous regular and glandular hairs; glandular hairs of the leaves with heads usually rounded . . . . . 1. C. sativa.

Young branches with rare regular and glandular hairs; glandular hairs of the leaves rarer than in C. sativa, with heads rounded at the summit, tapered at the base . . . . . 2. C. dentata.

b) Glandular hairs absent on the lower side of the adult leaves; on the young leaves pedicellace a long while, with head taller than it is broad, usually rounded at the summit, tapered at the base, teeth of the leaves traversed by a vascular bundle . . . . . 4. C. mollissima.

c) Glandular hairs absent on the lower side of the adult leaves, in the young subsessile leaves with rounded head or head wider than tall.; teeth of the leaves traversed by a single developed vascular bundle, sometimes also by two other rudinentary ones . . . . . 3. C. crenata.

B. Glandular hairs with heads armed with rare walls or no walls.

a) Glandular hairs not very rare on the lower. side of the adult leaves.

+ Regular hairs of the lower side of the adult leaves, some isolated and others stellate; the glandular hairs of the petiole pedicellate a long while, with pedicelle 3 or 4 times longer than the head . . . . . 5. C. Segrunii.

++ Regular hairs ordinarily lacking on the lower sfde of the adult leaves; glandular hairs of the petiole subsesille . . . . 6. C. Davidii.

b) Glandular hairs rather rare or very rare on the lower side of the adult leaves; stellate hairs on the lower side of the adult leaves, glandular hairs of the petiole subsessile . . . . . 10. C. alnifolia.

c) Glandular hairs usually absent on the lower side of the adult leaves.

+ Edges of the leaf blade with very reduced support and aquiferous tissue, shaded leaves smooth . . . . . 11. C. paucispina.

++ Edges of the leaf blade with rather developed support and aquiferous tissue.

x Regular hairs on the lower side of the leaves very numerous, even on shaded leaves, isolated or with not very numerous, even on shaded leaves, isolated or with not very numerous arms (4-6), slender, from 200-500μ long . . . . . 7. C. pumila.

xx Regular hairs on the lower side of the leaves rather numerous, even on shaded leaves, stellate, with numerous arms, slender, from 150-300μ long . . . . . 8. C. Ashei.

xxx Regular hairs of the lower side of the leaves rare or absent on shaded leaves, numerous on the others, with 8-16 arms from 60-120μ long . . . . . 9. C. floridana.

~ ~ ~ ~ Regular hairs on the lower side of the adult leaves absent or stellate and with numerous arms, short (50-150μ) . . . . . 3. C. crenata.

C. Regular hairs and glandular hairs absent on the adult leave . . . . . 12. C. Henryi.

Sect. Eucastanon

Eucastanon Dode in Bull. Soc. Dendr. Fr. (1908), p. 140 - Usually 3 fruits to the bar, at least the middle one as wide as tall, or wider, (without the torch); pericarp tapered at the summit into an obvious torch.

1. - C. sativa

C. sativa Miller, Guard. Dict. ed. VII, I (1768); Duhamel, Arbres et arbriss., I, p. 134; Koehne, Deutsche Dendr., p. 122; Nyman, Consp., p. 660; Suppl., p. 278; Parlatore, Fl. ital., IV, p. 170; Caruel, Prodr. fl. Tosc., p. 578; Piccioli, Monogr. d. Castagno, ed. 2, p. 5; Scop., Fl. carn., ed. 12, II, p. 242; Vis., Fl. dalm., I, p. 207; Ambros., Fl. Tyr. austr., IT, p. 61; Briquet, Prodr. Fl. Corse, I, p. 411; Hallier et Wohlf., Synops. Deutsch. u. Schw. Flora, p. 2294; Kirchner, Fl. v. Stuttgart, p. 190; Hegi, Ill. Fl. Mitt. Eur., III, p. 101. f. 438; Ardoino, Fl. Alp. Marit, p. 341; Elwes et Henry, Trees of Great Brit. and Irel., p. 839; Grecescu, Consp. fl. Roman., p. 527; Halacsy, Consp. fl. Gr., III, p. 125; Dode in Bull. Soc. Dendr. (1908), p. 146; Coste, Fl. Fr., III, p. 255; Rouy, Fl. Fr., XII, p. 307; Bornmüller, Beitr. zur Flora Macedoniens, III in Engler, Bot. Jahrb. (1928), p. 116. -- Fagus Castanea L., Sp., I, p. 997 (1753): Du Roe, Harbk. Baumg., I,, p. 270; Ali. Fl. pedem., II, p. 190; Suffren, Pl. Frioul, p. 189; Pollin, Fl. veron, III, p. 122. - - Castanea vulgar-is Lamk., Dict., 1, p. 708 (1783); Nouv. Duhamel, III, p. 65, t. 19; Spach, Veg. Phan., XI, p. 188; DC., Fl. Fr., III, p. 506; Prodr., XVI, II, p. 114 (excl. var. γη); Mathieu, Fl. forest., p. 284; Boiss., Fl. orient., IV, p. 1175; Ten. Fl. nap., V, p. 263: Fiori et Paol., Fl. Ital, I, p. 105, f. 905: Moris, FL. sard., III, p. 519; Savi, Fl. pis, II, p. 347; Gaudin, Fl. helv., VI, p. 168; Mouillief., Tr. arbres et arbriss., p. 1149; Gren, et Godr., Fl. Fr., III, p. 115: Koch, Syn., II, p. 736; Willk., Forstl. Flora, p. 428 (1887); Willk. et Lange, Prodr. Hisp., I, p. 246; Heldr., Nutzpfl. p. 18; in Sitzungsb. Wiss. Berl. (1883), p. 5; Raul., Cret., p. 857; Albow, Prodr. Fl. Colch., p. 219; Rad., Fl. des südwestl. Caspi-geb., p. 411, f., I. -

- C. vesca Gaertn., De Fruct., I, p. 181, t. 37 (1788); Loundon, Encyclopedia of plants, n° 13 361 (1841); Engl. Bot., t. 886; Reichb. f. Icon. fl. Germ., XII, p. 6 (1850); Nocc. et Balb., Fl. ticin., II, p. 192; Laguna, Flora forestal Esparola, pl. 28; Seb. et Mauri, Fl. rom. prodr., p. 331; Ten. Syll., p. 475; Puccin., Syn. fl. luc., p. 509; Guss., Syn. fl. sic., XI, p. 609; De Notar., Rep. fl. lig., p. 358; Bert., Fl. ital., X, p. 225; Griseb., Spic. fl run. et bith., II, p. 339; Marsh. Bieb., Fl. caucasica, II, p. 402; Hochstrasser in *Mitt.* Deutsch. Gesell. (1908), p. 174; Masclef, Atlas Fl. Franc., p. 174. -- C. Castanea Karsten, Deutsche Flora, p. 495 (1882); Schneider, Handb. Laubholzh., I, p. 156; Aschers. et Graebn., Syn. Mitteleur., IV, p. 441.

Icon.: Duhamel., 1. c., pl. L; Nouv. Duhamel, III, t. 19; Gaertn., 1. c.; Reichb. 1., 1. c., pl. DCXL; Hegi, 1. c., f. 488; Schneider, 1. c., f. 92; A. Camus, Castanea et Castanopsis, Atlas pl. 1, 2, 3, 6 et f. 1-4.

Common names of the chestnut tree and the chestnut

France: Chataigaier, Chataigner (1), Marron; Prov.: Castagnié, Castagne; Langue d'Oc, Castagnie, Castagno; Normandié: Cataigner, Catanier (Joret). -

1. The name of chestnut tree and chestnut has been given to other varieties of trees and to the fruit of different species:
Châtaignier de Malabar = Artocarpus incisa L. F.
Chataignier d'Amérique = Cupania americana L.
Châtaignier de la cote d' Espagne = Pachira insignis (Sw.)
Châtaignier de la Guyane = Pachira princeps (L. F.)
Châtaignier de Saint-Domingue, des Antilles = Cupaaia americana L.
Chataignier du Brésil = Bertholletia excetsa H. B. K.
Châtaignier de Tahiti = Inocarpus edulis Forst,
Chataigner corne = fruit du Trapa nutans L.
Châtaigne d'Amérique = fruit du Sloanea dentala L.
Châtaigne d'eau = macre, fruit du Trapa natans. L.
Chataigne de cheval, Marron d'Inde = fruit de L'AEsculus Hippocastanum L.
Châtaigne de la Martinique = fruit de Sioanea dentata L.
Chataigne de la Trinité = Pachira insignis (Sw.).
Chataigne de l'Inhambane = fruit du Telfairia pedata Hooker,
Chataigne de mer ou Caeur de Saint-Thomas = graines de l'Entada (Mimosa) scandens Bentham.
Châtaigne de Para = grames de Bertholletia excelsa H. B. K.
Châtaigne de terre = tubercules du Bunium Bulbocastanum, du Conopodium denudatum et du Lathyrus tuberosus L. f.
Châtaigne de Bresil = graines du Bertholletia excelsa H. B. K.
Châtaigne de Malabar = Artocarpus integrifolia L.
Châtaigne marine = fruit du Trapa natans L.
Chataigne sauvage = Brabejum stellutum Ph.

- Angleterre: Chesnut, Chesnut-tree, Eatable Chesnut, Spainsh Chesnut, Sweet Chesnut, Meat-nut. -- Allemagne: Kastanie, Dastanienbaum, Koestenbaum, Susser Kastanienbaum, Zahmer Kastanienbaum, Europaische Kastaniebaum, Essbarc Kastanie, Echte Kastanie, Edelkastanie. -- Flamand: Knstanieboom, Tamme Kastanieboom, Tamme Kastanji. -- Hollande: Kastanje-boom, Tamme Kastanje. -- Danemark: Kastanietrae. -- Suede: Castadie-tra. -- Prologne: Kaszlan. -- Hongrie: Geszleny. -- Boheme: Kastane. -- Italie: Castagno, Castagna, Marone (Ligurie, Marche, Ombrie, Toscane, Latium, prov. merid.); Castagn, Castan, Castegna, Castagna, Castagna (Piemont); Castan (Lombardie); Castagnar, Castegna, Castagno, Castagn, Maronera, Maronaro, Castagnard, Castagner, Ciastinar, Tistinnr (Venetie); Castangia, Castanza (Sardaigne); Castagnu, Castagnaro (Sicile, d'apres Piccioli). -- Tyrol: Kesch'n, Koscht'n. -- Croatie: Kostanj, Kesten, Marun. -- Transilvanie: Castagnar, Chistagner. -- Roumanie: Castan, Castane. -- Arabe: Kastel. -- Syrie: Kastana.

Main root: rather elongated, very {strong / stout}, secondary roots not very numerous, not very large, very ramified, spreading themselves out more or less in the earth and attaining a considerable depth. Tree usually from 10-15 m. tall, can reach 30-35 m. tall and 6-8 m. in circumfrence, usually {thick-set / squat; crooked / winding} trunk, dark grey, erect and slender, not very branched only in dense cover; ample {summit / crown}, spread out, with strong branches numerous and unibus; large branches twisted, spread out erect, almost horizontal, the lower nes rather often hanging down; young branches redish or olive brown, angular, when they *are* vigorous, and round when they grow slowly, armed with disciform hairs which sometimes give them *a* {scurfy / furfuraceous} appearance, then smooth, with greenish grey curtex, shiny, armed with elongated lenticelles, whitish or greyish, usually the year's brand redish brown, then greyish; towards 3-6 years, cortex olivish or greyish, armed with lenticelles transversely elongated, later, cortex of a silver grey, smooth and shiny until. about 18-22 years, at this time the internal periderm is formed and a thick rhytidome appears, lasting, largely and deeply fissured

longitudinally, of a rather dark brown. Buds avoid--rounded, smooth, greenish, tinted with red, those at the summit of the branch mostly larger, the first scale small and short, the second longer, each formed of two stipules united, smooth and {fringed / ciliate}, the third corresponding to a stipule, covered with {injury flat / appressed} hairs, as long as the leaf that is wrapped up, the fifth pair formed of narrower scales and almost the length of the leave. Leaves (1) opening up generally in May and falling in October or November, often disposed 2/5, on the small lateral branches 1/2 (3/8 and 5/13 have sometimes been observed), alternate, not or scarcely pendant, elliptic-lanceclate, oblong-lanceolate or oval-lanceolate, rounded and often with small appendages like auricles at the base, deciduous, 8-20 cm. long, 5-8 cm wide, armed with suspidate teeth, prolonged in a find' point, at least the {superior / upper} ones curved upwards and corresponding to the extremity of the veins, the young ones creased during {leafing / vernation} following the principal veins and the secondary veins, armed above with glandular capitate hairs, yellow, numerous, below finely haired, whitish and with glandular capitate hairs, yellow, rather abundant, the adult ones firm, dark green, shiny above, sometimes a little dull, smooth on the veins, except for a few sparce deciforme hairs, below {becoming sea green / glaucescent} and almost glabrous, at the end almost of uniform color, sometimes hairy below, often, on the same tree, silvery, pubescent-silky below, at the extremity of the branches on the annual wood, of a uniform color and smooth or almost smooth below on the wood more than a year old and the shoots(2); midrib and secondary

1. The difficulty in distinquishing between isolate:' leaves of the chestnut tree and those of Quercus serrata and castaneaefolia has often been emphasized, If the form of these leaves is sometimes analyagous, the different nature of the hairs prevents any confusion, the presence of capitate hairs, in the chestnut, is quite characteristic.
2. I observed this difference on a very large number of our chestnut, especially at Garde-Freinet (Var.) [southern France]. It appears to be the same with C. mollissima, and probably also in other species, but with a difference perhaps less striking between the tomentum and the smoothness of the surface of the underside of the leaves. The leaves in shadow are usually much smoother than those exposed to the sum.

veins salient below, the latter impressed above in youth, 12–20 pairs, right, simple, almost paralled; petiole 1.5–3 cm long, rarely less (0.5 cm), puberulent; stipules rapidly falling off, narrow, oblong, slightly wider below the middle, with large insertion, 1.5–2 cm. long, armed with glandular hairs, foliar scars obcordate or semi–circular, prominent. showing the trace of the 3 groups of petiole bundles; scar of the stipules elongated, linear. Catkins the 1 ones assembled at the extremity of the branches, at short intervals from one another, almost verticellate, the others (above superior, (bisexual androgynous. ♂ catkins 10–35 cm. long, usually 20 cm., very numerous, erect, upright or slightly curved, pale yellow, reaching 1 cm. in diameter, axis almost cylindrical, armed with short sparse hairs. ♂ Flowers in little glomerules more or less distant at the exilla of a ~carious bract; yarianth with 6 divisions (rarely 5) in 2 rows, erect–exposed, almost pointed, flagellate, more or less visibly; 8–12 (rarely 20) staymen, inserted in the bottom of the pericanth; fibers free, white and smooth (1); anthers salient quite a while, small, yellow, ((2-celled) notched bilocular, emarginate at the two extremities, (fixed on the back dorsifixus with almost glovelous cells opening in two lontudinal fissures; yellow pollen. At the base of the androgenous catkins, 1–3 ♀ (lower flower clusters inferior flomerules, next several groups of ♀ flowers, often 6 staymen in 2 verticiles: 3 large ones and 3 small ones, sometimes 12 staymen, with short fiber and aborted anther. ♀ glomerule formed, at the axil of a decaying scale, with 2 prophylls an involucre with 4 values and 3 ♀ flowers (rarely 1–7) which have one terminal. and 2 lateral secondary ones. Flowers: perianth with 6 hairy–tomentose lobes; inferior ovary with 6–8 (10) ~.ells, each lobe biovulate; cells unequally developed, showing sinuosity on the transversal

1. In the bud, the staymen have their fibers curved within. The external staymen at first erect their fibers, but sometimes, in the faded flowers, some staymen keep their fiber curved within.

section; ovules suspended, elongated: anatropous, descending, with micropyle /superior
(growing above and on the exterior, 2 to a cell, well developed at the time of (full bloom
(anthesis; 6-9 styles, often 7(2), cylindrical, rigid, at first erect, slender, pale green, brown at the summit before becoming entirely brown, stigmateferous only at the summit and within, often hairy at the base, smooth above. Involucre or cupule (chestnut bur or toothed cylinder) at maturity almost spherical or a little depressed, from 5-6 cm. in diameter in the forest varieties, sometimes 10 cm. (with the spikes), in the cultivated varieties, the inferior cupule of each fructiferous axis almost touching a branch with leaves, with rather thick walls, silky interior, hardly hairy exterior, sometimes having small scales, then subulate spines, elongated, branching, almost smooth, at first green, then brown. The cupule almost entirely surrounding the flower, leaving the styles that remain free and visible close together at the summit, (swelling
forming around them a rather thick cushion, lobed, with edges slightly recurved, very tomentose, which should not be confused with a pericanth; the perianths of the three flowers are enclosed. At maturity, the cupides are found or androgenous catkins whose upper male part often still persist dried out, the axilla of developed leaves, at the extremity of the branches that have 2-3 large leaves above. Cupule opening at maturity, in 4 values armed with small bracts on the lines of dehiscence and, on the rest of their surface, with branching spines, more or less close together, enclosing as many large fruits as there are flowers, usually 3. At the moment of anthesis, a single ovule is developed, it enlarges, grows and destroys the walls, filling the cavity of the pericarp, displacing the central column of the ovary. 'Chestnuts usually 3 (sylvatic varieties), sometimes 1-5, at first green, then brown, tapering at the summit

2. Many authors attribute 3 or 6 styles to the chestnnt. I have never observed 3, very rarely 6, often 7-8, sometimes more. The median flower often has more styles than the lateral flowers.

in a rather long torch, 2.5–4 cm. at the largest diameter, less in the sylvatic varieties, the lateral ones convex on one side, the median one with sides flattened by conpression, usually containing a fertile seed. Pericarp very coriaceous (leather-like), elastic, armed with barely distinct lines resembling meritians, usually almost smooth at maturity or having some white hairs especially towards the summit, silky on the torch; scar large, but only occupying the base of the chestnut, whitish or almost yellowish. Coriacious legument, brownish, rather fragile when it has arrived at a certain degree of dissication, with quite visible veins, hairy. Seed having at the summit the aborted ovules. Adult embryo lacking albumen. Cotyledons 2, unequal, floury (mealy), occupying almost the whole seed undulated – plicate (folded), yellowish-white, firm, mealy, sweet, without constant orientation (1), separated from one another with difficulty (2), with numerous and deep sinuosities. Relatively small radicle, growing above, erect, cylindrical, almost obtuse, firm. Flowering: June-July; and of May in Var (South Prance); fruits: end of September-October. The cupules open from top to bottom in 4 valves, a little later in the sylyatic varieties. The chestnuts appear crowned with the perianth and their styles, attached by their large scar. They fall or remain attached, according to the variety. Whether the cupules open or remain closed, I have confirmed that the decurtation (fall of the one-year-old healthy branches) takes place at the base of the androgenous catkin. Whether the latter has one or several cupules, the axis of the catkin, rather fat and a little lignified at the base, often still topped at the summit with the desicated part carrying the ♂ flowers, falls in aulomn, taking with it the cupules. This mode of fall does not appear to have been noticed.

