



Ghent University Botanical Garden

Quercus L. (Fagaceae)

**VEGETATIVE KEY TO SPECIES
CULTIVATED IN WESTERN EUROPE**

Jan De Langhe

(21 April 2009 - 06 July 2012)

Vegetative key.

This key is based on vegetative characteristics visible during the longest period of the year. Fruits are rarely needed.

Taxa treated in this key: see page 31.

Taxa referred to synonymy in this key: see page 32.

Questionable/frequently misidentified taxa in this key: see page 33.

To improve practice:

- **Examine only mature leaves** unless otherwise mentioned.
Depending the taxon, all other leaves can differ enormously in size, **margin** and lateral vein number!!!
Also juvenile specimens can key out wrong.
- Beware of hybridisation, especially with plants raised from seed gathered in collections.

Features based on:

- JDL herbarium specimens.
- living specimens in various arboreta, botanic gardens and collections, especially these from wild origin.
- literature:

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Nixon, K.C. - (1997) - *Quercus* in Flora of North America vol. 3., 436-506.
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<http://www.plantentuin.ugent.be>.

KEY TO SUBGENERA AND GROUPS

- 01 a Lamina entire to (minutely) dentate (teeth <3mm) **AND** apex with "drip tip" **AND** not aristate, forked secondary veins absent or rare (secondary veins usually equidistant, often strictly parallel and intercalary veins absent).
..... **Subgenus *Cyclobalanopsis*: see page 3**
- b Lamina lobed or coarsely dentate (teeth >3 mm); **IF** entire to (minutely) dentate then apex aristate, **OR** secondary veins often forked (secondary veins often irregular, intercalary veins often present). **Subgenus *Quercus***. **02**
- 02 a Lamina always entire (only some undulation may occur, **summer flushes excluded**).
..... **GROUP A: see page 5**
- b Lamina lobed **OR** dentate **OR** variably entire to dentate to lobed. **03**
- 03 a Lamina generally dentate **OR** at least with some teeth, **AND** most teeth <1/4 distance lobe-apex to midvein (horizontally measured and arista excluded). **04**
- b Lamina generally lobed **OR** at least always with 1 lobe >1/4 distance lobe-apex to midvein (horizontally measured and arista excluded). **06**
- 04 a Teeth aristate (vein extending into soft flexible appendage). .. **GROUP B1: see page 10**
- b Teeth not aristate-tipped. **05**
- 05 a Teeth with small blunt-tipped **non-spiny** projections, **OR** +/- obtuse without projections - **these projections usually do not prick/sting**. **GROUP B2: see page 13**
- b Teeth with sharp-tipped **spiny** projections (cuspidate to mucronate, or spinulose to spinose) - **these projections usually prick/sting**. **GROUP B3: see page 17**
- 06 a Lobes with apex and teeth aristate. **GROUP C1: see page 24**
- b Lobes or teeth not aristate. **07**
- 07 a Lobes and teeth +/- soft with small blunt-tipped **non-spiny** projections, **OR** +/- obtuse without projections - **these projections usually do not prick/sting**.
..... **GROUP C2: see page 27**
- b Lobes and teeth with spiny projections (cuspidate to mucronate, or spinulose to spinose) - **these projections usually prick/sting**. **GROUP C3: see page 30**