---

1. The regularity of orientation described by Le Monnier (Roch. sur la nervation de La graine) is not stable. Tognini thinks that the petiole of the cotylendous is slightly oblique as related to the symetrical plan of the seed.
2. As turgescence dimishes, these cotyledous finally separate. A lenticellular chamber appears between them.

Principal root of a young plant 10 cm. tall, (Pl. 1, . 7 Piliferous stratum base still bearing hairs. Ccrtex (Ec) formed of 18 to 20 layers of small rounded cells, with very thin walls, containing tannin and starch, sometines in great quantity. Endoderm (End) rather marked distinguished, formed of cells with thin walls. Pericyclic cells (P) with thin wails, 6–10 vascular bundles, then phloem (L) forming a ring, containing relatively large crystals and some starch. Some rare sparce fibers in the phloem begin to be differentiated. Xylem (B) forming a frequently interrupted ring between the bundles. There are not yet any thick–walled elements in the xylem. Pith (M) very large, formed of polyognal cells which leave small intercellular spaces in between, containing very much starch and tannin.

Principal root of an older and larger young plant, (Pl. 1, f. 6). All the cortex has been sloughed off by the internal periderm. The cork consists of several layers of small flattened cells. Phloem (L) developed., back to back with small masses of little fibers (F), and containing a thick ring of 2–4 layers of fibers with a slightly larger section cross section. Xylem (B) forming a ring where the primary bundles are hardly distinguished any Longer. Xylem fibers with walls not very thick. Vessels with small cross section section. Numerous rays, uniserate, Pith (M) very large, relatively, formed of cells with thin walls, cells of 1–2 external layers with slightly lignified walls like certain sparse cells in the pith.

Slender radical fibers originating in a principal root, (Pl 1, f. 8). Cortex (Ec) comprising about 6–7 layers. Amyliferous endoderm. Phloem (L) in occasionally interrupted ring facing the xylem poles. Xylem cylinder (B) continued, without thick–walled elements. Vessels with small cross section section, 4–5 xylem and phloem poles.

Older root. - Very clear annual increases in growth, marked by a zone of very fat vessels, close together, even touching one another, followed by vessels with

cross section
small grouped sections arranged in lines or disseminated; very narrow uniseriate rays.

Branch

Epidermis. - The epidermis at first has extremely numerous "regular" hairs, unicellular, pointed at the summit, isolated or in groups of 2, or rarely 4, reaching 10-40µ (individuals from the Paris area), or 40-50µ (Pl. 1, f. 23-27), or 120-200µ and even 750µ (individuals from Garde-Freinat, Var).

This epidermis is also armed with abundant glandular hairs (pl. I, f. 18-22) making the stem nery glutinous.

All the hairs fall rather rapidly with the epidermis.

Periderm (Pl. I, f. 9). - It orginates in the first hypodermic layer. The cork is formed of tubular cells, with russety contents arranged in radial lines. In a first year branch, at the end of autumn, one sees, under the epidermis, 5-6, sometimes 8 layers of cork with walls regularly thick and only one layer of phelloderm formed of almost isodiametric cells (12-18µ) or slightly flattened radially on a transversal section, but two times taller than wide, with not very thick walls and ordinarily containing chlorophyll.

In 2 year old branches, the phelloderm is still formed of only one layer whose walls are thicker and, in the longitudinal cut, the horizontal walls are not as thick as the vertical ones,

In the 3 year old branches, the phelloderm consists of one or two layers of cells very developed tangintially which can reach 35-40µ on the major axis. Their walls are thick and slightly collenchymatose.

In the 4 year old branches, the periderm still only contains a few layers. In the old branches the collencymatose cells of the phelloderm ere not drawn out longitudinally as in the young branches, 'but come to ressemble very much the cells of the primary cortex and almost be confused with them. On a longitudinal section, both are isodiametric.

The rhytidome appears towards the eighth or twelfth year and reaches 2–3 cm. in thickness, in very old trees. It is formed of little plates 2–3 cm. thick.

Cortex. - Cortex usually rich in chrystals (pl. I, f. 10) and formed of more or less rounded cells; in the external region it is collenchymatose and has slightly thick walls. Interior cortex with thin walls and forming a slightly loose tissue. I have not observed any cortical mechanical cells with thick walls.

Pericycle. - Pericycle formed of a ring of little fibers with very thick walls, next cover arks containing longitudinally elongated fibers, with small ('section (corn-section, united by large mechanical cells not longitudinally elongated and whose corn-section reaches 80μ in diameter.

Phloem. - Isolated riddled tubes, or in twos, with walls directed very obliquely and provided with several { riddles / sewes / screens. Developed callous plates.

Phloem fibers arranged in tangential groups which can form, at nearly regular intervals, thick rings, from 3–6 layers of fibers in thickness (pl. I, f. 11, Fil), interrupted opposite the rays. The fibers are 1.5–2 mm. long.

Phloem contains numerous simple crystals and crystals of calcium oxalate, the former especially near the phloem fibers, the latter spread around in no apparent order.

Medullary rays always formed of a single series of cells with rather large, almost equal lumen.

Xylem. - Large vessels in distinct zones, in the spring wood. Vessels with walls of average thickness, in transversal section (pl. I, f. 13) irregular oval or irregular polygonal, elongated radially, very unequal varying approximately in the proportion of 1 to 6 from one edge of growth to the other, the largest reaching about 60–80μ, sometimes isolated, sometimes appearing to be joined side by side in twos laterally, radially, or obliqueiy, but ordinarily, in this case, the separation is formed by more or less flattened

parenchyma cells, the vessels of the interior edge arranged in 2–3 rows or more, nunierous and very large, rather close together, forming with a tissue a less thick wall, a more porous zone on the interior edge, then usually diminishing rapidly in the ,corn–section ':section, then more or less insensibly up to the exrorior edge. These vessels, localized in the largest radial sections, form either bands or irregular lines, sinuous, raidiating, oblique in relation to the rayl but more radial in the autumn wood sometimes interrupted, sometimes originating in the ,depth thickness of the growth (accretion; continuity of these lines more or less distinct across the successive accretions. Longitudinal course of the vessels more or less oblique. Horizontal or oblique walls of the primordial cells forming the old contacts completely reabsorbed in the largest vessels, not having quite dissapeared in the little ones. Len numerous punctuations than in the genus Quercus, more or less lacking in 'incrustations in forms of a ung .,areolas little and rounded when they are in contact with the. short parencyma; in the form of a horizontal or oblique line near the arsolate parenchyma, irregular ones in contact with the rays and closer together, numerous acd in the form of large areolate lines, in the rather rare contacts between 2 vessels. Tn the perpect xylem, yellow–brownish tyloses (pl. I, f. 17).

Parenchyma areolate elongated in a spindle, often in a very irregular form, arranged in not very numerous rows around the vessels. Areolate punctuations in the form of an oblique line in the contacts with the other similar cells, the rays and the cells of the short parenchyma and in the form of horizontal lines in the contacts with the vessels. Thickness of the walls of the areolate parenchyma nearly equal to that of the fibers, but very irregular transversal sections.

Short parencyma forming sinious tangential layers, more or less continuous and separating 2-4 fibers, in the transversal section less irregular than chat of the areolate parenchyma, quite modified by the pressure of neighboring cells, on the longitudinal section very irregular near the vessels, but rectangular when this parenchyma is surrounded by fibers, with thin walls, thicker around the punctuations. Horizontal walls and walls separating similar cells provided with small punctuations that are numerous and irregular; punctuations are less abondant in contact with the vessels, the areolate parenchyma and the rays, very rare near the fibers, especially in the autumn wood. Rows of lignions parenchyma sometimes crystalliferous. Lumen often enclosing small granular concretions, brown or hyaline in the shape of an olive.

With the parenchyma, the fibers form small radial secters 2–4 cells wide and fill with it, the parts of the largest secter, 8–10 ceil wide in which the cells of the areolate parenchyma and the vessels are situated. Arrangement of the fibers rather irregular, sometimes in radial rows. Fibers irregular section, usually polygonal, with walls about 3 times thicker towards the exterior of the accretion, also very compressed radially. this edge could also be very marked, even if in the following zone there were no large vessels and no thin-walled tissues. Sometimes fibers armed with punctuations in the form of oblique dashes (pl. I, f. 16), with, at the center, a small areola visible, especially in the sping fibers; punctuations existing especially in the radial walls where they are r latively numerous; tangential walls appear through/on locality plaited
by position slightly plicate in a spiral. No meatus between the
per place
fibers and the central cells of the rays.

Meduldary rays very numerous (about 7–10 per mm.), uniseriate, rectilinear, 6–30 cells tall, usually i4; several smaller rays, only from 3–6 cells tall. (pl. I, f. 15), sometimes a cell divides in two, rarely several. Groups of cells forming the meddellary rays in tangential section (pl. I, f. 14) fusiform and rect'ilinear or slightly arched following the direction of the neighboring

cells, rectilinear in the radial sense, only deviated by the proximity of the largest vessels of the spring wood and then in a very irregular form; cells about 7-8 times longer than the cross section of the fibers, shorter toward the exterior edge of the accretion where this length often equals the cross section of the most flattened fibers of this zone (1).

Ray cells of two kinds: one kind in 1's and 2's forming the extremity of the groups and sometimes the. center or the smallest rays of 3-4 cells, oval, elongated or more or less triangular at the extremity of the rays, in irregular (shape
'form, with thinner walls, armed with smaller punctuations than the other cells, the latter more numerous, situated at the center and forming the greatest part of the long rays, on the tangertial section rounded or square, rounded at the corners, with rather thick walls armed with punctuations that are a little larger. Tangential walls of these 2 kinds of cells more parallel or more or less oblique or curved and armed with rounded punctuations. Horizontal walls provided with not very abundant punctuations, sometimes two on the same alignement facing the cells of the parenchyma. Vertical walls armed with rather numerous puncutations opposite the parenchyma, a little larger and slightly areolate in contact with the areolate parenchyma, rarely existing opposite the fibers; larger punctuations, in irregular form and covering more than half of the contact with the vessels, especially in the spring wood. Cross section of the wall a little thickened around the punctuations. Lumen containing through by the spot some granular concretions and some hyaline crystals.

Elements of the xylem all smaller In youth, growing in length and size until 7- and 80 years, than diminishing again, The xylem of the sylvatia varieties is harder, more compact than that of the orchard varieties.

---

1. Thil, Caract. microscop. des bois indigenes [Le micrographe preparateur, VI, p. 206 (1898).]

The differences that are found in the form and dimension of the annual rings depend especially on the conditions of vegetation and on the part of the tree and not on the particular variety.

Pith. - Pith formed of polygonal cells on a transversal section; almost quadrangular in the lonitudinal section, with very thin walls, some oxaliferous. Tanniferous cells usually grouped., I did not observe any mechanical cells.

Petiole. Initial (Pl. II, f. 3). - Elongated section. Subepidermal collenchyma with very thick walls. Cortical parenchyma containing extremely numerous crystals, and, in the internal part, some mechanical cells with thick walls, grouped between the meristeles, 3 meristeles, the median formed of 5 bundles. Very few above the initial one, vascular bundles arranged in rings. - Characteristic (Pl. II, f. 4). Slightly elongated. section. Epidermis having short "regular" and secretory hairs like those of the leaf blade. Collenchyma and parenchyma like that fibers with very thick walls. More or less interrupted vascular ring surrounding a vascular bundle, internally elongated, more or less continuous, furnished with infraphloem fibers with thick walls., Internal pith formed of cells with thick walls.

Midrib. Base. - Biconvex section. On both surfaces, collenchyma with slightly thick walls, extending a little on the leaf blade to the upper surface. Oxaliferous parenchyma. Periderm and vascular ring same as on the summit of the petiole. - Center (Pl. II, f. 5). Bioconvex section, abrubtly bulging above. Collenchyma and parenchyma like lower part. Thick periderm. Vascular system more or less interrupted, especially the middle bundle; phloem containing numerous parenchyma; no fibers with thick walls. Internal pith formed of cells with thin and lignified walls; sometimes a few fibers of the phloem in the internal vascular bundle.

Secondary veins (Pl. Ti, f. 6). - Biconvex xection. Collenchyma with thin walls on both surfaces; parenchyma containing some twin crystals on the inferior surface. Periderm formal of fibers with thick walls. Vascular ring with interrupted phloem. Internal pith relatively large, formed of cells with thin walls. - Veinlets on the flat plane section; periderm with slightly thick walls attached to the epidermis by some lignified tissue or by colorless parenchyma with thin walls.

Parenchyma of the leaf blade (Pl. II, f. 7). - Thickness - 160-180μ. Upper epidermis glabrous in the adult stage, 18-20μ deep, formed of cells reaching a diagonal measurement of 40-50μ, with recticurvilinear lateral walls, ordinary (pl. II, f. 8), with ordinary exterior walls, not perceptibly bulging. On the young leaves, upper epidermis having numerous glandular hairs, pedicels, with multicellular top, rounded or wider than tall, usually 8-cellular, with contents colored more or less by acetic or canet. Tissue palisade-like in 2 layers, 1 towards the edge of the leaf blade, the upper height of 25-30μ. Lacunose tissue rather loose, containing some twin crystals. Inferior epidermis 8-10μ high, formed of cells of rather unequal size, sometimes attaining a diagonal measurement of 6-70μ, with lateral thin walls, undulating (pl. II, f. 9), with exterior thin walls, slightly bulging, having secretory hairs with multicellular tops, with dividing walls less numerous than in those of the upper epidermis, often lacking in the adult leaves, and structural hairs single, double or in bundles, sometimes reaching 500-750μ, when they are single, 250-300μ long when they are in threes or fours, at first numerous then rarer or lacking in the adult stage; stomata 25-30μ long, numerous. - Edges of the leaf blade (Pl. II, f. 11) strongly bent backward recurved. Marginal epidermis with little cells furnished with an ext. bulging wall, of medium thickness. Several layers of collenchyma with thin walls; no hypodermis extending on the leaf blade.

- Teeth (Pl. II, f. 10). Base of the tooth formed by a leaf blade 150 thick towards the center and 90μ towards the edge. Epidermis with exterior wall:; thicker than on the leaf blade. There is a palisade-like layer and some lacunose tissue. This leaf blade is traversed by a developed midrib with flat-convex or concave-convex sections, with a vascular bundle in an arc which is attached to the upper epidermis formed of little cells with external walls bulging and thin, by some lignified ceils and to the lower epidermis by an arc of the fiber bundle and 3-4 layers of collenchyma sometimes having thin walls. Towards the edge, on each side, one sees a veinlet with bundles hardly'developed and abundant support tissue. At the very edge, the epidermis is formed of cells a little smaller, with exterior walls slightly thick. Under the epidermis there are several layers of water-bearing tissues.

Stipules. - Epidermis having numerous capitate glanular hairs (pl. II, f. 24 and 25).

Varieties of Castanea sativa cultivated in the United States

C. sativa bears fruitswhich are not highly estined in the U. S. Its cultivation has been rather productive in New Jersey, Pennsylvania, Delaware and Maryland and several varieties of C. sativa bearing good chestnuts were introduced west of the Rocky Mts., in California and Oregon. C. sativa, like C. dentata, was stricken, in America, by Endothia. The former resist this disease perhaps slightly better than the latter.

We shall site among the varieties the most important(1):

Anderson - Average or small cupule. Fruits of average size; pericarp brilliant red-brown, pubescent at the summet and on half of the fruit. Hardy tree having small or average leaves.

1. Cf. Ragan, Revised Eatal. of Fruits in Bull. U. S. Dept. Agric., Div. of Pomology, No. 8, p. 46 (1899).

Bartram - Average or small. cupule. Average fruits armed. at the summit with a thick tomentum, dark brown, three to a bur, good quality, not attacked very much by insects. Vigorous tree, spreading. productive, with large leaves.

Chalon - (Marron Chalon Early) - Introduced from France. Fruits of average size, abondant, early.

Combale - French variety of chestnut sometimes cultivared in the littoral region of California where it was introduced in 1970.

Comfort - Large fruits of good quality. Variety cultivated in Delaware, New Jersey, Maryland, Virginia, etc.

Cooper - Good quality fruit of average size. Cultivated in the same regions.

Carson - Plymouth. Large bur. Large. or average fruits, usually 3 to the bur, dark brown, striped striated, pubescent at the summit, of very good quality. Vigorous tree, spreading, very fruitful.

Dager - Average bur. Average or large fruit, dark brown, with thick tomentum, usually 3 to the bur, good quality. Vigorous tree, spreading, productive. Descended from a seedling seed plot at Ridgely.

Darlington - Average or small bur. Average or large fruits, usually 3 to the bur, dark, distinctly striated, armed at the summit with a thick tomentum; sweet kernal, good. Vigorous tree. One of the varieties very early to mature.

Lyon Chestnut Marron de Lyon - Does very well in California, but is less productive than the combale variety which it resembles.

Marrons Chestnuts - Several varieties are cultivated under this name.

Miller - Average fruit of mediocu over age quality.

Moncur - Average bur. Average fruit, light colored, tomentose. Vigorous tree, spreading, ve'ry productive. Descended from a seedling at Ridgely.

Norizillard - Variety from ~en·tralFrance which bas been tried without much success in Pennsylvania, California and New Jersey.

Numbo - Average bur, conical. Large fruits, 2-3 to the cupule, shiny brilliant brown, striated, ~tightlytomentose; good quality kernal. Compact and weeping tree, of uncertain yield. Often planted.

Paragon (Great American, Sobers Paragon) 0 Possibly a hybrid of C. sativa with C. dentata. Very large cupule. Large fruits, usually 3 to the bur, large; shiny brown pericarp armed with a thick tomentum at the summit and on a part (about 2/3) of the fruit: kernal of very good quality. Spreading tree, vigorous, with narrow leaves, roughly fastened, very productive, but not very resistant to cryptogamic diseases. It is a variety often planted in the U. S., and the one which gives the best results.

Quercy (Marron Quercy) - Fruit of average size. Sometimes planted in California for its precocity and production qualities. Origfnated in Prance.

Ridgely (DuPont) - Average bur. Average or large fruit, moderately tomentose, dark, of very good quality. Vigorous tree, very productive, with narrow leaves, spreading, resistant to cryptoganic diseases.

Scott. Average bur. Average fruits, scarcely pointed, usually 3 to a bur, lustrous, dark brown, scar only tomentose at the summit. Spreading tree, very productive. Only rarely stricken by Endothia.

Styer - Average cupule. Average fruits, pointed, dark brown, striated, tomentose at the summit, 1--3 per cupule. Very vigorous tree, erect, with large green leaves. Resists rather well against cryptogamic diseases.

2.--C. dentata

C. dentata BORKAUSEN, *Handb. der Forstbot.*, I, p. 741 (1800); SUDWORTH in *Bull. Torrey Bot. Club*, XIX, p. 152; *Rep. Soc. Agric. U. S.* (1892), p. 328; SARGENT, *Silva North Amer.*, IX, p. 13 (1896); HITCHC. et STANDLEY, *Flora Distr. of Colombia* in *Contr. U. S. Nat. Herb.*, 21, p. 137 (1919); BRITTON et BROWN, *Illustr. Flora*, I, p. 515; SCHNEIDER, *Handb. Laugh.*, I, p. 156; DODE in *Bull. Soc. Dendr.* (1908), p. 148; MOHR, *Plant life of Alabama* in *Contr. U. S. Nat. Herb.*, VI, p. 468 (1.901); GRAY, *New Man.*, ed. 7; ROBINSON et FERN, p. 338; BAILEY, *Cycl. Hort.*, 9eth ed., I, p. 742-(1927); ELWES et HENRY, *Trees of Great Brit. and Irel.*, IV, p. 856.--Fagus Castenea WANGENHEIM, *Beschreib. Nordam. Holz.*, p. 90; (1781); SCHOEPF, *Mat. Med. Amer.*, p. 139; WALTER, *Fl. Car.*, p. 233; CASTIGLIONI, *Viag. negli Stati Uniti*, II, p. 239; non L.--Fagus Castanea dentata MARSHALL, *Arbust. Am.*, p. 46 (1785).--C. ~~vesca~~ americana MICH., *Fl. Bor. Am.*, 11, p. 193 (1803); LOUDOB, *Arb. et Frut. Brit.*, III, p. 1984 (1838); EMERSON, *Trees and shrubs of Massachusets*, p. 164; ed. 2, I, p. 187; PERSOON, *Syn.*, II, p. 572; PURSH, *Fl. Am. sept.*, II, p. 624; NUTTALL, *Gen.* II, p. 217; ELLIOTT, *Sketch of Bot. Car. and Georg.*, II, p. 614; TORR. *Fl. N. Y.*, II, p. 195, t. III.-C. vesca WILLD. *Spec.* IV., pt. I, p. 460 (1805), p. p. ; DESF. *Hist. Arbres et abrisseaux*, 11, p. 500, p. p. ; BIGELOW, *Fl. Boston*, p. 224; MICH., *Arb. don. Am. sept.* 11, p. 156; HAYNE, *Dendr. Fl.*, p. 165; SPRENG. *Syst.* III, p. 856; RAFIN., *New. Fl.*, III, p. 82; GRAY, *Man.*, p. 417; DARLINGTON, *Fl. Cestr.* ed. 3, p. 270; CHAPMAN, *Fl.* p. 424; CURTIS, *Rep. Geol. Surv. N. Car.*, III, p. 46; non GAERTNER.--C. americana RAFINESQUE, *New N. Amer.*, III, p. 82 (1836); NUTTAL, *Sylva*, I, p. 24; SPACH, *Hist. Veg.*, XI, p. 191; KOCH, *Dendr.*, II, pt. II, p. 23; DIETRICH, *Syn.*, V, p. 305; LAUCHE, *Deutsche Dendr.* ed. 2 p. 289; DIPPEL, *Handb.*

Laubholzk., **11**, p. 57; MAYR, *Wald. Nordam.*, p. 177; KOEHNE, *Deutsche Dendr.*, p. 122.--C. vulgaris var. americana A. DC., *Prodr.*, XVI, **11**, p. 114 (1864); SARGENT, *Forest Trees N. Amer. 10th Census U. S.*, IX, p. 157; HOUILLEFERT, *Akb. et arbriss.*, **11**, p. 1151.--C. sativa var. americana SARGENT, *Garden and Forest*, II, p. 484 (1889); WATSON et COULTER, GRAY'S *Man.*, ed. 6, p. 479.

Common names: Chataignier d'Amerique (French).--American Chestnut (English).--Amerikanische Kastanie (German).

SARGENT, *Silva N. A.*, IX, t. 441; BRITTON et BROWN, *l. c.*; MICH. F., *l. c.*, f. 911; A. CAMUS, *Castanea et Cantanopsis*, *Atlas*, pl. 8, 9.

Tree reaching 30–35 m. height in the forest; lofty trunk, straight, from 1–1.20 m. in diameter or short when the tree is not impeded by other trees, rarely attaining 3–3.5 m. in diameter, and being divided not very high above ground level in 3 or 4 horizontal or slightly hanging branches which give rise to a rounded summit of about 30 m.; cortex of the trunk from 2.5–5 cm. thick, dark brown or grayish, divided by straight, irregular and frequently interrupted furrows, being separated at the surface into thin little scales, {lying flat / oppressed}; slender branches, often angular in youth, yellowish green sometimes tinted with red, shiny, scarcely puberulent, armed with numerous little lenticels, whitish, oblong, then soon becoming smooth and green-olive tinted with yellow, or brown tinted with green, and finally a blackish brown. Winter buds (1) ovoid, pointed, about 6–7 mm. in length, smaller than those of C. sativa, puberulent, covered with dark chestnut scales, scarious on the edges. Leaves oblong-laneolate, pointed, tapering long to the summit, tapered or {wedge-shaped / cuneate} at the base (not rounded as in C. crenata and mollissima), 15–20 cm. long, 4.5–5.5 cm. wide, rather thin in the adult state (often thinner than in C. sativa and shinier), but firm, dark green and smooth above, a slightly paler green below, not very discolored, smooth or

armed with rare "regular" hairs along the veins, with disciform hairs that are rarer than in C. sativa or absent (1); leaves unravel late in spring time, are then puberulent above and below, armed on both sides with disciform hairs, in autumn turning shiny bright yellow; edges largely toothed-serrate, with ascending teeth, pointed; mid-rib pale yellow; secondary veins 18-20 pairs, ? slightly arched, terminating in teeth; hardy petiole, puberulent or smooth, 1-1.50 cm. long, often tinted with red, expecially when it is young; stipules oval-lanceolate, pointed, 1.25-1.50 cm. long, puberulent. ♂ Catkins at first green at the base and bright red above the middle, 15-20 cm. long in the adult state; developed axis, briefly puberulent, entirely covered with bundles of flowers; staminous threads russety. Androgenous catkins slender, puberulent, 6-13 cm. long, armed toward the base with 2-3 involucres of ♀ flowers, conglomerate, carried on a hardy robust axis sometimes reaching 3 cm. length and often having mostly oval bracts, bright green and small bractlets; involucres about 8 mm. long and not quite as wide when the flowers are developed; above these involucres of ♀ flowers are some bundles of ♂ flowers, which are a little smaller than those on ♂ catkins, falling from a durable spine that continues to grow above the short cluster of fruits. ♀ Flowers: usually 10 styles per flower. Cupule becoming developed quickly and rapidly reaching its final size, 5-7.5 cm. in diameter, sometimes slightly taller than wide, sometimes flattened at the summit with walls armed inside with a russet pubescence, lustrous, outside almost smooth and ornamental with irregular fassicular spikes, slender, smooth or almost smooth, branching. Fruits 2 or 3, rarely 4 and even 7-9, differing little from those of C. sativa (1), but more swollen, long taper at the upper part, in a slender tube

1. In winter C. dentata is distinguished from C. sativa by its smooth branches and its smaller, more pointed buds.
I. The fruits are often attacked by the Balanin us.

(torch) slightly tomentosc at the summit, with a thin pericarp, usually very compressed, 1.25–2.5 cm. wide and usually wider than tall, but sometimes almost cylindrical, oblong, tapered at the summit, covered at the tip with a thick tomentum, pale, often spreading to the middle and even to the base, on the dried fruit often striped with dark longitudinal bands; longer torch than in C. sativa; scar medium; kernal sweeter than in C. sativa. Certain botanists have regarded this species as a variety of the European chestnut, but it differs quite a lot from the European because of its more pointed buds, thinner leaves that are narrower and tapered at the base, smooth above, its Fruits more tapered in a torch at the summit, with more tomentose thinner outer pericarp, and sweeter kernal.

It hardly ever bears fruit before the 20th year. It flowers late in the year at the end of June or the beginning of July, when the leaves are completely developed. This chestnut is (proterandre), its ♀ flowers opening about 10 days after the ♂ flowers have bloomed (2). It is obvious that this species reproduces by cross fertilization. The S flowers emit a disagreeable odor. The fruits are ripe at the end of August and at the beginning of September. The burs begin to open at the first frost and the fruits fall late, in autumn or winter (3).

Solitary trees are usually sterile even though they carry both ♂ and ♀ flowers. This fact can of often observed on the trees that grow on the Pacific coast.

Teratologic cases, anomalies.--Sometimes the root has curious buddings with shoots (4).

2. Cf. Meehan in Bot. Jahrb. (1880), p. 167 and Proc. Acad. Mat. Sci. Philad. (1879), July 8, p. 166.
3. Schneck in Bot. Gazette, VI, p. 159, noticed in Illinois at Mount Carmel where the species is not indigenous, an example of several chestnuts having a large number of burs, but without fruit.
4. Cf. Warming, On some Rnopdannelse paa rodder in Bot. Tidsskr., III, II, p. 54 (1877).

It sometimes happens that all the flowers of the catkin are Eemale (f. spicata A. Camus). It is a parallel form with f. spicata of C. sativa (5).

Baily and Ames have observed that trees attacked by Endothia often produce leaves with a striking resemblence to those of Quercus rubra and that the xylem, formed by the sick cambium;' has the structure of the Quercus xylem (1).

Varieties of C. dentata cultivated in the United States

The spontaneous C. dentata is rather variable in size, shape, quality, productivity and time of maturity of the fruits. It is quite distinct from our chestnut, which is known in the U.S. under the names of French, Spanish, Italian, European chestnut and of Sweet Chestnut of the English, which was introduced by Irenee Dupont to Wilmington, Delaware, in 1830. Previously, in 1773, Jefferson grafted it onto C. dentata near Charlottesville (Monticello), in Virginia.

Several cultivated varieties of C. dentata have been distinguished and propagated, among the most widespread are:

Dulaney.--Productive tree even when isolated; large fruits of good quality.

Griffin.--Large fruits, very silky, of good quality.

Hathaway.--Often 5-7 fruits in one bur, small, average or large, of very good quality, very sweet. Cultivated in Nova Scotia, New Hampshire, New York, Ohio and Michigan.

Ketcham.--Fruits usually slightly large, oblong, tomentose, with sweet kernal.

Murrell.--3 fruits to the bur, rather big or average, of very good quality. Cultivated in Maryland, Virginia, the Carolinas and Mississippi.

---

5. Cf. Martindale in Proc. of the Nat. Sc. of Philad., I, p. 39 (1878).--Meecham in Proc. of the Acad. of Nat. Sci. of Philad. (1880), p. 351 and 353.--Fernow in Bull. Torrey Bot. Cl., XIII, p. 171 (1886).

1. Baily and Ames in Abs. in Science, n. ser., XXXIX, p. 290 (1914).

Otto.--Big fruits, oblong, very hairy at the summot; very sweet.

Rochester.--Fruits of average or large size, sometimes rounded, usually 3 to the bur, brown, hairy at the summit; excellent quality kernal. Rapidly growing tree, quickly bearing fruits that ripen late in the year.

Watson.--Average or large fruit, compressed; pericarp scarcely silky, very good kernal.

Anatomy

Branch a little more than a year old.--Cork formed of 6-7 layers of cells reddish brown, tangentially elongated. External cortex formed of cells with thick walls. Interior cortex having numerous crystals. Large amount of little pericyclec fibers not very spaced out, some rare large mechanical cells. Rather regular rings of phloem fibers cut by narrow rays. Oxaliferous phloem. Xylem fibers with very thick walls. Numerous vessels, often in pairs, with radially elongated cross-section, reaching 60-70 u on the main axis. Numerous rays, uniseriate, rarely biseriate or triseriate, often very close together, separating only one row of fivers. Little perimedullary cells with thick walls in front of the primary xylem bundles.

Leaf.--Petiole.--Initial (Pl. 111 f. 1) Rather depressed section on the upper side. Epidermis having glandular hairs with rather short stalk. Characteristic collenchyma having several crystals. Parenchyma rich in crystals, especially in the 3 meristeles. Characteristic (pl. III, f. 2). Cross section slightly elongated. Epidermis armed with glandular hairs. Rather thick periderm, especially in the lower curve; fibres with thick walls. Vascular ring surrounding an interior vascular bundle, more or less divided.

Midrib.--Base. Biconvex section. Collenchyma on the 2 sides, slightly

prolonged on the upper side of the leaf blade. Parenchyma above and below the periderm, but not very abundant on the upper side. Very thick periderm, formed of fibers with thick walls. Vascular system almost like the Characteristic, but often continuous interior bundle armed with infra-phloem fibres. Internal pith formed of cells with thin walls, lignified, containing some crystals.

Middle portion (Pl. III, f. 3). Biconvex section. Almost the same structure as lower down.

Secondary veins (Pl. III, f. 4).--Biconvex section. Collenchyma with thick walls attaching the upper epidermis to the periderm. On the lower side, parenchyma with hypertrophied crystals and rather abundant collenchyma. Very thick periderm, especially on the upper part. Vascular ring disjointed at the extremities and sometimes divided at the upper arc. Internal pith formed of cells with lignified walls.--Veinlets.--Slightly biconvex section or flat. Vascular bundles armed with several peridermic fibers tied to the epidermis by a narrow strip of lignified tissue or to the lower epidermis by a few collenchyma or uncolored parenchyma.

Parenchyma of the leaf blade (Pl. III, f. 9, 10).--Thickness of the vein: 200 µ; 160-170 µ a short distance from the vein. Upper epidermis 25-30 µ deep, made up of cells reaching 60-80 µ across the diagonal with recticurvilinear lateral walls, rather thin (pl. III, f. 5), with exterior walls of medium thickness or thin, slightly convex, smooth or having very rare isolated "regular" hairs and some glandular hairs, capitate, briefly with very thin pedicel (pl. III f. 6). Palissade tissue 2 layers, 3 near the mid-rib, the upper one 40-55 µ long. Lacunose tissue rather loose, containing numerous crystals. Lower epidermis from 10-12 µ deep, formed of cells reaching 30-35 µ across the diagonal, with thin lateral walls, recticurvilinear, with thin external wall, convex,

having in the young leaves some "regular" hairs, slender, thin-walled, with arms reaching 200-250 μ in length (pl. III, f. 8) and, on the principal veins, rare isolated hairs, elongated; on the adult leaves some "regular" hairs and, towards the teeth, some capitate hairs, pedicellate, with head armed with transversal and longitudinal walls (pl. III, f. 7); stomata from 25-30 μ long.--Edge of the leaf blade (pl. III, f. 11 and 13) not or scarcely swelled. Epidermis made up of little cells with exterior wall a little thick, slightly convex. At the very edge, 3 or 4 layers of collenchyma with walls of medium thickness; no marginal fibers.--Teeth (pl. III, f. 12). At the edge of the teeth, the collenchyma is well characterized and the leaf blade is 120 μ thick. The two epidermises are nearly like on the leaf blade. Epidermises not especially used as reservoirs for water, not having more development than on the rest of the foliar leaf blade, the upper 20 μ deep; at the very edge, cells less deep and narrower on the transversal section, with exterior wall a little thick and convex. Above the 2 lateral veins, the upper epidermis is also formed of little cells, with exterior wall thicker and convex, with internal wall rather thick. There is a palisadic layer and some lacunose tissue. Mid-rib developed (more than in most of the other species of the genus'), on the scion section flat-convex; vascular bundle in arc, xylem rather developed relative to what it is in the other species; abundant non-lignified parenchyma. Periderm formed of 2 arc:: of fibers with medium-thick walls. Collenchyma with thin walls between the periderm and the upper epidermis and parenchyma and collenchyma on the lower side. Secondary veins with developed xylem, but often almost no phloem; support tissue reduced to a little collenchyma on the lower side.

Requirements.--Dislikes moist soils; likes the sunshine, so much that it

attains a rather large size, isolated or on the edge of the forest.

Associations.--Often with Liriodendron tulipifera, oaks and other species.

Habitat.--Hills, rockworks, low mountains; comes on rather dry soil, well drained, deep.

Geographic distribution (1).--Eastern United States. Hardly further north than 43° of latitude in New Hampshire. From Main and New Hampshire to the southern edges of Lake Ontario, to Michigan, to Indiana, towards the south to Alabama and to Delaware; found in the Allegheny Mountains (it was one of the most important species of the Allegheny Mountains, before the ravage of Endothia), South Carolina, Georgia, Kentucky, and Tennessee to the south in Mississippi, Louisiana and Alabama where they tend to disappear in certain forests of the foot hills (f. Mohr, Pl. life of Alabama in Contrib. U. S. Nat. Herb., VI (1901), p. 61).--This Castanea was common in the region from Ontario, until south of Delaware, in Maine, New Hampshire, in the valleys of the Connecticut and the Merimac, in the forests of Tazewell County, in the south-west of Virginia, in Georgia, Tennessee, it was one of the most common species. Michaux (Arb. for Am. sept., II, p. 158) regards C. dentata as not spontaneous in Maine, Vermont, the seashore and lower part of southern Virginia, of the Carolinas; of Georgia, Florida, southern Louisiana up to the juncture of the Ohio and Mississippi. It grew the tallest in Carolina and Tennessee. It was noticed in Columbia, by Hitchcock and ,Chase, but was certainly cultivated there.

C. dentata made up about 10% of the forests of the United States before the introduction of Endothia.

---

1. We are giving the distribution as it was before the ravage of Endothia.

translated from Camus, A. 1929. Les Chataigniers. Monographie des genres Castanea et Catanopsis. Lechevalier, Paris.

3.--C. crenata

C. crenata SIEB. et ZUCC. in *Abh. der Mathem. Phys. Cl. d. Koniglich Bayer. Akadem. der Wissenschaften*, Bd. IV, Abt. 3, p. 224 (1846); WILSON, *Plant. Wils.*, III, p. 197; KOIDZUMI in *Bot. Mag. Tokyo*, XXX, p. 99 (1916); *Pl. Asiæ orient.* in *Bot. Mag. Tokyo*, XL, p. 338 (1926); ELWES kt HENRY, *Trees of Great Brit and Irel.*, IV, p. 854; KOEHNE, *Deutsche Dendrol.*, p. 122; SCHNEIDER, *Hand. Laubh.*, I, p. 804 (1904); GALLOWAY in *Dep. circ. 383, Un. St. Dep. Agr* (1926), p. 13; BAILEY, *Cycl. Hort.*, 9e ed., I, p. 742 (1927); .--Fagus Castanea THUNB., *Fl. lap.*, p. 195 (1784); non L.--Castanea ~~vesca~~ BLUME, *Bijdr. Fl. Ned. Ind.*, I, p. 524 (1825); SIEB. in *Verhandl. van hat Batav. Genootschap van Kunsten en Wetenschappen*, XII, p. 25 (1830); non GAERTNER.--C. vesca β pubinervis HASSKL., *Catal. Pl. Hort. Bogor.*, p. *73* (1844), *nom nud.*; SIEB. et ZUCC., *l. c.*, p. 224 (1846), *nom nud.*--C. chinensis HASSKL., *l. c.*, p. *73* (1844).--C. stricta SIEB. et ZUCC., *l. c.*, p. 225 (1846).--C. japonica BLUME in *Mus. bot. Lugd.-Bat.*, *I*, p. 284 (1850); DODE in *Bull. Soc. Dendr. Fr.* (1908), p. 149, cum ic.; MIQ. in *Ann. Mus. Lugd.-Bat.*, I, p. 121.--C. vulgaris var. elongata, subdentata DC., *Prodr.*, XVI, II, p. 115 (1868).--C. vulgaris FRANC. et SAVAT., *Enum. pl. Jap.*, I, p. 450 (1875).--C. Castanea var. pubinervis SARGENT, *Silva*, IV, p. 9 (1896).--C. vulgaris var. japonica SHIRASAWA, *Inconogr. essences forestieres du Japon*, t. 31 (1900).--C. sativa var. pubinervis MAKINO in *Box. Mug. Tokyo*, XXIII, p. *12* (1900).--C. pubinervis SCHNEIDER, *l. c.*, I, *p.* 158, f. 93 (1904).