Subgenus

Cyclobalanopsis

- 01 a Lamina predominantly entire **AND** secondary veins anastomosing, (only in small part of the leaves some teeth-like undulations or tiny teeth may occur towards apex). 02
- b Lamina predominantly dentate (sometimes minutely) **AND at least in apical part secondary veins ending in teeth.** 07
- 02 a Lamina lanceolate L/W >5/1. *Q. neglecta*
- b Lamina elliptic L/W 2/1-3/1. 03
- 03 a Apex acute to abruptly and short-acuminate. *Q. sessilifolia*
- b Apex acuminate to caudate. 04
- 04 a Lamina elliptic L/W 2/1-3/1. Petiole >2 cm. *Q. acuta*
- b Lamina narrowly elliptic L/W ≤4/1. Petiole <2 cm. 05
- 05 a Lamina secondary veins poorly visible to the naked eye nor easy noticeable by touch. *Q. longinux*
- b Lamina LS secondary veins obvious, often impressed on US and raised on LS. 06
- 06 a Lamina LS green (US and LS almost concolorous), base clearly decurrent on petiole. *Q. hondae*
- b Lamina LS +/- glaucous, base cuneate. *Q. augustinii*
- 07 a Lamina LS covered with +/- thick continuous layer of overlapping stellate hairs clearly visible to the naked eye and +/- hiding the green surface. 08
- b Lamina LS glabrous, **OR IF** pubescent then with thin scattered layer of stellate or single hairs (often only visible with 10× LENS) not hiding the green surface, sometimes a thin whitish, easy detachable powdery layer occurs. 09
- 08 a Lamina US flat between secondary veins, base attenuate to cuneate. *Q. gilva*
- b Lamina US bullate between secondary veins, base broadly cuneate to obtuse. *Q. delavayi*
- **IF** lamina LS floccose stellate pubescent to glabrescent (subgenus *Quercus*). *Q. engleriana*
- 09 a Secondary veins ≥15/side (some small laminas with fewer veins may occur) **AND** lamina dentate at least from lower 2/3. 10
- b Secondary veins ≤15/side, **IF** >15/side then lamina dentate in apical 1/3. 13
- 10 a Lamina apical 2/3 margin minutely dentate **AND** LS with thin whitish and easy detachable powdery layer (slight touch may cause local disappearance of it). *Q. liboensis*
- b Lamina apical 3/4 margin dentate, LS sometimes with pale, much less detachable layer. 11

- 11 a Lamina 14-30(-50) × 6-12(-20) cm. Secondary veins (deeply) impressed and curved, (15-)20-25(-30)/side. LS with pale detachable layer (often absent in young plants).
..... *Q. lamellosa*
- b Lamina 12-20(-25) × 3-6(-8) cm. Secondary veins not or slightly impressed, straight or almost so, 15-20/side.
- 12 a Lamina margin serrate-dentate almost to base. LS pubescent with single hairs.
..... *Q. oxyodon*
- b Lamina apical 3/4 margin serrate-dentate. LS pubescent with stellate hairs.
..... *Q. ningangensis*
- 13 a Lamina margin with 10-12 or more teeth/side. 14
- b Lamina margin usually with ≤10 teeth/side, (occasionally some laminas present with 11 teeth/side). 15
- 14 a Lamina width 3,5-6 cm, LS pubescent with at least long hairs on venation.
..... *Q. argyrotricha*
- b Lamina width ≤3,5 cm, LS minutely glabrescent to minutely pubescent (only detectable with lens). *Q. stenophylloides*
- 15 a Lamina elliptic to ovate oblong, L/W 2/1-3/1. 16
- b Lamina lanceolate to lanceolate oblong, L/W (2/1-)3/1-4/1. 18
- 16 a Secondary veins of lamina apical half often straight. *Q. glauca*
- b Secondary veins of lamina apical half curved. 17
- 17 a Apex abruptly acuminate. Lamina LS greenish to blue-green, secondary veins 8-12/side. *Q. schottkyana*
- b Apex gradually acuminate. Lamina LS silvery-blue, secondary veins 10-15/side.
..... *Q. hypargyrea*
- 18 a Lamina LS +/- shiny blue-green to silvery-grey (sometimes very minutely dentate but usually with up to 10 incurved tiny teeth/side). *Q. salicina*
- b Lamina LS dull green to grey/blue-green. 19
- 19 a Lamina US with secondary veins not or slightly impressed and LS with tertiary veins not visible to the naked eye. 20
- b Lamina US with secondary veins impressed and LS with tertiary veins visible to the naked eye (at least in part). Taxa belonging subgenus *Quercus*. 21
- 20 a Lamina oblong to lanceolate, secondary veins at >45° to midvein. Margin minutely denticulate in >apical 1/2, teeth without or with very shallow sinus. *Q. myrsinifolia*
- b Lamina oblong to oblanceolate secondary veins at <45° to midvein. Margin dentate in apical 1/2 at least in part of the leaves, teeth with sinus pronounced. *Q. morii*
- 21 a Lamina base broadly subcordate to rounded, texture thick and rigid. *Q. engleriana*
- b Lamina base subrounded to cuneate, texture not thick but firm. *Q. tatakaensis*