Common names: Kuri (Japan). Chataigner du Japon (French). Japanische Kastanie (German). Japanese Chestnut (English).

SHIRASAWA, *l. c.*; SCHNEIDER, *l. c.*; BAILEY, *l. c.*, t. 912; *A.* CAMUS, *Castanea et Castanopsis*, *Atlas*, pl. 10, 11, 12; pl. 73, f. 3.

Tree less vigorous and shorter than C. sativa and dentata (reached 15 m. at most in Japan). Trunk from 3-5 m. in circumference, with brown surface, fissured longitudinally, rather deeply; dense {crown structure / top}, spreading branches; branches very finely pubescent or almost smooth in youth, rapidly smooth, reddish-brown, shiny, armed with whitish lenticels. Buds little, ovoid, reddish-brown shiny, smooth or almost smooth. Leaves (1) oblong-lanceolate, rounded or cordate at the base, {long-tapering / acuminate} at the summit, 9-15 cm. long, 3-3.5 cm. wide, often smaller than in the European and American chestnut (1), the young ones armed above with sparce disciforme hairs and long whitish "regular" hairs on the mid-ribs, below {bluish-green / glaucous}, having numerous disciforme hairs and some "regular" hairs, at least on the veins, in the adult state very shiny above, with sparce disciforme hairs and, on the veins, "regular" hairs, glaucous below and usually finally almost smooth; edges armed with regular teeth, fine, with point erect, sometimes not very evident in certain cultivated specimens; mid-rib impressed above; 16-25 pairs of secondary nerves, sometimes less than 16, slightly impressed above, salliant below, sometimes slightly curved at the base of the leaf blade, even bifurcate, sometimes having ramifications from the side turned towards the base of the leaf, ending with the teeth, except for the 2 or 4 lower pairs, the edge being whole in this place; veinlets very slightly visible below; rather short petiole, 10-12 mm. long, smooth; stipules 10-15 mm. long, oblong-lanceolate, almost smooth, indeciduous, with almost parallel veins. ♂ catkins erect, from 5-20 cm. long, usually from 8-12 cm., close together in the panicle, often foliaceous, and surmounted with leaves; finely wooly-whitish axis; ♂ flowers

1. In this species, the leaves are less attacked by fungi than in related species.

1. I also noticed that in this species, sometimes on the same stalk, the terminal leaves of the fruit-bearing branches were rather tomentose below, while the lower leaves, which probably came well in the shade, were a little larger, smooth below and with more evident teeth.

rather close together; perianth with 5-6 oval, hairy divisions; little anthers; threads often reddish. Androgenous catkins usually above and lateral, having 1-3 lower ♀ flower:;, the others ♂, often rather rudimentary; principal axis puberulent or pubescent; about 8 styles per flower, very elongated, almost smooth or puberulent. At maturity, branches having rather numerous leaves above the fructiferous axis. Cupules usually placed laterally and not at the summit of the branches, as in C. sativa, slightly depressed, from 3.5-5.5 cm. in diameter (with the spikes), covered with slender spikes, rather close together, fasciculate, 8-12 mm. long, irregular, largely spreading, smooth or almost smooth (much smoother than in C. mollissima), with-wall about 2 to 3 mm. thick, very silky within, less pubescent outside, with evident lines of dehiscence, opening in 4 rather deep valves. Fruits 1-2-3, usually 3, (rarely 5 or 7) to the bur; the lateral ones usually rudimentary, the central one developed, all obtuse or rounded at the summit, more obtuse than the fruits of C. sativa, very rounded at the base, 2-2.5 cm. tall, with almost smooth pericarp, puberulent at the summit, rather thick, of a beautiful color, terminating at the summit in a torch 4-6 mm. long, silky-whitish; scar dull, a little wrinkled, convex, large, occupying the lower part of the Fruit and mounting on the sides, sometimes covering ½ of the fruit and even more in certain cultivated varieties, relatively smaller in the wild varieties (2).--Is especially distinguished from C. sativa by its much narrower leaves, sinuate (wavy) - crenelate and not dantate - serrate, with obtuse, subcordate base, not cuneate, with mid-rib hairy above, finally by the fruit more rounded at the summit, with a larger scar.--The first leaves are more strongly ondulate than in C. sativa and slightly dentate.

This species, which does not develop to a very large tree, flowers when it

2. These fruits are not attacked very much by Balaninus.

is still very young, in the shrub stage of 2 or 4 years. It bears fruit early in the year.

Monstrosity.--Blanco (1) noticed a curious rapid mutation appeared on a Japanese chestnut, obtained by germination of fruits that came from Japan. The inflorescence of this tree shows a hypertrophied receptable whose surface is divided in polygous, in which are inserted as many flowers, more numerous than in the type. The involucrant bracts are absent.

Varieties

Var. japonica (BLUME) KORDJUMI, *Pl. Asiæ orient.* in *The Bot. Magaz. Tokyo* (1926), p. 339.--C. japonica typica BLUME in *Mus. Bot. Lugd.-Bat.*, I, p.284 (1850).--C. vulgaris var. japonica DC., *Prodr.* XVI, 2, p. 115 (1868); excel. syn.--Largely oblong leaves, fiddle-shaped, acuminate, with subcgrdate base, with sinuous edges, mostly crenelate, armed with cuspidate teech, (bristled, setaceous, curved, incurvated.--Japan: (*Herb. Lugd.-Batav.*, no. 901, 309-9, SIEBOLD).

Var. canescens KOIDJUMI, *l. c.*, (1926).--C. japonica var. canescens BLUME in *Mus. Bat. Lugd.-Batav.*, I, p. 286 (1950).--Leaves with persistant (lasting) tomentum below.--Japan: (*Herb. Lugd.-Batav.*, no. 901, 308-594, legit SIEBOLD).

Var. stricta (C. jap.) BLUME, *l. c.*, p. 286 (1850).--C. stricta SIEB. and ZUCC., *l. c.*, p. 225, no. 790.--C. pumila HASSK., *Cat. Hort. Bag.*, p. 73; not MICHX.--Leaves almost coriaceous, oblong or oblong-lanceolate, with rounded base or subcordate, acuminate at the summit, with edges crenelate - serrule on the lower side densely glandulous - (powdery) puberulent, covered with a star-shaped tomentum. Japan.

Var. pendula MIYOSHI in *Bot. Mag. Tokyo*, XXXIII, p. 185-188 (1919); XXXIV, p. 185 (1920).--Pendant branches.--Japan: pr. Shinauo. Could be reproduced by

1. Blanco, *Una mucation nueva en C. castano del japon* in *Bot. r. Soc. esp. Hist. nat.*, XXVI, p. 95 (1926).

seed, according to Miyoshi.

Var. Kusakuri (C. japon var.) BLUME in *Mus. Lugd.-Bat.*, I, p. 285 (1850).--C. vulgaris var. Kusakuri DC., *Prodr.*, XVI, 2, p. 115 (1868).--Castanea Kusakuri KOIDJUMI, Plant *Asiæ orient* in *Bot. Magaz. Tok.* (1926), p. 337.--Vernacular name: Kusakuri.--Young branches with ashen gray tomentum, year old ones red-brown. Fiddle-shaped leaves, obtuse or pointed, with base very obtuse or rounded, the young ones armed with numerous appressed hairs, with the lower side almost smooth, except for the mid-ribs which are pubescent-ashen; between the veins, temporary capitate hairs; mid-rib at first armed on two sides with a dense tomentum, appressed, but above with temporary russety hairs, then with stellate tomentum, soft, whitish; adult leaves smooth on both sides; petiole from 1-2 mm. long, pubescent; temporary stipules. Small fruit.--Japan: (BUERGER in *Herb. Lugd.-Batav.*, no. 901, 309-11-12).

Var. crenata (C. jap.) BLUME, *l. c.*, p. 285 (1850).--C. chinensis HASSK., *Hort. Bag.*, p. 73.--C. crenata SIEB. and ZUCC. in *Abh. Munch. Akad. Wiss.*, IV, III, p. 224, no. 789.--C. vesca β fructibus maximus herb. SIEB.-- Leaves oblong-lanceolate, acuminate, with rounded or almost cordate base, rarely acutiuscule, with serrate-crenelate edges, densely glandular-puberulent and hairy below on the veins.--Japan.

Var. Ookasi (C. jap.) BLUME, *l. c.*, p. 285 (1850).--Leaves of the preceding variety, but often with tapered base.--Japan: Ookasi.

Var. quercina (C. jap.)BLUME, *l. c.*, p. 185 (1850).--Oblong or lanceolate leaves, with subcordate base, or obtuse, or tapering, acuminate at the summit, unequally dentate-serrate, often with setaccous teeth, with mid-rib and secondary veins pubescent on the lower side.--Japan.

Var. longispina (C. jap.) BLUME, *l. c.*, p. 285 (1850).--Leaves like those

of the preceding variety, but with setnccous-serrule edges, veins closer together; cupule with elongated spikes.

Var. obtexta (C. jap.) BLUME in *Mus. Bot. Lugd.-Bat.*, *I*, p. 286 (1850).--Leaves like those of the Shiba-guri variety, but often with longer petiole (6-16 mm.), almost coreaceous, crenelate-serrate, often with setaceous teeth, with lower side armed with a stellate pubescence, gray.--Japan.

Var. elongata (C. jap.) BLUME, *l. c.*, p. 286 (1850).--Leaves like those of the obtexta variety, but longer subulate-acuminate, with subcordate or obtuse base, with veins very close together; elongated catkins, in interrupted glomerules.

Var. Siba-kuri (C. jap.) BLUME in-MU. *Bot. Lugd-Bat.*, I, p. 286 (1850). Vernacular names: Siba-kuri, Shiba-gury, Shibu.--A. Camus, *Castanea et Castanopsis, Atlas*, pl. 10.--Oblong or lanceolate leaves cuspidate, crenelate-serrate, with rounded or subcordate base, the young ones armed with numerous glands below. Flowering for a very long time. Cupule rather small, provided with spikes not quite covering the wall. It is a wild Japanese chestnut. Widespread spontaneously, in coppice form, in Japan, either in pure populations or mixed with oaks or pines.

In cultivation, according to M. Coulagne, it makes bushy shrubs from 1 m. 50 tall, with uniform foliage and fruit. It bears fruit from the third year of sowing and flowers in a continuous fashion until frost so that it gives many small chestnuts over a long time.

According to Tessier (1) the seedlings of Shiba are, on the average, 0 m. 30 tall at one year; certain exceptional subjects reach 1 m. in height. The 2 year old plants, transplanted at one year, are 30-50 cm. tall.

---

1. Tessier, *La culture des Châtaigniers d'Extreme-Orient dans le sud-ouest de La France* in *Bull. Soc. Hist. nat. Toulouse* (1925), p. 98.

In Spain, at Guernica, at M. Mazeredo's home, there is a Shiba sprung from seed, about 25 years old, gnarled, not very vigorous, 4 m. 50 tall, bearing few fruits.

The forest service in Biscaye province (Spain) has undertaken the introduction of Japanese chestnuts in the vicinity of Bilbao.

The variety edulis Nakai, l.c., with pleasing and rather large fruits, could be spontaneous in Korea, according to Nakai.

Var. tamba.--Its fruits are large, good, rather depressed with large scar. Almost all the varieties of Tamba are interesting grafted on Shiba. Shiba is rather resistant to cryptogamic diseases and Tamba has good fruit.

At' the nursery of Bilbao, there are, according to M. Tessier, some Tambas 2 years old, not transplanted, reaching a height of 1 m.

Plants of Tambas sprung from seed and Tambas grafted on Shibas, sent from Yokahama, were 90% recovered in a nursery in spite of a very long voyage, thanks to care and the mild and humid autumn climate.

Three principal forms of Tamba are distinguished: Tamba gury, Tamba lon gury, Tamba gury okuté.

Var. Tamba gury.--A. Camus, *Castanea et Castanopsis, Atlas* pl. 11.--Cupules larger than the Shiba variety, containing 3 fruits, the central one rather developed, the lateral ones often flattened and rudimentary.

M. Conderc cultivates, at Aubenas, a handsome variety of Tamba that is pictured in this monograph.

M. Elessagnes had obtained, in the neighbothood of Saint-Jean-de-Luz (Pyranees foot hills), some very important plantations of more than 5,000 plants of Tamba gury and of Shiba guri. Tamba gives excellent fruit.

According to Laporte (1) Endothia exists in these cultivated varieties of Tamba, but appears to be localized on the grafts; the Shiba guri stock resists the disease.

In cultivation, hybrids are often produced of C. sativa and Tamba. Pure Tamba is recognizable by its branches with yellow bark, while the hybrids have, from youth, a gray bark and more vigorous growth.

Sub-variety Bournetii A. Camus.--A. Camus, *Castanea et Castanopsis*, Atlas, pl. 12.--Variety obtained by M. Bournet, of the Ardeche (central France), from Tamba guri seedlings coming from Japan. The leaves, according to M. Courderc, who sent me some good specimens of this variety, are of a uniform type, but the fruits are of variable size and shape, always with a large scar. The fruits that I saw were a beautiful light mahogany color, very large, reaching 5.5 cm. wide and 3.5 cm. tall, the scar occupying the whole lower side of the fruit and rising on the sides. There are 3 developed fruits per bur, and the bur sometimes exceeds 11 cm. in diameter. The largest fruit weighed 44 gr. It is probably one of the most handsome varieties cultivated.

Var. Tamba gury okuté.--Late maturing type.

Var. Tamba lon gury.--Very rapidly maturing type.

Var. Guri noki.--Could be, according to Tessier, a variety of C. crenata cultivated without being grafted, reaching 15-25 m. tall, having good quality fruits, large (30-32 mm.), 3 to the bur. This variety is planted with a spacing of 12 m., about 70 to the hectare (10,000 m^2; 2.471 acres).

Var. Guri noki osaya.--Very precious, prolific variety, grafted on Shiba guri, in the Aude (France), where it has been cultivated; it is invaded by

1. Laporte in *Bull.* Sac. *Agr. Aude* (1925), p. 84.

disease and killed in 2 or 3 years (Laporte).

Varieties of C. crenata cultivated in the United States

Let us cite among the most cultivated varieties:

Alpha.--New Jersey. Medium cupule. Fruits average or large, usually 3 to the bur, dark, of good quality, ripening very early. Very productive tree, with rather good vigour. Originated in New Jersey. Was obtained from seeds of Parry.

Beta.--New Jersey. Small cupule. Average fruits, with light brown pericarp, sleek, scarcely tomentose, it the summit; ripening after the previous variety . Obtained from Parry seeds.

Biddle.--New Jersey. First bore fruit in Maryland. Average bur. Large fruits, 2-5 to the bur; light brown pericarp, mostly densely tomentose; kernal of good quality. Vigorous tree, with rounded crown.

Black or Dr. Black.--New Jersey. First bore fruit in Maryland. Large bur, average or large fruits, 3-7 to the bur, of irregular size; dark brown pericarp, scarcely tomentose; kernal of good quality. Very precocious maturation. Vigorous tree, very productive. From imported seed.

Coe.--California. Giving very sweet fruit. They have not been cultivated for long. From imported seed.

Felton.--New Jersey. First bore fruit in Delaware. Small bur. Average fruit, dark brown, scarcely tomentose, of good quality, ripening rather early, abundant production. From seeds from an imported tree.

Giant.--Japan. Several varieties have been imported from Japan under this name.

Hale (Eighteen Months).--California. Newly introduced variety. Large

fruit, dark brown, excellent quality, ripening very early. From imported seeds.

~~Kent~~ (~~Extra~~ Early).--New Jersey. First bore fruit in Delaware. Small bur; average or large fruit, dark, usually 3 in the same bur, ripening very early, of good quality. Precocious tree. From seeds from an imported tree.

Kerr.--New Jersey. First bore fruit in Maryland. Small bur; average or large fruits, dark brown, usually 3 in each bur, ripening early, excellent quality. Vigorous tree, very productive. From imported seed.

Killen.--New Jersey. First bore fruit in Delaware. Very large bur. Fruits very large, fat, light brown, very good quality; average maturity. Tree of average vigour, productive. From seeds from an imported tree.

Mammoth.--Name given commercially to Japanese chestnuts, with large fruit, but not applying to a particular variety.

Martin.-- New Jersey. First bore fruit in Maryland. Large bur. Fruits very fat, large, brilliant red-brown, scarcely tomentose, 3-5 in the bur, good quality; average time of maturity. Vigorous tree, spreading, productive. From imported seed.

McFarland.--California. Very large bur. Fat fruit, of good quality, ripening early. Spreading tree, very productive. From imported seed. Only recently cultivated.

Parry.--Japan. Very large bur. Very fat fruit, 1-3 in each bur, large, sometimes with dipressed apex, dark brown, good quality. Tree of average vigour, spreading, with large leaves. One of the most beautiful chestnut trees.

Prolific.--Japan. Small bur. Average fruits, mostly long, striped, 3 in a bur, precocious. Vigorous tree, with dense crown with small narrow leaves.

Reliance.--New Jersey. Average bur. Average or large fruit, mostly long, light brown, streaked, good quality, ripening towards the middle of the season.

Spreading shrub, pendant, productive, not very demanding. From seedlings of Parry.

Success.--New Jersey. Bur very large. Fruits very fat, often 3 to the bur, quality not very estimed, ripening towards the middle of the harvest season. Erect tree, productive. From seedlings of Parry.

Superb.--New Jersey. Large bur. Fat fruit, large brown, usually 3 to the bur, precocious, good quality. Vigorous tree, very productive. From seeds of Parry.

Anatomy

One year old branch.--Cork comprising several layers. External cortex formed of thick-walled cells, containing some crystals and a few rare mechanical cells (pl. 111 f. 4). Interior cortex rather loose, containing crystals. Mass of small pericyclic fibers joined by very large mechanical cells tangentially drawn out and arranged in an almost continuous ring. Phloem containing rather numerous crystals, especially near the fibers, rather continuous ring of phloem fibers, formed of 3 to 4 rows of fibers. Vessels with cross section reaching 60-70 μ, mostly smaller than in C. sativa, numerous, very rarely 2 contiguous vessels. Primary xylem bundles developed. Xylem fibers with walls mostly thicker than in C. sativa. More numerous uniserate rays. Annual zones specially marked by very large, very sinuous vessels. Pith formed of cells with slightly thick walls, without distinct mechanical cells.

Leaf.--Petiole.--Initial (pl. III, f. 15). Elongated section. Hairs reaching 200-500 μ, fat (pl. f. 21), with thick walls, isolated or in twos. Collenchyma with thick walls. Parenchyma containing crystals. 3 meristeles. Characteristic (Pl. III, f. 16). Slightly elongated cross section. Thick periderm, formed of thick-walled cells. Vascular ring surrounding an internal

bundle with xylem (above) (or with support xylem) and with infra-phloem fibers dignified. Internal pith formed of thin-walled lignified cells.

Mid-rib.--Base. Biconvex section. Upper epidermis having "regular" hairs, isolated or in 3's or 4's, the shortest from 50-60 μ long, the others from 100-150 μ. Collenchyma with walls less thick on the upper side than the lower. Parenchyma much more abundant below the periderm than above. Almost the same arrangement of tissues as further down.--Middle. (Pl. III, f. 17) Biconvex section. Vascular rings disjoint at the extremities; internal bundle more or less interrupted.

Secondary veins.(Pl. III, f. 18).--Very slightly biconvex section, situated in a depression of the leaf blade. Abundant collenchyma on the upper side, very little developed on the lower side. Peridermic ring formed of thick-walled fibers. Vascular ring interrupted at the extremities; internal pith with thin, lignified walls.--Veinlets. Flat-convex or flat section. Several peridermic fibers, sometimes two small arcs joined to the epidermis by a narrow strip of lignified tissue. Veinlets with support tissue usually not very developed.

Parenchyma of the leaf blade. (Pl. III, f. 20).--Thickness 190-200 μ. Upper epidermis from 30-35 μ deep, formed of cells reaching 40-50 μ across the diagonal (pl. III, f. 22), with thin lateral walls, recticurvilinear, with external walls of medium thickness, slightly convex, often having an irregular tangential wall, almost smooth in the adult state, the young leaves having stellate or simple hairs, with braces, arms brackets joined for a long while to the base, and extremely numerous glandular hairs, briefly pedicellate, with depressed head (pl. III, f. 23-24). 2 layers of palissadic tissue, the upper about 50 μ long. Lacunose tissue containing some crystals. Lower epidermis from 8-10 μ deep, formed of cells reaching 24-40 μ across the diagonal, with thin lateral

walls, from 60-120 μ tall, rarely 200 μ, with numerous braces, arms brackets (pl. III, f. 27-29), the glandular hairs appear to be lacking; on the young leaves, glandular hairs with head of 40-50 μ diameter almost sessile (pl. III, f. 25-26), hairs in thickets and single hairs from 150-250 μ long; numerous stomata.--Edges of the leaf blade (pl. III, f. 19) recurved. Epidermis with external wall slightly thick, convex. At the very edge, 4-5 laters of collenchyma formed of very large cells with medium or rather thin walls, a little prolonged an the upper side of the leaf blade in a biseriate hypodermis. Marginal vascular bundle armed with 2 arcs of the fiber bundle, the upper one larger; no marginal fibrous bundles touching the collenchyma.--Teeth (pl. III, f. 31). Edges of the leaf blade armed with an epidermis with convex external wall, of medium thickness. Under the epidermis, at the extremities, several cells of collenchyma, with thin walls. No sclerenchyma. A palassadic layer under the upper epidermis. Towards the edge, on each side, mass of lignified cells, spiral-formed. Mid-rib with vascular bundle formed of developed phloem and less abundant xylem; numerous cells of non-lignified parenchyma separating some vessels. Periderm attached to the epidermis by lignified tissues with thin walls.

Habitat.--Often in clay soil, on hillsides, associated with pine, Quercus serrata or Cryptomeria japonica; also often on granitic terrain; not found on limestone, according to Nakai. Seen isolated or in small groups but not forming pure or very widespread populations.--Descends onto the plains in all the northern part of its habitat, but towards the south, becomes more and more a mountain species.

Geographic distribution.--Japan, especially spontaneous in the mountains of the central provinces where it reaches about 12 m. in height and where it does not form extensive xylem wood; abundant at Kiou-siou to the mountains of Hondo

and to the center of this island.--Eastern China, Korea (spontaneous).

4.--C. mollissima.

C. mollissima BLUME in *Mus. Bot. Lugd.-Bat.*, I, p. 286 (1850) (4); SEEMAN in *Bot. Jahrb.*, XXIX, p. 288 (1900); REHDER in BAILEY, *Stand. Cycl. Hort.*, II, p. 682 (1914); NAKAI in *Tokyo Bot. Mag.*, XXIX, p. 54 (1915); WOON YOUNG CHUN, *Chin. ecan. trees*, p. 84, pl. 29; REHDER et WILSON, *Pl. Wils.*, III, p. 192 (1916), p. p.; MERRILL, *An enumeration of Philippine flowering plants* (1923), p. 24; GALLOWAY in *Dep. Circ. 383, Un. St. Dep. Agr.* (1926), p. 5, f. 1-3.--C. vesca. BUNGE in *Mem. Sav. etr. Ac. Sc. Petersb.*, II, p. 137 (Enum. Pl. Chin. bor., p. 62) (1833); non GAERTNER.--C. Bungeana BLUME in Ma. *BoX. Lugd.-Bat.*, I, p. 284 (1850); NAKAI in *Tokyo Bot. Mag.*, XXIX, p. 54 (1915).--C. vulgaris HANCE in *Journ. of Bot.* X, p. 69 (1872), non LAMK; DEBEAUX in *Act. Sac. Linn. Bordeaux*, XXXI, p. 363 (*Fl. Tché-four*, p. 130(1876); l. c.,XXXIII, p. 64 (*Fl. Tien-tsin*, p. 41(1879). --C. vulgaris var. yunnanensis FRANCHET in *Journ. de Bot.*, XIII, p. 196 (1899).--C. sativa SKAN in *Journ. Linn. Soc.*, XXVI, p. 523 (1899), p. p.; LÉVEILLÉ *Fl. Kouy-tchéou*, p. 125 (1914); non MILLER.--C. sativa α typica SEEMEN in *Bot. Jahrb.*, XXIX, p. 287 (1900).--C. Duclouxii DODE in *Bull. Soc. Dendr. France* (1908), p. 150; in FEDDE, *Rep. spec. nav.*, X, p. 239 (1911); SCHNEIDER, *Ill. Handb. Laubholz.*, 11, p. 899 (1912); KOIDZUMI in *Tokyo Bot. Mag.*, XXX, p. 99 (1916).--C. crenata HENRY in ELWES et HENRY, *Trees Great Brit. and Irel.*, IV, p. 854 (1909), p. p., non SIEB. et ZUCC.--C. sativa var mollissima PAMPANINI in *Nuov. Giorn. Bot. Ital. n.* ser. XVII, p. 250 (1910).--Le C. sativa var. formosana HAYATA in *Journ. Coll. Sc. Tokyo*, XXX, p. 304 (1911); *C. formosana Gen. Ind. Fl. Formos.*, p. 71 (1917); MAKINO et NEMOTO, *Fl. Jap.*, p. 1090 (1925); is perhaps synonamous with C. mollissima.

Vernacular names: Pan li, Mao ta hu li shu (according to Seeman), Mao li (according to Hers), Tsouy ly tse, according to Farges.

A. camus, *Castanea et Castanopsis*, *Atlas*, pl'. 13, 14, 73 (5-9), and f. 6-8.

Tree reaching 15-20 m; trunk 1-2 m. in circumference, with fissured bark; whitish-pubescent young branches, finely and densely wooly and armed with some sparce hairs on the figorous shoots and the young trees, the oldest ones red-brown and with white lenticeles wider than tall, next becoming grayish. Small winter buds, largely and briefly avoid, pubescent-silky. Leaves.--usually very discolored, large, oval, tapered or rounded, sometimes asymetrical at the base, briefly acuminate at the summit, often rather rigid, 14-20, rarely 25 cm. long, 5-7 cm. wide, rarely 9, very variable in shape and size, the young ones with sparse disciform hairs, extremely silky-whitish below, the adults dark green on the upper side, smooth except sometimes on the mid-rib, on the lower side paler, more whitish, sometimes very tomentose; on the same branch the older leaves and those of the shoots are almost smooth on the lower side (1), with sparse hairs and the upper ones armed below with numerous white hairs in bundles; no disciform hairs; edges armed with large irregular teeth, spreading or spreading-erect, setaceous, terminating in a setaceous point or reduced to a mucro; 12-16 pairs, rarely more, secondary veins impressed above, salliant below, anastomosis a little visible; petiole 7-8 mm. long, almost smooth or puberulent; stipules oval {sickle-shaped / falciform}, or cordate, with large assymetric base, pointed at the summit, rather persistant. ♂ Flowers: bractate and divisions of the perianth whitish-tomentose; yellowish threads. ♂ Catkins 8-20 cm. long, rarely 11-15 cm., situated in the shelter of the upper leaves, or {tasseled / fascicular at

1. I have observed that the leaves almost smooth above, probably grown in the shade, are larger and more irregular than those of the extremity of the flower-bearing branches, the latter sometimes oval-oblong or oblong and tomentose-whitish below.

the summit of the branches, rarely surmounted by leaves; rather thick axis, very densely hairy-whitish. Androgenous catkins sometimes branching, capable of carrying several very long bracts cordate at the base. ♀ Flowers 1-2 at the base of the upper catkins, sometimes on almost all the catkins; oval bract, obtuse, hairy; thick divisions of the perianth, oval-rounded, very tomentose, visible in the young fruits and even the adult fruits; styles usually 7-9 (?cm) long (very visible at the summit of the young cupules), erect or spreading, extremely pubescent, armed with long spreading hairs. Young cupule very densely tomentose-whitish, with developed bracts, at first very visible, forming wide zones at the site of the 4 lines of union, soft spines appearing late, the styles very elongated almost equal in height to the young cupule. Adult bur cupule rounded, 5-6 cm. in diameter, usually 5.5 cm, sometimes 8-11 cm. (with the spikes) in certain cultivated individuals, prolonged at the summit in a cone to surround the torch; external wall remaining silky outside, extremely silky within, covered on the exterior except on the 4 lines of dehisence which only have tomentose bracts, with numerous spikes, rather irregular, branching, not very hard, not very wounding, usually keeping their very silky pubescence at maturity, reaching about 10-12 mm. Fruits 2-3 to the bur, russety-brown, lustrous, often smooth at the base, silky at the summit, often from 2.5-3 cm. in diameter, sometimes larger, almost as tall as broad, with a slender torch, extremely long, reaching 6-8 mm., longer than in the other species; silky-whitish; large scar, rough, but very much smaller than in C. crenata.

Anatomy

Year old branch.--Epidermis armed with hairs, some in bundles of 2-6, 40-60 μ long, slender, very numerous (pl. IV, f. 1), others very fat, from

700–1,100 μ long, isolated or in 2's, with thick walls and erect lumen. Ring of cork and phelloderm formed of several layers from the first year; cells of the phelloderm with walls slightly collenchymatose. Primary cortex containing some crystals. Large amount of little percyclic fibers more or less distant and joined by large mechanical cells. Small phloem fibers. Phloem containing crystals of ca oxolate. Medullary rays formed of a line of cells separating 2–7 rows of fibers. Xylem parenchyma usually much less abundant than in C. sativa. Vessels a little unequal, usually isolated, with cross-section elongated radially, reaching 60 μ across the axis. Xylem fibers with hexagonal or quadrangular cross-section, with thick walls. Perimedullary cells with thick walls in front of the primary xylem bundles. Pith formed of cells with thin walls, containing simple or twin crystals.

Leaf.--Petiole.--Initial (Pl. IV, f. 2). Cross-section almost in a crescent with rounded extremities. Epidermis having simple "regular" hairs, isolated or in 2's, or shorter and stellate and, especially on the upper side, glandular hairs with elongated stalk. Sub-epidermic collenchyma with walls not very thick. Cortical parenchyma containing cell with simple crystals often grouped, very numerous cells with twinned crystals and some large masses of mechanical cells with thick walls. Vascular bundle more or less united in 3 meristeles.--Characteristic (Pl. IV, f. 3). Cross-section almost rounded. Epidermis having "regular" hairs isolated or in pairs. Sub-epidermic collenchyma with rather thin walls. Cortical parenchyma containing numerous twin crystals and lacking mechanical cells. Thick periderm, fibrous. Vascular system formed of a ring surrounding an interior bundle or 2 vascular arcs; oxaliferous phloem. Internal medullary cells with thin lignified walls.

Mid-rib.--Base. Biconvex section. Epidermis having large isolated "regular"

hairs, numerous, from 500–750 μ long (pl. IV, f. 9–10), with base deeply sunken in the underlying tissue, some more slender and shorter hairs, in pairs or stellate and some glandular hairs (pl. IV, f. 5–7), often with unicellular head. Sub-epidermic collenchyma with not very thick walls, slightly lignified, especially certain cells. Cortical parenchyma containing some twin crystals. Periderm formed of 6–9 layers of fibers with very thick walls mixed with some parenchyma cells with very thin walls. Vascular ring more or less continuous surrounding an internal vascular bundle; vessels with cross-section of 60–70 μ across the axis; xylem parenchyma not lignified in the central bundle with upper xylem and in the upper bundle with lower xylem, near the internal pith; xylem fibers with very thick walls; phloem rich in twin crystals, containing a few isolated fibers.-- Center. Biconvex section. Almost the same arrangement of tissues as lower down.

Secondary veins (Pl. IV, f. 4).--Biconvex section rather convex above. Subepidermic collenchyma with rather thin walls. Not very abundant parenchyma above the periderm, hypertrophied below, containing abundant twin crystals, vascular ring surrounding a small internal phloem bundle. Interior pith very large, enclosing twin crystals. Veinlets.--Flat or Plain or sometimes flat-convex cross-section. Vascular bundle reduced, joined to the epidermis by lignified tissue with very thin walls, sometimes dipping into the uncolored tissue or the chlorophyll tissue.

Parenchyma of the leaf blade.--Thickness = 150 μ. Upper epidermis smooth or almost smooth in the adult state, still having some glandular hairs (pl. IV, f. 19–25), 20–25 μ tall, formed of cells reaching 30–50 μ across the diagonal, with lateral walls recticurvilinear (pl. IV, f. 8), with exterior wall of medium thickness, not convex. On the young leaves, numerous stellate hairs

and glandular hairs (pl. IV, f. 11–18) numerous, with very long stem, having vertical and horizontal walls. Palissadic tissue in 2 layers, the upper 40 μ deep. Lacunose tissue containing numerous twin crystals. Lower epidermis 8–10 μ deep, formed of cells reaching 40 μ across the diagonal, with thin lateral walls, ondulate, with thin exterior wall and slightly convex, having, at least in youth, "regular" and glandular hairs. In the Blume type, the adult leaves, on the lower side, have on the veins, large isolated hairs reaching 500–700 μ in length and 20–25 μ in diameter, with thick wall. In other specimens, on the same branch, I have found that the upper leaves have on the lower side, on the veins large simple hairs, like the preceding, and on the parenchyma, stellate hairs, with slender branches (pl. IV, f. 27), other leaves on older wood or on lower shoots only have simple isolated hairs on the veins. None or hardly any glandular hairs on the adult leaves, but under the *young* leaves, numerous glandular hairs briefly pedicellate. Edges of the leaf blade armed with marginal collenchyma; no special fibrous bundles.--Teeth. Towards the middle, almost triangular cross-section. Epidermis with thick exterior wall formed, at the extremities, of cells with external wall slightly convex. A vascular bundle armed with a periderm with very thin walls and two developed flanges of tracheids (pl. IV, f. 28) or reduced lateral bundles. No chollenchyma at the edges, nor any aquiferous tissue, or rather characteristic chollenchyma.--Towards the summit of the teeth, almost eliptic section, slightly depressed above (pl. IV, f. 29). Epidermis with thin exterior wall. A palissadic layer on the upper side. Median xylem band.

Sect. BALANOCASTANON

Balanocastanon DODE in *Bull. Soc. Dendr. Fr.* (1908), p. 140.--
Average fruit, one per cupule, taller than wide; obvious torch; teeth of the leaves not setaceous-appressed.

7.--C. pumilla

C. pumila MILLER, *Dict. ed. 6, n° 2* (1768); LAMARCK, *Dict.*, I, p. 709; WILLD., Spec., IV, p. 1, p. 461; *Enum.*, p. 980; MICHAUX, *Fl. Bor.-Amer.*, II, p. 193; Nauveau *Duhamel*, III, p. 79; PERSOON, *Syn.*, II, p. 572; DESFONT., *Hist. Arb.*, 11, p. 500; DU MONT DE COURSET, *Bot. Cult.* ed. 2, VI, p. 418; MICHAUX F., *Hist. Arb. forest* Am. *sept.*, 11, p. 166, t. 7; AITON, *Hort. Kew*, ed. 2, V, p. 298; PURSH, *Fl.* Am. *sept.*, 11, p. 625; NUTTALL, *Gen.*, II, p. 217; RAFINESQUE, *Fl. Ludov.*, p. 159; *New Fl.*, III, p. 83; HAYNE, *Dendr. Fl.*, p. 165; ELLIOTT, *Sk.*, II, p. 615; SPACH, *Hist. Veg.*, XI, p. 192; TORREY, *Fl. N. Y.*, II, p. 196; *Bull. Torrey Bot. Cl.* (1922), p. 267; DIETRICH, *Syn.*, V, p. 305; DARLINGTON, *Fl. Cestr.*, ed. 3, p. 270; CHAPMAN, *Fl.*, p. 424, p. p.; CURTIS, Rep. *Geolog. Surv.* N. *Car.*, III, p. 47 (1860); A. DC., *Prodr.*, XVI, pt. 11, p. 115 (excl. β *nana*); KOCH, *Dendr.*, 11, pt. II, p. 24; LAUCHE, *Deutsche Dendr.*, ed. 2, p. 289; ELWES et HENRY, *Trees* and *Great Brit. and Irel.*, IV, p. 857; SARGENT; *Forest Trees* N. *Am. 10th Census U.S.*, IX, p. 156; MAYR, *Wald. Nordam.*, p. 177; BRITTON ef BROWN, *Illustr. North. U. S.*, p. 515, f. 1227; GRAY, Man., ed. 6, WATSON et COULTER, p. 479; ed. 7, ROBINSON et FERNALD, p. 338; COULTER, Man. *Pl. W.* Texan in *Contr. U. S. Nat. Herb.*, 11, p. 418; HITCHC. et STANDLEY, FC. *of Columbia* in *Contr. U. S. Nat. Herb.*, XXI, p. 137 (1919); DEAM, *Trees of Indiana* in *Ind. St.* Fvh. (1919) p. 299; DIPPEL, *Handb. Laubholzk.*, II, p. 58,

f. 25; KOEHNE, *Deutsche Dendr.*, p. 122; SCHNEIDER, *Ill. Handb. Laubholzk.*, I, p. 159; MOUILLEF., *Tr. arbres et arbriss.*, p. 1151; BAILEY, *Cycl. Hort.* 9e ed., I, p. 742 (1927): DODE in *Bull. Sac. Dendr. Fr.* (1908), p. 154(1).-- Fagus pumila, L., *Sp.*, II, p. 998 (1753); DU ROI, *Harbk. Baumz.*, I, p. 275; WAGENHEIM, *Beschreib. Nordam. Holz.*, p. 57, t. 19, f. 44; MOENCH, *Baume Weiss.*, p. 41; SCHOEPF, *Mat. Med. Amer.*, p. 140; CASTIGLIONI, *Viag. negli Stati Uniti*, 11, p. 239; STOKES, *Bot. Mat. Med.*, IV, p. 415; ABBOT et SMITH, *Insects of Georgia*, II, p. 113, t. 57.-- Fagus Castanea pumila MUENCHHAUSEN, *Hausv.*, V, p. 162 (1770); MARSHALL, *Arbust. Am.*, p. 47.--Fagus pumila var. serotina WALTER, *Fl. Car.*, p. 233 (1788) ?