Subgenus

Quercus

GROUP A

MARGIN ENTIRE

- 01 a Lamina LS glabrous OR soon glabrescent and only pubescent near midvein. 02
b Lamina LS persistently pubescent (LENS, sometimes scattered pubescent by end of season or on shade leaves). 35
- 02 a Shrub, usually <1(-2) m AND lamina 1-2(-3) cm. 03
b Shrub or tree, lamina >2 cm. 04
- 03 a Lamina +/- concolorous, petiole ≤2 mm. *Q. hinckleyi*
b Lamina discolorous with LS bluish, petiole >5 mm. *Q. vaciniifolia*
- 04 a Lamina L/W <2/1. 05
b Lamina L/W 2/1-6/1. 07
- 05 a Lamina flat AND +/- concolorous. *Q. myrtifolia*
b Lamina convex, OR IF flat, then conspicuously discolorous. 06
- 06 a Lamina flat to (slightly) convex and revolute, conspicuously discolorous (LS +/- bluish-white waxy and +/- golden pubescent on young growth), secondary veins 8-12/side. *Q. chrysolepis*
b Lamina strongly convex and revolute, slightly discolorous (LS yellowish-brown scurfy), secondary veins 5-8/side. *Q. inopina*
- 07 a Lamina US conspicuously bullate to rugose, secondary and tertiary veins deeply sunken, texture rigid leathery and +/- 1 mm thick. 08
b Lamina US +/- smooth, secondary veins not or partly sunken, texture papery or soft leathery and much thinner. 09
- 08 a Lamina 7-25 × 8 cm, apex acute, base auriculate. *Q. rysophylla*
b Lamina 4-10 × 2-5 cm, apex obtuse to rounded, base broadly cuneate. *Q. costaricensis*
⚠ Closely related or synonymous? ⚠ *Q. irazuensis*

09 a	Lamina L/W 4/1-6/1.....	10
b	Lamina L/W <4/1.	16
10 a	Lamina L/W 5/1-6/1, linear to narrowly elliptic, apex acute.	<i>Q. phellos</i>
b	Lamina L/W 4/1-6/1, narrowly elliptic, apex often acuminate to caudate.	11
11 a	LS venation with 0-5 intercalary veins/side.	<i>Q. gulielmitrelesei</i>
b	LS venation with 5-many intercalary veins/side.	12
12 a	Shoot (at least initially), petiole and lamina US on basal midvein part stellate pubescent. Lamina apex weakly aristate or mucronate.	13
b	Shoot and lamina glabrous. Lamina apex clearly aristate.	14
13 a	Lamina apex weakly aristate, base cuneate to subrounded.	<i>Q. crispifolia</i>
b	Lamina apex mucronate, base rounded to subcordate.	<i>Q. parvula</i>
14 a	Lamina apex acute, base obtuse to broadly cuneate.	<i>Q. hemisphaerica</i>
b	Lamina apex acuminate to caudate.	15
15 a	Lamina base cuneate and decurrent along +/- slender petiole.	<i>Q. delgadoana</i>
b	Lamina base cuneate to subrounded not decurrent, petiole thick.	<i>Q. salicifolia</i>
16 a	Rhizomatous shrub, usually <1(-2) m.	17
b	Shrub to three.	19
17 a	Lamina base rounded to broadly cuneate, apex acute.	<i>Q. vaciniifolia</i>
b	Lamina base cuneate to attenuate, apex predominantly obtuse to rounded.	18
18 a	At least part of the leaves lamina margin with mucronate teeth.	<i>Q. minima</i>
b	Lamina margin not mucronate.	<i>Q. chapmanii</i>
19 a	Lamina base cuneate to attenuate.	20
b	Lamina base broadly cuneate to rounded, or rounded to subcordate or subtruncate.	24
20 a	Lamina apex obtuse to acute.	21
b	Lamina apex acute to acuminate.	22
21 a	Lamina base cuneate to attenuate, margin entire	<i>Q. laurifolia</i>
b	Lamina base cuneate to obtuse and margin often finely undulate.	<i>Q. acherdophylla</i>
22 a	Petiole length >8 mm <u>AND</u> simultaneously lamina texture papery thin and LS with 0 or only very few short intercalary veins.	<i>Q. benthamii</i>
b	Petiole length <8 mm, <u>OR</u> lamina LS with numerous intercalary veins, <u>OR</u> lamina texture leathery thick.	23