Common names: Chincapin, Chincapin chestnut, Dwarf chestnut, Virginia chestnut.--English: Chinquapin.--American: Common chinquapin, Tree chinquapin, Dwarf chestnut.--German: Zwerg-Kastanie.

MICHAUX F., *l. c.*; BRITTON et BROWN, *l. c.*; DIPPEL, *l. c.*; SCHNEIDER, *l. c.*; ABBOT et SMITH, *l. c.*; LOUDON, *Arb.*, f. 1717, 1718; BAILEY, *l. c.*, p. 742, A. CAMUS, *Castanea et Castanopsis*, pl. 18.

Shrub, not very tall, about from 1 m. 50 to 2 m., with rounded crown, often spreading shruby tree in coppice, rarely reaching 15 m., sending out suckers, having numerous branches, intricate, hardy, sometimes little tree 8-13 m. or rarely 15 m. tall, with short trunk, erect, from 50-90 cm. in diameter, with slender branches, spreading; rough bark on the trunk, reaching, in large individuals, 1.50-2 cm. in thickness and even more, light brown tinted red, with narrow furrows and divided on the surface in scaly plaques; slender branches, at first a brilliant red brown at the extremity and covered by a pale tomentum that soon disappears, then smooth towards the second year (1), lustrous,

1. In winter, C. pumila is distinguished from C. dentata by its more slender branches, especially armed at the summit with a loose pubescence and by its ovoid buds, not pointed at the extremity.

olive green or orangy-brown during the second year, then gradually darker; small lenticeles, numerous. Buds ovoid, not pointed at the apex, about 3-6 mm. long, covered, when they appear, in autumn, with a thick tomentum, wooly, grayish, temporary then, during winter, red and sometimes pubescent-scaly or tomentose. Leaves oboval, oboval-oblong, or oblong, pointed or acuminate at the summit, imperceptibly and often unequally rounded or cuneate ?edge-shaped at the base, 8-12 cm. long, 1.5-2.5 cm. wide, rarely 5 cm.; when they unfold, covered above with a temporary tomentum, pale, reddish increasing in depth until they are entirely developed and with some sparse disciform hairs, rather numerous, armed below with a white tomentum; when they are half-way emerged, they are yellow-green and scarcely puberulent above, especially on the veins, and silky-pubescent below; thick when they are adult, of firm texture, a brilliant yellowish-green, lustrous, armed above with rare disciform hairs and a few "regular" hairs on the mid-rib, below tomentose or wooly, becoming dark yellow before falling; edges of the leaf blade armed with short teeth, fat, rigid, cuspidate, spreading or curving inward; 15-16 pairs of secondary veins, strong petiole, 5-10 mm. long, pubescent, flattened above, stipules shorter than the petiole, pubescent on both sides, with edges folded under the center; those of the lower leaves large, oval, pointed, covered at the apex with a reddish tomentum, those of the last leaves oval-lanceolate, often oblique, pointed and those at the extremity of the branches often linear; scar left by the leaves and the stipules is smaller than in C. sativa. Flowers opening when the leaves are entirely developed. ♂ catkins very odorous, situated in the shelter of the upper leaves, sometimes surmounted by androgenous catkins, ♀ at the base, ♂ on the upper part, appearing when the leaves are unfolding, pubescent, green at the base, red at the apex, 10-15 cm. long when they are developed; strong axis, covered with white wooly tomentum;

bundles of ♂ flowers close together or spaced out. Androgenous catkins 7–11 cm. long, axis densely covered with a white–silky tomentum; often 5 or 6 ♀ flowers, rather spaced out at the base of the catkins; bundles of ♂ flowers usually smaller at the apex of the androgenous catkins than on the completely male catkins; reddish staminal threads. Young cupule briefly pedicellate, tomentose, with pubescent–glandular scales, with thick pedicel1 and tomentose–whitish; 6–7 styles, almost smooth, erect–spreading. At maturity the cupules are placed on the axix of the androgenous catkins situated in the shelter of the leaves and whose upper male part often remains dessicated; the branch has leaves above the fruit–bearing axis. Adult cupules almost ovoid, reaching 2.5–3 cm. in diameter, with thin wall, covered within with pale hair, lustrous, tomentose outside and covered with bundles of slender spikes, numerous, compact, regular, almost smooth or with bundles disseminated and stronger spikes, finally opening in 2 valves, arranged in isolated fruit–bearing {tufts / heads} sometimes terminal, more often lateral, sometimes rather long. Fruit 1 to the bur, ovoid–conical, rounded at the base, imperceptibly tapered at the summit in a torch more or less covered with a silvery–white tomentum, 2–2.5 cm. tall and 0.8–1 cm. in diameter, with brownish chestnut pericarp, very lustrous, thin; sweet kernal with a pleasant taste.

The flowers open from the end of May to the end of June in the southern region or in July in the central states, the androgenous catkins last. The maturation of fruit takes place from the end of September to October. This species is the one that ripens the earliest in the year and this character is one of those estimed in its hybrids.

Parthenogenesis.--Morris (1) has observed cases of parthogenesis in C. pumila.

1. Morris in *Journ. of Heredity*, V, p. 29 (1914).

A certain number of ♀ catkins had been covered with paper bags and deprived of any contact with polen. These bags remained in place without fertilizing the flowers. When the bags were removed, the branches were covered with completely developed fertile fruit; a few were partially blemished. The cotyledons were salliant in the involucre before the fruits were entirely developed. The embryo showed a band of chlorophyll. The plants that these fruits produced were remarkable for their inequality in size, some becoming very much bigger, others smaller than C. pumila sprung from normal gametes.

The following year, Morris repreated these experiments with all necessary precautions, and acquired the conviction that C. pumila can develop fruits by parthenogenesis or by budding of several cells.

Teratological case, anomalie.--The presence of casual adventive shoots on the root has been noticed (1).

Anatomy

One year old branch.--Epidermis and hair still remaining. Already 5-7 layers of cork and about 1 layer of phelloderm. Cells of brown cork, flattened radially. Phelloderm cells a little flattened. Cortex containing some twin crystals and very rare mechanical cells with thick walls, not very fat, usually in groups. Large pericyclic accumulation formed of 6-7 layers of fibers. Phloem containing rows of cells with rather abundant twin crystals and, near the fibers, rows of cells with simple crystals of ca. oxalate. Phloem fibers in layers less thick than the pericyclic ring. Annual rings of wood less evident than in C. sativa. Vessels reaching 40-60 μ in diameter. Rays slightly sinuous. Xylem. fiber with very thick walls, cut into zones by a layer of xylem parenchyma.

1. Warming in *Bot. Tidsskr.*, III, II, p. 54 (1877).

Pith formed of cells with not very thick walls, very punctuated.

Leaf.--Petiole.--Initial (Pl. VI, f. 1). Almost rounded cross-section. Epidermis having stellate hairs, from 80-120 μ long. Sub-epidermic collenchyma distinguished, with rather thick walls. Cortical parenchyma containing some twin crystals. Vascular bundles arranged in 3 meristeles. Characteristic (Pl. VI, f. 2). Epidermis having stellate hairs. Distinguished sub-epidermic collenchyma. Periderm in thick ring; fibers with thick walls. Vascular ring surrounding a central bundle armed with infra-phloem fibers. Internal pith very large; formed of thin-walled cells.

Mid-rib.--Base. Biconvex section. Epidermis of the mid-ribs and secondary veins having isolated or stellate hairs, 200-500 μ long, rarely 650 μ, the longest ones isolated, very fat, with thick wall especially at the base. Almost the same arrangement as in the summit of the petiole.--Center (Pl. VI, f. 3). Biconvex section. Epidermis sometimes having a few glandular hairs with small rounded head. Sub-epidermic collenchyma with not very thick walls. Cortical parenchyma more abundant on the lower side. Very thick periderm, especially in the upper part, fibers with walls thicker than in the lower curve of the ring. Internal pith large, lignified. Vascular ring usually interrupted; internal vascular bundle armed with a fibrous infra-phloem arc; rather large vessels; fibers not very numerous.

Secondary veins (pl. VI, f. 4).--Slightly biconvex section, not very convex above. Vascular ring surrounding a lignified internal pith and armed with
arcs of developed fibers
2 developed arcs of fibers.--Veinlets with flat cross-section, with vascular bundle armed with some fibers joined to the epidermis by an uncolored parenchyma, sometimes a little collenchymatose.

Parenchyma of the leaf blade (Pl. VI, f. 6). Thickness = 200-250 μ. Upper

epidermis almost smooth in the adult state, from 28–35 μ deep, formed of cells reaching 50–60 μ across the diagonal, with lateral walls recticurvilinear or undulating, of medium thickness (pl. VI, f. 8), like the external wall, the latter relatively rather thick for the genus, gelatinized within, not convex, often certain cells have a thin tangential wall. On the young leaves, upper epidermis having hairs reaching 100–250 μ, isolated or grouped in lines (pl. VI, f. 9). Two layers of palissadic tissue, the upper one more elongated. Lacunose tissue formed of more or less irregular cells, containing some twin crystals. Lower epidermis 8–9 μ deep, formed of cells with thin lateral walls, recticurvilinear, with thin external wall, slightly convex, having very slender "regular" hairs, isolated or 4–5 in a bundle, 180–400 μ long, with extremely thin wall; others longer, reaching 500 μ, with thick walls; glandular hairs absent; numerous stomata.--Edges of the leaf blade (pl. VI, f. 5). Epidermis celis much smaller than those of the leaf blade, with exterior wall a little thick, scarcely convex. At the very edge, 3–4 layers of collenchyma, with not very thick walls, being prolonged on the upper side in a biseriate hypodermis. Small marginal xylem vascular bundle armed with two fibrous arcs and attached to the epidermis, by some uncolored tissue with slightly collenchymatose walls.

C. ozarkensis

C. ozarkensis ASHE in *Bull. of the Torrey Bot. Club*, L, p. 360 (1923). *A.* CAMUS, *Castanea et Castanopsis*, *Atlas*, pl. 74, f. 3–6.

Tree reaching 12–20 m. tall. Young branches smooth. 2–4 mm. thick. Buds obtuse, smooth except at the extremity. Leaves spreading, sometimes hanging, those growing in the sunlight lanceolate, 12–20 cm. long, brilliant green above,

yellowish-pubescent below; those growing in shade much larger, sometimes 9-10 cm. wide, glaucous, smooth or puberulent below, profoundly and sometimes doubly serrate, with teeth 0.5-1 cm. long, often pointed mucronated with Germinal point mucro reflected, with obtuse concavity sinus ; secondary veins a little arced, 14-15 pairs; petiole 6-10 mm. long. ♂ Catkins 12-15 cm. long, from 7-9 mm. in diameter. 5-7 styles. Fructiferous spike 6-12 cm. long, (2.7-3, 2 cm. thick); axis densely velvety-whitish, covered with fruits almost down to the base. Cupule 2 cm. in diameter, covered with dense spikes, 1-1.3 cm. long. Fruit ovoid-oblong, dark brown, often 1.5 cm. long.--Curious form, especially distinguished by the leaves of the shaded branches.

Geographic distribution.--United States: Arkansas, Missouri, Oklahoma; common to the north from the Arkansas River, from Center Ridge, in Arkansas, to the north, to the south-west of Missouri and in the west, in the valley of the White River (see map. f. 27).

Var. arkansana ASHE in *Journ. of the Mitchell Society* (1924), p. 45.--C. arkansana ASHE in *Bull. Tam. Bot. Cl.*, I, p. 361 (1923).--Leaves exposed to the sun almost smooth and glaucescent below. Are spread from the western part of the state of Arkansas to the south to the Arkansas River, up to the vicinity of Mena; Carroll, Madison, Franklin, Benton and Washington Counties, the type like that near War Eagle Creek, Madison County.

10.--C. alnifolia

C. alnifolia NUTTALL, *Genera*, II, p. 217 (1818); *Sylva*, I, p. 36, t. 6; DODE in *Bull. Sac. Dendr. France* (1908), p. 156; ASHE in *Bull. Torrey Bat. Club*, IL, p. 276 (1922); in *Journal of Elisha Mitchell So. Sac.*, XLI, p. 267

(1926); PALMA in *Journ. Am. Arboret.*, IV, p. 20 (1923); SCHNEIDER, *Handb. Laubholzk*, II, p. 899, *Nachtrag zu Band I-?*.--Fagus pumila var. praecox WALTER, *Fl. Car.*, p. 233 (1788).--C. nana ELLIOT, *Sk.*, II, p. 615 (1824); RAFINESQUE, *New Fl.*, III, p. 83; NUTTALL in *Trans. Am. Phil. Soc.* n. ser. V, p. 168.--C. pumila ß nana A. DC., *Pradr.*, XVI, p. II, p. 115 (1864).

Common names: Châtaignier à feuille d'Aune.--English: Alder-leaf chestnut.--American: Bush Chinquapin.

A. CAMUS, *Castanea et Castanopsis*, pl. 19, f. 6-8.

Very small bush often reaching scarcely 0 m. 30 in height, hardly exceeding 1 m., forming little thickets and spreading by means of runners in sandy soil; young branches very slender, slightly pubescent or smooth, armed with disciform hairs. Buds ovoid, russety, a little pubescent. Leaves oblong, or narrowly oval-oblong, or oboval-oblong, tapered, a little rounded at the base, almost obtuse at the summit, on the sterile branches oblong-oboval, rounded at the apex, wider above the middle, imperceptibly contracted at the base, those of the fruit-bearing branches larger, lanceolate, often pointed, 7-14 cm. long, 3.5-4.5 cm. wide, the young ones armed above with sparce disciform hairs and, towards the base of the mid-rib, some long "regular" hairs, below hairy except on the veins. The adult ones coriaceous, very lustrous, almost smooth, except for rare disciform hairs above, almost smooth or tomentose and pale yellowish-green below, the lower leaves and those of the sterile branches almost smooth below, the upper ones very hairy; edges armed with slight, pointed teeth spreading-erect or erect; 12-15 pairs of secondary veins, rarely vifurcate towards the center; petiole 3-6 mm. long. ♂ Catkins 5-11 cm. long, usually 6 cm., axis armed with sparce hairs, having flowers spaced out especially towards the base of the catkin, the upper ones androgenous. ♂ Flowers: stamine with brownish thread. ♀ Flowers 2-4 at the base of the upper androgenous catkins; 6 styles,

elongated, almost smooth. Fruit-bearing axis 1–2 cm. long, thick, having 2–4 cupules, almost smooth at maturity (this characteristic distinguishes C. alnifolia from C. pumila and from C. neglecta). Cupule from 2–3.5 cm. in diameter, similar to that of C. pumila, but a little larger, covered with very fine spikes, covering its wall well, divided at the base, not very hairy, glabrescent. Single fruits in the bur, from 1–1.6 cm. It is distinguished from C. pumila, with which it is often confused, by its leaves, usually obtuse, dark green above, green scarcely pubescent or tomentose below, by its cupules with almost smooth pdeoncle, a little thicker, in a short head, by its larger fruit, which ripen still sooner.

NUTTALL, *Sylva*, I, p. 19, distinguishes from the type, with pointed leaves, smooth on both sides, the young ones only hairy below, and living in Florida, a variety β pubescens Nuttall with shorter leaves, obtuse and all pubescent below in the adult state, first found in Carolina in the vicinity of Charleston and spreading from southern Carolina to southern Louisiana, to Gainesville towards the south.

C. seguinii Dode

Anatomy

Root. -- Cork formed of flattened cells. Phloem containing twin crystals. Layers of phloem fibers rather thick. Lylem fibers with very thick walls. Not very numerous vessels, reaching 25-30μ in diameter.

Year-old branches. -- Cork formed of 2-3 layers of little cells not very drawn out tangentially. Phelloderra formed of one layer. Exterior cortex with not very thick wall; interior cortex much more developed, parenchymatose, having twin crystals and some rare groups of mechanical cells. Pericycle formed of very thick (8-10 layers) mass of little fibers, 15μ in diameter and some mechanical cells, drwan out tangentially, uniting these masses. Phloem with twin crystals; mass of phloem fibers developing at first between the primary bundles in thinner beds (2-4 layers) than *the* large mass of pericyclic fibers. Vessels reaching about 30μ in diameter. Very numerous rays, uniseriate. Xylem fibers with very thick walls. Xylem parenchyma not very abundant, in tangential lines. Pith formed of cells with not very thick walls, apparently lacking in mechanical cells.

Leaf. - Petiole. - Initial (pl. V, f. 18). -- Section almost crossing rather high. Endermis having capitate glandular hairs, with unicellular head and bicellular ortricellular stem (pl. V, f. 26). Sub-epidemic collenchyma distinguished. Cortical parenchynia containing numerous twin crystals, not appearing to contain any mechanical cells. 3 meristells; non-lignified parenchyma abundant. -- Characteristic (pl. V, f. 19). Section slightly elongated. Epidermis having numerous capitate glandular hairs, with rounded or oval head, unicellular. Parenchyma with twin crystals less numerous. Thick peridermic ring; fibers with thick walls. Vascular ring surrounding on internal bundle with upper {wood / xylem.

Mid-rib. - Base. Biconvex section. Periderm and vascular system like at the summit of the petiole. - Middle. (pl.V, f. 20). Biconvex section. Collenchyma on both sides and parenchyma on the lower side. Perideim formed of a ring of fibers,

Vascular system like lower down.

Secondary veins (pl. V, f. 21). - Slightly biconves section. Periderm forming a ring of medium thickness. Vascular ring with phloem more or less disjointed. Upper epidermis attached to the periderm by some collenchyma and inferior epidermis attached to the periderm by some collenchyma with not very thick walls and by a little cortex. Veinlets with slightly biconves section. Little vasculare bundle aimed with two arks of fibers joined to the upper epidermis by a fragment of lignified tissue and to the lower epidermis by a small amount of collenchyma.