23 a	Lamina elliptic (thick leathery, secondary veins 12-14/side).	<i>Q. rapurahuensis</i>	
b	Lamina oblong, narrowly elliptic to lanceolate (leathery, secondary veins 10-12/side).	<i>Q. salicifolia</i>	
24 a	Apex obtuse to acute.		25
b	Apex acute to acuminate.		29
25 a	Lamina up to 9 × 4 cm. Secondary veins ≤10/side.		26
b	Lamina >10 × 5 cm. Secondary veins often >10/side.		27
26 a	Lamina US dull +/- blue-green, margin flat.	<i>Q. oblongifolia</i>	
b	Lamina US shiny green, margin revolute.	<i>Q. chapmanii</i>	
27 a	Lamina L/W more often ≥3/1 (petiole slender, often >4mm).	<i>Q. crispipilis</i>	
b	Lamina L/W more often 2/1-3/1 (petiole thick, often <4 mm).		28
28 a	Lamina US with secondary veins impressed and tertiary veins visible.	<i>Q. elliptica</i>	
b	Lamina US with secondary veins not to slightly impressed and tertiary veins slightly visible.	<i>Q. sapotifolia</i>	
29 a	Lamina <4 × 2 cm, secondary veins ≤9/side.	<i>Q. galeanensis</i>	
	Lamina 3-12(-20) × 1-5(-6) cm, secondary veins >10/side (at least part of leaves).		30
30 a	Lamina margin finely and regularly crispy-undulate, texture thin, 6-8 × 2-3 cm, apex acute.	<i>Q. acherdophylla</i>	
b	Lamina margin flat to irregularly undulate, texture +/- thick, 3-12(-20) × 1-5(-6) cm, apex acute to acuminate.		31
31 a	Lamina apex mucronate <u>AND</u> base rounded to subcordate.	<i>Q. parvula</i>	
b	Lamina apex aristate (examine several leaves: less visible when laminas are damaged or aged), base obtuse to (broadly) cuneate.		32
32 a	Lamina LS glabrous <u>AND</u> venation +/- poorly visible.	<i>Q. hemisphaerica</i>	
b	Lamina LS stellate pubescent at least along midvein <u>AND/OR</u> secondary veins obvious, tertiary veins +/- visible.		33
33 a	Lamina LS stellate pubescent at least along midvein.	<i>Q. laurina</i>	
b	Lamina LS glabrous or soon so.		34
34 a	Lamina L/W +/- 4/1, largest width in the middle.	<i>Q. salicifolia</i>	
b	Lamina L/W +/- 3/1, largest width in or below the middle.	<i>Q. eugeniifolia</i>	
35 a	Lamina US rugose <u>AND</u> LS cinnamon to rusty-brown pubescent.	<i>Q. miquihuanensis</i>	
b	Lamina not simultaneously with US rugose and LS cinnamon to rusty-brown pubescent.		36
36 a	Lamina L/W <2/1.		37
b	Lamina L/W 2/1-6/1.		43

- 37 a Lamina midvein length >3,5 cm **AND** LS pubescence spreading in a thick layer (LS velvety greyish tomentose-pubescent and remarkably soft to the touch). *Q. senescens*
- b Lamina midvein length ≤ 3,5 cm **OR** LS pubescence appressed in a thin layer. 38
- 38 a Lamina LS greyish or bluish-white. 39
- b Lamina LS yellowish-brown scurfy. 42
- 39 a Secondary veins 8-12/side. Lamina LS +/- bluish-white waxy and +/- golden pubescent on young growth. *Q. chrysolepis*
- b Secondary veins 4-8/side. Lamina LS greyish-white. 40
- 40 a Lamina US glabrous or soon so **AND** older leaves (almost) entire but often spinose-dentate at apex, younger leaves with margin spinulose- to spinose-dentate and extremely prickly to the touch. *Q. baloot*
- b Lamina US stellate pubescent (LENS), almost all or only older leaves (almost) entire and often mucronate at apex margin mucronate- to weakly spinulose-dentate. 41
- 41 a Tree >3 m. Lamina US secondary smooth to poorly impressed. *Q. rotundifolia*
- b Shrub <3 m. Lamina US secondary veins deeply impressed. *Q. intricata*
- 42 a Lamina +/- convex (4-8,5 × 2-4,5 cm). *Q. inopina*
- b Lamina planar to undulate (8-12 × 4-8 cm). *Q. semecarpifolia*
- 43 a Rhizomatous or suckering shrub <1(-3) m. 44
- b Shrub or tree >4 m. 45
- 44 a Lamina base acute to rounded, narrowly ovate, elliptic or obovate, 2,5-10 × 1-3,3 cm, petiole 2-8(-10) mm. *Q. pumila*
- b Lamina base rounded to subcordate, lanceolate to elliptic or oblong, 1-6(-7) × 1-2,5(-3) cm, petiole ≤5 mm. *Q. microphylla*
- 45 a Lamina obovate or elliptic to obovate, base gradually narrowing **AND** apex rounded, obtuse to acute. *Q. oglethorpensis*
- b Lamina not simultaneously obovate and with base gradually narrowing and apex rounded. 46
- 46 a Lamina LS secondary veins rarely or only a few forked (extremely variable, entire or dentate, US +/- bullate). *Q. ilex*
- b Lamina LS secondary veins usually forked before reaching the margin. 47
- 47 a Lamina base variable from cuneate to obtuse or rounded. 48
- b Lamina base variable: rounded or almost truncate to cordate or subauriculate. 53
- 48 a Lamina LS green, loosely stellate-pubescent. *Q. imbricaria*
- b Lamina LS grey to whitish, densely stellate-pubescent (except shade leaves!). 49

- 49 a Lamina simultaneously thick, LS whitish **AND** US rugose with secondary veins deeply impressed and strongly branched. *Q. hypoleucoides*
- b Lamina not simultaneously with these characters (often thin, LS greyish, US not rugose, secondary veins slightly/not impressed). 50
- 50 a Lamina up to 10 × 3,5 cm **AND** apex aristate. *Q. incana*
- b Lamina apex not aristate. 51
- 51 a Lamina up to 6 × 2 cm **AND** apex mucronate (petiole 2-5 mm). *Q. brandegeei*
- b Lamina apex not mucronate. 52
- 52 a Lamina LS stellate-pubescent (oblanceolate, obovate or elliptic, margin flat or slightly revolute, acorns single) ⚠. *Q. virginiana*
- Scarcely different, lamina in general more lanceolate than oblanceolate. *Q. fusiformis*
- b Lamina LS stellate- and simple-pubescent with erect hairs (lanceolate to elliptic, sometimes convex, margin revolute, acorns in two's) ⚠. *Q. geminata*
- 53 a Lamina with largest width clearly from middle to base. *Q. durifolia*
- b Lamina with largest width in the middle or from middle to apex. 54
- 54 a Lamina elliptic oblong to obovate oblong, L/W ≤3/1. 55
- b Lamina elliptic oblong to lanceolate or narrowly ovate, L/W >3/1. 58
- 55 a Lamina conspicuously discolorous with LS +/- bluish-white waxy and +/- golden pubescent on young growth. *Q. chrysolepis*
- b Lamina not or slightly discolorous. 56
- 56 a Lamina up to 9 × 4 cm. Secondary veins ≤10/side (US dull, +/- blue-green in autumn, margin +/- flat and sometimes dentate, LS pale gray-green). *Q. oblongifolia*
- b Lamina >10 × 5 cm. Secondary veins predominantly >10/side (leaves with less secondary veins may occur). 57
- 57 a Lamina apex not aristate, up to 22 × 8 cm (petiole thick, often <4 mm). *Q. elliptica*
- b Lamina apex aristate, up to 15 × 6 cm (petiole slender, often >4mm). *Q. crispipilis*
- 58 a Lamina LS contorted/interlaced branched stellate-pubescent (LENS). *Q. mexicana*
- b Lamina LS straight to curly branched stellate-pubescent. 59
- 59 a Lamina US venation clearly impressed, LS straight to lax curly-branched stellate-pubescent, often glabrescent. *Q. crassipes*
- b Lamina US venation not to poorly impressed, LS straight-branched stellate-pubescent usually persisting along midvein. 60
- 60 a Lamina entire, ≤15 × 4 cm (acorn cupule 2/3 enclosing gland). *Q. gentryi*
- b Lamina entire to dentate (at least on juvenile growth) ≤8 × 3 cm (acorn cupule 1/3 enclosing gland). *Q. saltillensis*