Parenchyma of the leaf blade (pl. V, f. 25). - Thickness=180-200μ, 150μ in the thinnest parts, towards the edge. Upper epidermis 30-40μ deep, formed of cells reaching 50-60μ across the diagonal, with lateral walls recticurvilinear, punctuated especially on the veins, thin (pl. V, f. 24), with exterior wall of medium thickness, hardly convex, often having some glandular hairs even in the adult leaf. Two layers of palissadic tissue, the upper one 35-40μ tall, the second shorter. Rather loose lacunose tissue, containing numerous and large twin crystals. Lower epidermis 9-10μ deep, formed of cells with thin lateral walls, recticurvilinear, with external wall rather thin, scarcely convex, having capitate glandular hairs, depressed, almost sessile, usually very numerous on the adult leaf, and numerous {stellate hairs / "regular hairs} in tufts, with 6-16 spreading arms, reaching 120-160u in length (pl. V, f. 27); stomate 30μ long, usually not as deep as the epidermic cells and situated in the external surface. Edges of the leaf blade (pl. V, f. 22) recurved, rather thick. Epidermis formed of cells with small lumen, with external wall rather thick, not conver or slightly convex. At the very edge, abundant collenchyma (4-5 layers) a little prolonged on the upper side. Vascular bundle adjacent to the edge with support tissue normally developed. -- Teeth (pl. V, f. 23). Upper epidermis formed of large cells, tall, serving as water reservoirs, sometimes having a tangential {well / partition}, the cells of the lower epidermis a little smaller, with external wall convex. At the extremeties of the

section, uncolored parenchyma with thin walls. Mid-rib with vascular bundle formed of an extremely reduced xylem; on the lower part of the phloem, rather developed ark of fibers, with thick walls, only a few fibers with very thin walls on the upper part, sometimes none. Collenchyma attaching the 2 epidermis to the periderm. A palissadic layer, on the upper side of the messphyllum and lacunox tissue, on the lower side.

C. crenata x pumila

x C. Fleetii A. Camus. - C. crenata x pumila Van Fleet in The Journal of Heredity, V, no 1, p. 19-25 (1914), and XIII, p. 305 (1922); North Nat. Growers Assoc., VII, p. 54 (1916). - Cf. Bull. mens. renseign. agric. et malad. des planter, V, April 1914, p. 567.

A. Camus, Castanea et Castanopsis, Atlas, pl. 20, f. 11; pl. 73, f. 1-2.

Tree vigorous, rarely bushes with numerous branches, very spread out, bearing fruit from the age of 3 to 5 years. Leaves tapered at the base, acuminate at the suoninut, with edges armed with acuminate teeth, with veins numerous (often more than 20) and close together. ♂ Catkins rather fat, found on the same branches as the ♀ catkins and above them. Cupules fat, but in 3's to 5's on the same fructiferous axis, as in C. pumila, rarely solitary, containing 3 large fruits. Fruits intermediate in size and form between those of the parents, the fruits of C. crenata being almost as wide as tall, about 3 cm. 5 to 3.3, very rounded at the summit, with large scar, those of C. pumila very much taller than wide, about 1.8 cm to 1-1.1 cm, ovoid, very tapered at the summit, with small scar, the fruits of the hybrid are scarcely taller than wide, 2.7 to 2.5cm, tapered at the summit but not for as long as in C. pumila, with intermediate scar, mounting a little on the sides of the fruit, but less then in C. crenate. The pericarp is scarcely silky at the summit. The fruits do not have the starchy and astringent taste which the

Americans often find fault with in our C. sativa and in the chestnuts from Asia, but are not as sweet nor as pleasing as those of C. pumila, even wild. These fruits would be all the better if they were more like C. pumila.

Fructification is very precocious because it begins often from the third year, while the hybrids of C. sativa and of the Asian chestnuts are rarely fructiferous before 5 or 12 years.

This hybrid was artificially obtained (1) by Van Fleet who describes it. He presents very great qualities. The C. pumila gave it great resistance to Endothia and fruits of an agreeable and sweet flavour, C. crenata brought it its development. Few of these hybrids were attached by Endothia, and when they were, the infection was only local.

The trees are strong and decorative, especially when they are flowering or bearing fruit. They are as decorative as useful. At 9 years one of Van Fleets specimens was 2m. 70cm tall. Since these hybrids gave fruits very early, one could believe that they would not attain very large dimensions.

Unhappily, as with many hybrids, the characteristics were not maintained in the following generation, there was disjunction of characters. The germination of

---

1. The hybrid was obtained by Van Fleet with a very fertile and precocious C. pumila, from collected seed, in Virginia in 1889. All the stamines were completely removed from the shrub and each branch having young female flowers was protected, by paper bags, from pollen that could have been carried by wind or insects. The male catkins, chosen for fertilization, were themselves protected before the opening of the anthers. The pollen was applied with a brush, a painter's brush, or by delicately agitating the male catkin on the stigma. Van Fleet obtained, thus, many hybrid seeds having incontestable hybrid character.

the seeds of the hybrid gave a low percentage, but about half produced vigorous plants with varied foliage resembling the privinile stage of the beech, oak and holly.

The second year, the disjunction of the leaf characteristics was observed in a pumila type with delicate romentum below and a crenata with layer leaves, light on both sides.

In the second generation, the plants of C. crenate x pumila were not contaminated although always exposed to the infection.

The C. Fleetii is cultivated at Aubenas, by M. Couderc. It is a little tree which does not appear capable of large development.

C. crenata x dentata

x C. Endicottii A. Camus. -- C. crenata x dentata Detlefsen and Ruth in The Jcurn. of Heredity, XIII, p. 305-314, 1922 (1923).

Fruits rather early free in the slightly large bur, sometimes 7 or 8 in a bur, while the Japanese parent has only one well developed fruit and the American itself has only 3, very tightly encased in the bur, intermediate in form and shape between its parents, notably larger than in C. dentata, with intermediate tomeatum, less abundant than in C. dentata, with pericarp shinier and a prettier color, recalling that of C. crenata, often with intermediate scar, slightly larger than in C. dentata, clearly smaller than C. crenata; flesh of the kernal more pleasant, according to the Americans, than that of the kernal of C. crenata. - Not very sensitive to attacks by Endothia. Fruits rejoining early.

This hybrid was obtained, for the first time, by Endicott, in 1898 according to Detlefsen and Ruth, l.e.

rather large difficulty in obtaining this cross is that the flowering of the parents does not take place at the sane time.

Endicott obtained 5 hybrid seeds of which 3 gave trees that he named: Blair,

Boone et Riehl.

This hybrid has the advantages of C. crenata: large fruits, repining early, fatter, with not very tomentore pericap, of a pretty color, resistance to Endothia, rapid fructification.

From C. dentata it has the larger development, and friuts that are more agreeacle to the American taste.

The fruits of C. crenata being not very much attached by Balaninus, it was hoped that the hybrid would be less attacked by this parasite than C. dentata is.

The hybrids of the first generation Blair, Boone and Reihl had, the first two, 3 fruits to the bur, the other, a single perfect fruit, the two lateral ones reduced as in the Japanese parent. These hybrids gave fruit very early, towards the 4th or 5th year and in greater abundance than the parents.

Of the hybrids of the first generation, Boone was the most vigorous; it gave the best fruits, the most abundant, the fattest and began to bear fruit at about 17 montsh, while the Chestnut from Japan fructifier at 5 or 6 years and the American at about 12 years. Probably fertilized by the pollen of Blair or Riehl, it gave fruits producing 75 plants. There the results, from the point of view of the production of fruits, were imperfect, disjunction of characteristics was produced with intermediate forms, but especially with the extreme forms of the parents. The disjunction operated also on the other characters. Thus at the age of 14 years some individuals attained 6 to 7 meters, others only 2 m. 50. None of these hybrids of the second degree attained the fertility of those of the first degree, their fruits were inferior and appeared later, around 7 to 8 years.

The fruits of the hybrids of the second generation were very similar on the same tree, but very different from those of the hybrids of the first generation.

While the fruits of the first generation were intermediate between those of the parents, those of the descendants recall much more those of the ancesters, certain ones were as fat as those of C. crenata, others as small as those of C. dentata. Many of these hybrids of the second degree had *3* fruits to the bur, some a single developed fruit resembling an acorn a little and two rudimentery lateral ones. The bur is very variable in the hybrids of the second generation in regard to their thickness and to the length of the spikes. The spikes of certain burs are relatively soft and easy to handle while on other burs, the spikes are rigid and wounding.

Seeing how much the hybrids of the second generation were less interesting than those of the first generation since they almost reproduced the parents, Endicott tried to graft the hybrids of the first generation, but he had many failures.

C. crenata x sativa

x C. Condercii A. Camus - C. crenata x sativa A. Camus.

A. Camus, Castaneu et Castanopsis, Atens, pl. 21 and 22.

The hybrid that I describe, named Azuel, was planted at Aubenas, by M. Conderc. It is the product of a cross of C. sativa giving chestnuts of the Rournetii (Bournette) variety from seeds from C. crenata var. Trruba guri and obtained by M. Bournet. M. Conderc sent me same handsome branches and some fruits that. are drawn on pl. 22, f 1-10.

This hybrid is very developed, its leaves are silvery below, as in C. crenata, but their form is more that of C. sativa, the burs are arranged on the lateral peduncles and not at the extremity of the branches. There is the description:

Tree vigorous. Leaves recalling those of C. sativa, but larger still and of a narrow form than those of C. crenata, longly acuminate at the summit, silvery below, very hairy, armed with elongated teeth, erect and about 22 pairs of secondary veins; petiole smooth, about 15 mm. long. ♀ Flowers: periouth very silky; 7–9 hairy styles. Capules arranged on the lateral peduncles, reaching 9–10 cm. in diameter with the spikes, with a thick wall of 2–4 mm., very silky within, not very outside, opening usually in 2 deep valves, but with 4 lines of dehiscence marked, having bundles of spikes rather distant at the base, 12–15 mm. long, rather {extremely spreading / divaricate}, sharp, brownish in the adult state. Fruits usually 3 to the bur, fat, very rounded at the summit and at the base, often exceding 4 cm. in diameter and 3 cm. in height, smooth, finely striped, slightly silky-whitish at the summit, with torch 4–6 mm. long, with rough scar, yellowish, not as large as in C. crenata, but larger than in C. sativa.

The upper epidermis of the adult leaves, formed of cells with thin walls, like in C. crenata, reaching 40–50μ across the diagonal, is smooth, lacking capftate hairs. The lower epidermis has stellate hairs, numerous, with abundant branches, reaching about 150u in length and a few rare capitate hairs.

According to M. Conderc, Azuel is very vigorous and very fertile, its fruits are excellent. It resists drought better than C. crenata. To the present, it appears also to be resistant to the disease of Enere as well as the pure Japanese chestnuts, since the individuals of 8 or 9 years are not attached, while the stocks of C. sativa, which live with them, are dead after the fourth or fifth year.

According to Blaringhem (1) there could exist, at Meudon a hybrid C. crenata x sativa which would not have {direct influence / xenia like} of .foreign pollen C. dentata x sativa.

1. Blaringhem, Note sur la xinie chez. le chataignier in Bull, Soc. bot. Fr. (1919).

In cultivation there often exist spontaneous hybrids of C. crenata x sativa which are easily distinguishable by the young branches that are gray rather than yellow like those of C. crenata.

C. dentata x sativa

x C. Blaringhemii A. Camus - D. dentata x sativa A. Camus.

Fruits intermediate between those of the parents, not as short and wide as in C. sativa, less swollen than in C. dentata, with torch longer than in C. sativa, and shorter than in C. dentata.

This hybrid was obtained, by Van Fleet, in the U. S. It was doing very well, but succomed to Endothia in 1910 (Van Fleet in The Journal of Heredity, V, p. 21 (1914)).

M. Blaringhem observed some cases of xenia, in the seeds produced by cronning C. dentata and C. sativa. The hybrid embryo which has an intermediate form between the short form and the spreading form or the column form of the parents is usually found narrowly and hindered in its grouwth inside a not very elastic pericap of C. sativa which bursts before maturity.

C. dentata x pumila

x C. neglecta Dode in Bull. Soc. Dendr. Jr. (1908), p. 155; Ashe in Bull. Torrey bot. Club, IL, p. 266 (1922); Hitchcock and Standley, Flora of the District of Columbia and vicinity in Contrib. Un. St. Nat. Herb., XXI, p. 137 (1919). C. dentata x pumils A. camus. - C. pumila x dentata Kordzumi in Tokyo Bot. Mag. XXX, p. 99 (1916).

A. Camus, Castanea et Castanopois, Atlas, pl. 20, f. 7-10. Young branches pubsecent, armed with wooly elongated haus, rather persistant Buds brownish, ovoid, bubescent. Leaves obovaï-oblong or oblong, tapered at the base, not very tapered at the summit, 13-15 cm. long, 5-6 cm. wide, larger than in C. pumila and len hairy, the young ones armed above with sparce capitate hairs and hairs spreading towards the base of the mid-rib, below densely grayish-felty, the adults a little dull

above, smoothe, except for a few capitate hairs and some stellate hairs situated towards the base of the mid-rib, more or less pubescent below, grayish-woody, with 13-15 pairs of secondary veins; petiole 8-10 mm. long. ♂ Catkins numerous, 9-18 cm. long, usually 11-14 cm; whitish-wooly axis, with lasting puberscence, slightly less dense than in C. purnila, stamines with reddish thread. Androgenous catkins often situated above the ♂ catkins, having several ♀ flowers; very long style, hairy at the base. Young cupule ordinarily dimly pedicellate. Adult Cupules intermediate in size between those of the parents, or large, armed with rather irregular spikes, almost smooth. Fruits one or two to the bur, tapered at the summit. -- This hybrid has the large leaves of C. dentata, slightly pubescent below, much less tomentose than in C. pumila, the large burs provided with long spikes, irregular, almost smooth, dense, often containing 2 fruits.

Eastern United States: scattered, Georgia, Tennessee, southern Carclina, etc.

According to Barley, Cycl. Hort., 9th ed., I, p. 742, f. 913, bottom, the hybrids of C. pumila and dentata should exist in Pennsylvania in Arkansas and its Texas. They reach the size of trees.

Morris (1) obtained this hybrid with fatter fruits than those of C. pumila, and with sweet kernal. At first it was quite resistant to Endothia, then it was stricken at about 8 years old.

---

1. Morris, Chestnut blight resistance in Journ. of Heredity, V, p. 27 *(1914)*.

C. dentata x floridana Margaretta

x C. alabemensis Ashe in the Charleston Museum Quarterly, I, p. 30 (1925). - C. dentata x floridana var Margaretta Ashe.

A. Camus, Castanea et Castanopsis, Atlas, pl 74, f. 7–9.

Tree 5 to 10 m. tall, with a trunk at morst 4 dm. in diameter, with a dome-shpaed crown in the well developed individuals; branches from 2–2.5 mm. in diameter, smooth, dark brown, angular, with white lenticells. Winter Buds dorsally flattened, oblique in relation to the axis of the branches, very lightly and briefly puberulent. Leaves oblong–lancolate, sometimes oblong, 11–16 cm. long, 3–4 cm. wide, sometimes 6, contracted and often tapered a long while at the base, acuminate at the summit, smooth above and a dark bronze color when they spread open, finally dark green, smooth below except on the mid–rib and the secondary veins which have some appressed hairs that are often temporary, almost smooth and finally yellowish–green; edges deeply toothed, with erect or almost spreading teeth formed by the prolongation of the veins; prominent secondary veins, 14–18 sometimes 19 pairs. ♂ Catkins erect, axillary, rather dense, 8–10 sometimes 12–16 cm. long, from 0.5–1 cm. in diameter, smooth, except for the perianth and the bracts which are {fringed / ciliate}; {spine / rachis} scarcely puberulent, rapidly becoming smooth. Androgenons catkins usually situated above the ♂ catkins, having, at the base, 3–6 ♀ flowers; ♀ flowers isolated in each cupsule; styles elongated, usually 6 sometimes 5. Fruit–bearing head about 7–8 cm. long; smooth axis, a little bare at the base. Rounded cupule, from 2.3–3.5 cm. in diameter, densely covered with slender spikes, smooth or very lightly pubescent, usually branching from the base. Fruit isolated in each bur, dark brown, about 1.5 cm. in diameter. Flowers in the second half of May, when the leaves have almost emerged. Differs from C. arkansana by the form of its leaves, the color of the branches, the size and shape of the spikes, and bronze color of the leaves when they unfold. It resembles C. dentata very much, flowers at the same time, but its leaves are paler below, its catkins erect and

its burs only contain one fruit. This Castanea is quite probably a hybrid of C. crenata, whose leaves are very similar, with a type of the Balanocastanon section, whose fruits are the same. It is the only Chinquapin of the southern U. S. which has a smooth foliage on vigorous shoots.

Associations - Grows with Magnolia macrophylla, Tilia australis, Liriodendion and the Quercus, etc.

Geographic distribution - Southern United States. Alabama between Blount and Marion counties; type of Flannigan Creek, Lawrence County (Ashi).

C. mollissima x pumila

x C. Barbankii A. Camus - C. mollissima x pumila Murrill in Journ. of the New York Bot. Gard., XVIII. p. 213; Bull. mens. sens. agr. et malad. des pl. (1918), P. 347; Galloway in Depart. circ. 383, U.S.D.A. (1926) p. 8, f.4.

A. Camus, Castanes et Castanopsis, Atlas, pl. 73, f. 10-15.

Tree very resistant to Endothia. Cupule much larger than in C. pumila, often opening in 4 valves as in C. mollissinia, sometimes in 2 like in C. pumila. Fruits 1-3, about 2-3 times fatter than in C. pumila, almost as tall as wide or a little wider than tall, resembling more the form of those of C. mollissima, less tapered at the summit, but with a torch a little less long than in C. mollissima, obviously more elongated than in C. pumila; thin pericarp; kernal of pleasant taste and sweet that of C. pumila.

The corn was obtained, by Burbank, in 1899, in the U. S.

A tree more than 10 years old is growing, 17 km. to the north-east of New York, at Bell, where it bears fruit every year. It is discussed from a cross obtained by Van Fleet.

C. pumila x sativa

x C. pulchella A. Camus - C. pumila x sativa A. Camus.

This hybrid is intermediate between the two parents. It has fruits larger than those of C. pumila, resists Endothia poorly, but has the great advantage of bearing fruits from the second year on the shoots originating at the base of the dead trunks.

Was obtained by Van Fleet, in Journ. of Heredity, V, p. 21 *(1914).*

It would be very interesting to obtain certain crosses, as much from the botanical viewpoint as for the qualities of the hybrids.

C. Henryi x mollissima

The cross between C. Henryi and C. mollissima, both resistant to the "Encre", would give interesting hybrids, the wood of C. mollissima lacks some qualities which C. Henryi might add to it.

C. dentata x Henryi

C. Henryi could bring a resistance to Endothia to the hybrid and C. dentata the larger good quality fruits.

C. crenata x mollissima

This cross would probably also give excellent results, both C. mollissima and C. crenata being rather resistant to Endothia, and both capable of giving good fruit.

C. alnifolia x mollissima

x C. Morrisii A. Camus. - C. alnifolia x mollissima. Morris

This hybrid was obtained by Morris, in the U. S. (f. Morris in The Journ. of Heredity, V, p. 29 (1914). C. alnifolia brings the hybrid a resistance to Endothia and C. mollissima its development.

Incompletely known and doubtful Species

Since I was unable to see any of these species which are insufficiently described and doubtful, I give the desctiption according to their authors.