GROUP B
MARGIN DENTATE

B1

TEETH ARISTATE

(vein extending into soft flexible appendage)

- 01 a Lamina LS persistent pubescent (sometimes scattered and thin - LENS!!!). 02
 b Lamina LS glabrous or glabrescent, OR pubescent in vein axils and/or near midvein only. 11
- 02 a Lamina with secondary veins +/- equidistant, +/- straight and rarely forked AND intercalary veins absent (best observed on lamina LS). 03
 b Lamina with secondary veins irregular, curved and often forked AND/OR intercalary veins present. 04
- 03 b Lamina LS greyish green, loosely stellate pubescent, base rounded to subcordate (7-14 x 2-6 cm). *Q. brantii*
 b Lamina LS pale grey, densely stellate pubescent, base rounded to broadly cuneate (7-20 x 2-10 cm). *Q. variabilis*
- 04 a Lamina usually $\leq 7 \times 4$ cm (only a few longer may occur). 05
 b Lamina often > 8 cm long. 06
- 05 a Lamina apex +/- obtuse to acute, LS venation +/- poorly visible. *Q. eduardii*
 b Lamina apex acute, LS venation obvious. *Q. peninsularis*
- 06 a Lamina US with tertiary venation not or poorly visible (LS loosely pubescent).
 *Q. furfuracea*
 b Lamina US with tertiary venation clearly visible. 07
- 07 a Lamina width always < 8 cm. 08
 b Lamina width often > 8 cm at least in part of the leaves. 09
- 08 a Lamina US rugose (8-17 x 2-8 cm). *Q. castanea*
 b Lamina US +/- planar between secondary veins to slightly rugose (up to 15 x 6 cm).
 *Q. crispipilis*

- 09 a Lamina margin with 5-15 teeth/side. Shoot glabrescent..... *Q. candicans*
- b Lamina margin with 1-9 teeth/side. Shoot persistent pubescent (often +/- for several years). 10
- 10 a Lamina margin with 1-7 teeth/side towards apex + some entire leaves present (mature lamina $\leq 20 \times 10$). *Q. hintonii*
- b Lamina margin with 1-9 teeth/side above the middle (young shoot with lamina US purplish, mature lamina 10-20 \times 10-15 cm or more). *Q. crassifolia*
- 11 a Lamina apex rounded AND $\leq 1-4$ aristae in total. *Q. myrtifolia*
- b Lamina apex acute or acute to rounded, (1-)3-20 aristae or teeth/side. 12
- 12 a Lamina with ≤ 7 teeth/side. 13
- b Lamina with ≥ 8 teeth/side (or at least in part of the leaves). 25
- 13 a Lamina US bullate or rugose AND LS reticulate. 14
- b Lamina US not bullate nor rugose, LS not reticulate. 15
- 14 a Evergreen tree. Lamina with 12-20 secondary veins/side. *Q. rysophylla*
- b Deciduous tree. Lamina with 10-12 secondary veins/side. *Q. tristis*
- 15 a Lamina 2-4 \times 1-2 cm. *Q. galeanensis*
- b Lamina larger, 4-15 \times 1-5 cm. 16
- 16 a Lamina LS pubescent in secondary vein axils. 17
- b Lamina LS glabrous in secondary vein axils, or only the lower most pubescent. 21
- 17 a Deciduous tree. Petiole (1-)2-4 cm. *Q. xalapensis*
- b Evergreen tree or shrub. Petiole < 2 cm. 18
- 18 a Lamina apex obtuse to acute AND up to 15 \times 6 cm. *Q. crispipilis*
- b Lamina apex acute to acuminate. 19
- 19 a Shrub ≤ 4 m AND lamina 2-9 \times 1-3,5 cm. *Q. depressa*
- a Tree 10-20 m. Lamina 5-15 \times 1-5(-6) cm. 20
- 20 a Lamina LS vein axils pubescence yellowish-brown. *Q. acatenangensis*
- b Lamina LS vein axils pubescence whitish. *Q. laurina*
- 21 a Lamina largest width in or below middle, LS lower most secondary vein axils often pubescent. *Q. affinis*
- b Lamina largest width in or above middle, LS secondary vein axils glabrous. 22
- 22 a Lamina LS with tertiary venation visible to the naked eye AND 7-10 or more secondary veins/side. 23
- b Lamina LS with tertiary venation not or poorly visible. ≤ 7 secondary veins/side. 24

- 23 a Lamina up to 5-25 × 2-10 cm. Secondary veins 7-10 /side (LS with tertiary venation visible to the naked eye). *Q. conspersa*
- b Lamina up to 15 × 6 cm. Secondary veins >10/side. *Q. crispipilis*
- 24 a Lamina LS with often 1 or more tertiary veins ending in a teeth. *Q. acutifolia*
- b Lamina LS with tertiary veins not ending in teeth. *Q. cupreata*
- 25 a Intercalary veins absent. 26
- b Intercalary veins present (often regularly alternating secondary veins). 29
- 26 a Aristae longer than teeth high. 27
- b Aristae shorter than or as long as teeth high. 28
- 27 a Lamina 10- ≥20 cm long. Margin with 12-20 teeth/side. Petiole >2 cm. *Q. acutissima*
- b Lamina 7-12 cm long. Margin with 10-12 teeth/side. Petiole <2 cm. *Q. chenii*
- 28 a Petiole ≤8 mm. Lamina up to 10 cm, margin with ≤10 teeth/side, aristae <2 mm.
..... *Q. trojana*
- b Petiole ≥8 mm. Lamina up to 15 cm, margin with 8-14 teeth/side, aristae 2-5 mm.
..... *Q. libani*
- 29 a Lamina elliptic to obovate. *Q. planipocula*
- b Lamina elliptic to lanceolate. 30
- 30 a Lamina LS midvein and lateral veins partly yellowish stellate-pubescent. *Q. uxoris*
- b Lamina LS glabrous or except (basal part) midvein or vein axils. 31
- 31 a Intercalary veins long, regularly ending near sinuses. *Q. acutifolia*
- b Intercalary veins short, rarely approaching sinuses. 32
- 32 a All teeth at the end of a secondary vein. *Q. skinneri*
- b Some teeth at the end of a secondary vein forking. *Q. sartorii*

B2

Teeth with small non-spiny projections, OR without projections.