Castanca Bodinieri Le'veille' and Van. in Bull. Soc. bot. Fr., LII, p. 142 (1905). Castanopsis Bodinieri Koidznoni in Tokyo Bot. *Mag.*, XXX, p. 100 (1916)

Large tree or small tree, with velvety-glandulous branches. Coriacious leaves, oval, acuminate at the summit, reddish green above, reddish-tomentose below. Inflorescence formed of long heads / spikes / tufts, recurved, bristly-glandulous; protruding outward ♂ flowers arranged at the summit of the heads; 3 (?) stamines, exserted Burs in dense heads, of 10-20, sessile and close together.

China: Yun-nan, vicinity of Yun-nan-sen, wood of the pagoda of Kiang-tscheou-si February 2, 1897 (Bodinier).

Rehder in Journ. Amer. Arboretum, X, p. 118-119 (1929), connected Castanea Bodinieri with Castenopsis Hystrix. Such an incomplete description only leaves doubts.

Castanea Fauriei Le'veille'and Van, in Bull. Soc. bot. Fr., LIL, p. 142 (1905).

Leaves coriaceous, oval-lanceolate, longly acuminate at the summit, cumform at the base, discolored, a bright green abouve; vissety below, with uniterrupted whole edges or sinuous. Flowers on ♂ and ♀ catkins, loose, bery slender, pubescent. ♀ catkins with 10 or 15 flowers; 3 styles. Cupule obovoid.

Japan: Kiou-sion Island, around Nagasaki, June 5, 1899 (Faurie, no. 3081).

The generic attributions of Le'veille' are often erroneous. The presence of 3 styles, in this species, absolutely separates it from the genus Castanea; it is probably a Castanopsis.

Characteristics Permitting Differentiation Between Castanea and Castanopsis

Castanea	Castenopsis
Styles 7–9 (or more).	Styles 3, very rarely 4.
Ovary with 6 (–9) cells.	Ovary with 3 cells.
Involucre surrounding 7 flowers, usually 1–3 developed.	Involucre surrounding 1–3 flowers.
Tapered pericarp, prolonged at the summit in the form of a torch (1).	Pericarp not prolonged at the summit in the form of a torch.
Flowers ♀ situated at the base of the androgenous catkins.	Flowers ♀ often situated on separate catkins.
Cymetrical cupsul; point of insertion of the cupule diametrically opposed to the opening of the styles; cupule wall having elongated prickles, developed, except on the suture and dehisance times.	Cymetrical cupule; point of insertion of the cupule not opposite the opening of the styles; cupule wall having some prickles (often replaced by broots on the contiguous side of the axis, sometimes also on the opposite side, more rarely on 4 sides, these regions without prickles are always wider than the suture lines of the cupule which exist in the gender Castanea), some modules tubers or undulating areas.
Annual maturation.	Biennial maturation.
Deciduous leaves.	Indecidious leaves.

1. I have adopted the name of "torch", proposed by M. Dode, to designate the upper very tapered part of the pericarp, topped by the divisions of the perianth.

GRAFTING

The sylvatic chestnut trees usually give mediocre fruit. Through seedlings, one can obtain new varieties or select from the existing varieties, but to preserve the local fruit-bearing races with their qualities and have good fruit, it is necessary to graft the chestnuts from wood.

In France, we prefer to graft at the sight, 3 or 4 years after planting.

Piccioli recommends grafting in a nursery because the graft is protected better against harm from animals than in the forest and because the surveillance of the grafted trees is easier.

The wild stock unearthed in the vicinity ~~are~~ is sometimes preferable to individuals raised in a nursery; ~~they are~~ it is more hardy and better adapted to the terrain that is to be planted.

Sometimes it happens that a graft at the sight is made on trees 8 to 10 years old in the forest. This mode of operation often has the inconvenience of causing the subject to have a large yield which can bring about its death. Thus it is, according to Piccioli, that they kill the trees in the Apennines, by grafting individuals having at least 12 or 15 years.

If the grafting is not done in a nursery, one should graft at least 2 years after the planting when the subjects are well rooted and vigorous.

Preparation of subjects for grafting.-- In February or March, the subjects are prepared for grafting which will not be done until the following year or even 2 years later.

When the sap is resting, the trees are cut back to 2 or 3 m. height. Only the branches that are to be grafted the following year are left. Sometimes all the branches are removed to make several branches that will be grafted 2 years later. This process has the inconvenience of making the tree into a pollard.

Often one, 2 or 3 branches to draw sap are left to be cut off the following spring with the useless branches.

In the Apennines and the Piedmont, a process which gives poor results is employed, consisting of cutting back the tree to *4–5* cm. of the ground in hopes of obtaining sylvatic chestnut shoots good for wood and at the same time branches which cleft grafted with estimed fruit-bearing varieties, will give fruits. The branches do not last long since decay invades the trunk.

Usually grafts are made on 2-year-old wood, somestimes on one-year old. The graft is made either at ground level or *4–5* cm. above, so that the entire aerial part, or almost all of it, is made up of the domestic chestnut.

Season for grafting.--Grafts are made in spring, in May, when the chestnut begins vegetation and the bark is easily separated from the wood, in calm dry weather, usually in morning rather than evening.

For shield budding, it is preferable to await the slowing down of the movement of sap. For certain seldom used grafts done in winter, the graft should be protected, especially from wind, freezing and rain.

Choice of scions.--The scions are usually taken from choice trees, pollard or cut back every year or two. These scions are vigorous branches which should be used as soon as they are cut, however if we are concerned with early varieties, they are cut about 8 days before grafting and placed in humid soil, in the shade, to retard their vegetation and put them in harmony with that of their subject.

The lower part of a branch, whose bark is shiny, without scar and has buds close together, is chosen.

At the point of juncture of the 2 barks, a more or less noticeable swelling is produced, almost always visible on old trees. When adherence and

union is not perfect, the swelling is greater and can cause the death of the plant.

The best conditions for union are obtained by using cylinders of bark collected from shoots of the same age, of equal diameter and with easily detachable bark.

Principal grafts employed for chestnut.--These are: flute budding, or bevel graft, or ring grafting, graft en flute de faune, shield budding, simple cleft grafting, cleft grafting (with incased bud), cleft grafting (at a fork or junction), whip-grafting, top-grafting, crown-grafting and grafting on the root neck flange.

Flute budding or dievel graft or ring graft or cannon graft.--Flute budding which was done by Cabanis (1), in 1764, is already described by Parmentier.

This graft, very much in use in central France, gives good results, resists wind well, because of the perfect union, but it requires that the rings of bark be rapidly put in contact after having been detached; it cannot be employed if the scions come from a distance. The wild stock is decapitated at about 2 m. and the grafting is done on the young branches that are developed.

Flute budding is done in springtime.

The graft is formed of a cortex tube having at least one bud in the center. This cortex tube is obtained from a scion branch by making two parallel circular incisions with a grafting knife 3 cm. above and 3 cm. below the bud and for detaching it by the thinnest part, with the grafting knife, not damaging the bud. The grafts should be chosen on 2-year old branches having well developed buds and it is preferable to only use the lower part of the branch, the upper

---

Cabanis, Essais sur les principes de la greffe (1764)

buds being inferior for the production of fruit and tending to give wood.

On the stem of the subject, 2 parallel incisions are made, similar to those of the graft, to detach a ring of cortex similar to the graft and capable of replacing it. The graft ring is put in the place of the ring removed from the subject by slitting the graft longitudinally on the side opposite the bud and being careful that the bud be placed on the subject's bud. This bud attracts the sap to the graft and activates the recovery. Adherence should be perfect. It can be tied or covered with grafting wax. As soon as the union is assured, approximately at the end of 15 days, it is topped, sometimes gradually, to within 10 cm. of the upper bud.

Young hardy subjects are more adaptable to flute budding than old individuals. A rather old subject should be grafted on the branches rather than the body of the trunk.

If the diameter of the graft is larger than that of the subject, a width of bark equal to the difference is cut from the graft. In the opposite case, a narrow strip of bark is taken from the subject to cover the bare place left by the lack of width of the graft. It is always preferable that the diameter be the same, as we have already said.

In the Cevennes and Limousin (mountainous area in central France) and the Ardeche (central Rhone valley) and Var (Mediterannean coast), this method of grafting is employed. After a short while, the bark entirely recovers the grafting wound. Only the small circular crease, called the grafting ring, remains.

Graft en flute de fame.--This mode of grafting is resistant, solid and productive. After having cut back the subject to about 2 m., two years later, one cuts the strong shoots from the head, then the bark of the upper part is

divided into narrow strips that are thrown back toward the base, laying bare the generative layer for a length of several centimeters. A ring of the cortex and phloem from a branch having a diameter nearly equal to that of the subject is removed from the {scion / graft}. It is a little less long than the prepared {xylem / ligneous} body and has one or two buds. This ring is introduced around the prepared xylem cylinder and the narrow strips of bark of the subject are returned to their place over the graft but not covering up the buds. It is then tied with raphia not tightened very much. A little time later, the bud of the graft develops, the union is effective. The young shoot is fixed to a prop.

In certain regions, in the Ardeche for instance, the narrow bark strips are removed by an incision and a small corky layer between scion and stock is made which resists against a slipping of the ring.

When the graft en flute de faune is applied to hardy individuals, only a single sight is grafted.

Shield grafting.--This type of graft is made when the sap is running, around August 15 and can only be employed to graft on the {stalk / base} of young trees, shield grafts on the {crown / top} succeed poorly. The scion branches must be chosen of average size, with well formed buds, but not developed ones, situated in the middle of annual shoots. The extremities of the latter are cut, the leaves removed and a part of the petiole is saved, one cm. from the bud of the part saved, removing the shield; it is necessary to detach the least possible amount of xylem and not damage the bud.

These branches are put in the shade outside, the lower part in a vase full of water or damp moss, for several hours or more. The shield'is detached from the scion-branch at the same moment that the grafting is done.

At 5 or 6 cm. from the ground, with a grafting knife, the cortex of the

subject is opened, by making 2 incisions in the shape of a T on its entire thickness, the longitudinal one 3 to 4 cm. long. With the grafting spatula the edges of the longitudinal incision are raised and the shield is quickly slipped into the incision in such a way that the internal parts do not contact the air. The bud is situated in the crack and should be applied dorsally on the subject.

The shield is tied with raphia or wool. Beginning at the top, one makes successive turns around the subject in order to keep the shield from moving upward or coming out of the incision. An end of the tieing material is placed on the transversal line of the T, then crossed with 2 or *3* turns and finally the bond is rolled up around the grafted part, by close {windings / turns}, up to the sight of the longitudinal line. The second end of the tie is passed under the second to last turn and tightened well. It is useless to use grafting wax.

Shield budding with a dormant bud used in several regions, gives rather poor results, the {scion / graft} is easily detached by the wind. This process is employed in the Maures (Mountains near Mediterannean coast). Subjects of *3* or 4 years are pollarded at 2 m.; from the numerous shoots only *5* or 6 are saved to be grafted towards autumn.

Cleft grafting.--This graft is less resistant to wind than the "en flute" graft, because the union is less complete, thus it is rarely employed for the chestnut. It is used especially when the scions have been transported and the cortex adheres too much to the xylem for "bevel" grafting. Cleft grafting is done from the end of March to April, when the sap is rising, with scions cut in February, during mild and humid but not rainy weather, and preferably kept in almost dry sand, in the shelter of a wall, with a northern exposure or in a trench exposed to the north. Grafting is also done from August into October with

scions harvested at the same moment they are used.

The subject, which is usually 8–12 cm. in circumference, is truncated horizontally with a very sharp pruning knife, at a height of 1 m. 80–2mm.

The scion is a piece of well {lignified / ripened} branch, a year old at least, armed with one or more buds. It is often taken from pollarded individuals. The scion should be shorter, the younger the subject is. In cold rich soil, in a humid climate, scions with 4 or 5 buds must be preferred to short scions, while in poor soil and a dry hot climate, short scions give better results.

The scion is cut, at the lower part of the graft on two sides, in an almost triquetrous bevel beginning opposite a bud. At the summit of the bevel, a slight horizontal or oblique aperture is contrived at the top of each thin wall; the scion is thus supported more solidly on the adopted mother tree. To facilitate slipping, the point of the bevel is made slightly blunt.

The subject is slit vertically with the point of a pruning knife swinging the tool to separate the fibers from the xylem and not cut them. When the pruning knife has made a sufficient slit, it is opened by pressing, with one hand, a movement from left to right, while with the other hand the scions are inserted by the upper opening, making them slip downward as the incision enlarges. The pruning knife is removed rather early and the scion, pushed by hand, prepares its place. The bevel is slipped into its final place, so that the two generative layers, that of the subject and of the graft, are in contact, which is absolutely necessary. The upper part of the scion is sometimes placed, scarcely getting in from the interior side of the section, making the lower part project a little outside; thus, following the intersection, there is always a spot where the generative layers are in contact. It is tied next and the wounds of the subject and the scion are coated with lime. The liming is necessary, even in the case

of a half-cleft. The scions can be incased in a roll of paper to prevent them from drying out. Next it is useful to place a prop.

When a branch is left, to draw sap, in the graft without pollarding, it must be amputated when recovery is assured, along with what remains of the subject above the graft.

When the {stalks / stems} are not very strong, the graft is often made in a half-cleft with a single scion. The subject is only slit halfway through the horizontal cut, the other half, shortened slightly obliquely, retains the {graft / scion} well, and tying it is unnecessary. The double bevel of the scion should be {wedge-shaped / cuneate}.

Cleft grafting with encased bud.--The graft is also made with an encased bud. On the back of the bevel, a bud that is encased in the cleft of the cortex of the subject is contrived. A vigorous scion is thus produced, which is less easily harmed by wind. In addition it can be "palissé" against the upper part of the graft. It is then tied and waxed.

Cleft grafting at a fork or junction.--It is done on subjects that are not very large. At the junction of two branches and in the cleft the beveled graft is inserted.

{Whip-grafting / English cleft grafting or veneer grafting.}--It is done in nurseries, in spring, and the shield budding in August or September, if there is still enough sap.

In the first case, the scion should be cut in a bevel. Next a notch is made with a grafting knife cut from bottom to top, in a reversed V with unequal {sides / branches}. The subject is notched in a bevel shape permitting it to be joined to the scion. A new cut with the grafting knife prepares a hole at the base and another at the center in such a way that the bevels, in the form of small tongues opposite

one another are in perfect contact. The generative layers must be facing one another; the more live parts in contact the better the chance of recovery. When the scion is placed, it is tied and waxed and a prop is set up. This rapidly made graft is not very solid.

When the graft is done at the beginning of the sap run, it is called "with a sprouting bud"; done in August, "with dormant bud". In the first case the topping of the subject's head should be done 8 days after the grafting, 20 cm. above the graft, if the plant is tall enough.

When the scion grows, the subject is again pollarded, at least 15 days after the first operation, at 10 cm. This { notch, miter, (joint) unguis } serves as a prop; it is cut back when the leaves fall.

In the second case, when the graft is made at the end of the summer, with a dormant bud, the subject should be shortened to 10 cm., after the winter and the { notch, miter unguis } cut in August or September of the same year.

Crown graft.--This graft is sometimes made, especially to graft slightly large trees, particularly in the vicinity of Argeles-Gazost (Pyranees). It is done in April or May, as soon as the cortex is easily detachable. The subjects must be previously prepared, by pollarding to about 2 m., 3 or 4 weeks before grafting.

Branches are cut in winter for grafting and are placed in soil in a tub, in a basement or to the north of a building to keep them from budding and prevent their bark from drying or rotting.

The scion is made of a piece of branch from 5-12 cm. long. The lower part should be cut in a simple bevel and flattened in either a { hind "doe foot" } of { tip, mouthpiece "flute neck" } beginning opposite a bud, traversing the pith and ending about 2 or 3 cm. under this bud. The upper part of the scion should have 2 or 3 buds.

A small notch is contrived on the upper part of the bevel to seat the scion well in the subject, either flat or astride, according to its plane or oblique cut.

This scion is inserted on the head of the clefted subject, between the cortex and xylem. The two sides of the point of the slender bevel make sliding easier.

The scion is siezed by the top and made to slide under the cortex of the subject, which is detached with hand pressure. If the scion penetrates with difficulty under the cortex, it is necessary to slit the latter or lift it with a wooden spatula. Next it is tied with a moderately tight tie, avoiding compression of the cortex, then cover the wounds with grafting wax to prevent tearing. Care must be taken that the wax adheres well, that the sap that sweats from the cut parts is sponged up. One or two props are placed.

When the subject is large, several scions can be inserted, and more, the larger the cross-section of the subject; a scion every 6 cm. of circumference about, but it is necessary to make a longitudinal incision to facilitate slipping the scions without exposing the cortex of the subject to splitting.

They are tied and limed on the amputation of the stem, at the summit of the graftings, facing their backs and on the cortex of the subject.

root neck
Grafting on the flange.--According to Lavaille (1) aerial grafting has several inconveniences. The part of the trunk between the soil and the grafting ring is often subject to heart rot and shake, the heart rot in the trunk is indeed more frequent in grafted trees than in wild ones, but it is often an indication of age, of weakening resultant more often from wounds on exhausted individuals than from grafting, because the lesion caused by grafting can cause

1. Lavaille in Congr. Aabre et eau (1910), p. 91.

dry rot and other accidents. This is why Lavialle recommends grafting at soil level on the root neck or the root itself of C. sativa var microcarpa, resistant to the "Encre" disease. Grafting on the base is only recommended on very vigorous varieties according to Tricaud. Grafting on the stalk is more practical if the grafting wax adheres well.

Tie and closing obturation.--After grafting, it is often useful to tie with raphia, string, wool or leaves of Typha. In cleft or crown grafting, on a stem or on rather large branches, the tie can be made with osier (Salix viminales), broom (Cytisus), or with the cortex of willow, elm or linden.

As to the grafting wax to be used; we refer to special treatises.

Care to be given to grafted fruit-bearing chestnuts.

A short while after grafting, it is a good idea to watch the tie, to loosen it if it is strangling the graft and to tighten it if it is too loose.

Soon the cortex covers over the grafting wound. The graft is joined bodily with the subject and only a ridge, called the grafting ring, is left at the place of the graft.

When the graft has succeeded*, it is necessary to remove, right up till the end of summer, the new shoots not coming from the graft, which could be harmful to the budding of the graft, and it is useful to prop those that the graft has produced to give them good direction. Usually at least 3 or 4 scions are saved. Lavaille and Tricaud, however, find it preferable to cut back the scions little by little, except for a single one situated the nearest to the staff body of the tree and well developed. Lavaille also removes all the suckers except for one that should equalize the sap of the only remaining scion, and this sucker is removed next. The tree thus resumes its natural shape.

The suckers should be purned early. Cadoret recommended, to prevent their revival, to white wash the sections and their base with a solution of iron sulfate at 50% to which is added some sulfuric acid. If the suckers are kept and not removed every two or three years, to have a foliaceous expansion, the production of fruit is harmed and the life of the tree is shortened.

When the graft has failed, the operation can be begun again two years later on the good suckers.