- 01 a Lamina usually <10 cm long. 02
b Lamina often >10 cm long. 19
- 02 a Lamina LS greyish stellate-pubescent (sometimes dispersed: LENS). 03
b Lamina LS glabrous or glabrescent. 12
- 03 a Intercalary veins often present. 04
b Intercalary veins usually absent. 07
- 04 a Lamina elliptic to obovate or lanceolate to oblanceolate. *Q. deserticola*
b Lamina ovate to ovate oblong. 05
- 05 a Lamina LS pubescence greyish (greyish-white) covering the surface. *Q. alentejana*
b Lamina LS pubescence greyish but not covering green surface. 06
- 06 a Lamina margin coarsely dentate with teeth >5 mm. Secondary veins at 45° with midvein. *Q. look*
b Lamina margin dentate with teeth 3 mm. Secondary veins at >60° with midvein. *Q. faginea* subsp. *broteroi*
- 07 a Lamina entire to variably (often remotely) dentate above middle, with shallow narrow sinuses. *Q. ilex*
b Lamina regularly coarsely-dentate almost to base, with deeper and coarser sinuses. 08
- 08 a Lamina with 9-15 secondary veins/side (6-12 × 4-8 cm, petiole 5-10 mm). *Q. afares*
b Lamina with ≤10 secondary veins/side. 09
- 09 a Lamina margin with teeth gland-tipped AND forward-directed (LENS). 10
b Lamina margin with teeth not gland-tipped, AND forward- to sideward-directed (LENS). 11
- 10 a Lamina with petiole 10-30 mm. *Q. serrata*
b Lamina with petiole 3-5 mm. *Q. serrata* var. *brevipetiolata*
- 11 a Small rhizomatous shrub <2 m. Lamina with lowest teeth apices usually >1 cm above base. Secondary veins 4-8/side, teeth 5-7/side. *Q. lusitanica*
b Shrub to tree. Lamina with lowest teeth apices usually <1 cm above base. Secondary veins and teeth 5-12/side. *Q. faginea*

- 12 a Lamina variably (partly) entire to obscurely- and coarsely-dentate, often in apical 1/2-1/3 even sometimes on the same shoot. Apex rounded to acute. *Q. polymorpha*
- b Lamina regularly crenulate to prominently dentate. 13
- 13 a Margin crenulate-dentate with teeth +/- 1mm. *Q. phillyreoides*
- b Margin dentate, teeth larger. 14
- 14 a Lamina predominantly with largest width in or below the middle, apex acute, margin acutely dentate. *Q. trojana*
- b Lamina variable but often with largest width above the middle (apex variable: obtuse to rounded to acute, margin +/- sinuate-dentate). 15
- 15 a Lamina obovate or oblong obovate. Distance between central secondary veins near midvein 1-2,5 cm. *Q. wutaishanica*
- Lamina variable on one tree: elliptical to obovate. Distance between central secondary veins near midvein <1 cm. 16
- 16 a Petiole 5-25 mm (lamina LS glabrescent to floccose-pubescent near midvein and base, 3-15 x2-6 cm). *Q. infectoria* subsp. *veneris*
- b Petiole <10 mm. 17
- 17 a Small rhizomatous shrub <2 m. Lamina with lowest teeth apices usually >1 cm above base. *Q. lusitanica*
- b Shrub to tree. Lamina with lowest teeth apices usually <1 cm above base. 18
- 18 a Intercalary veins usually absent. Lamina LS predominantly glabrous. *Q. infectoria*
- b Intercalary veins often present. Lamina LS predominantly at least stellate pubescent near or on venation. *Q. faginea*
- 19 a Lamina dentate usually in apical part to apical 2/3. 20
- b Lamina dentate usually from base to apex. 28
- 20 a Shoot bristly pubescent (LENS) (lamina LS clearly yellowish-rusty pubescent at least on venation). *Q. insignis*
- b Shoot glabrous or glabrescent or densely but not bristly pubescent (LENS). 21
- 21 a Lamina LS stellate pubescent. 22
- b Lamina LS glabrous or minutely pubescent (LENS). 23
- 22 a Lamina midvein length 10-30 cm, margin with 5-10 teeth/side. *Q. liebmannii*
- b Lamina midvein length 5-15 cm, margin with ≤5 teeth/side. *Q. deserticola*
- 23 a Lamina US blue-green (oblanceolate, apex acute, 3-7 teeth/side). *Q. germana*
- b Lamina US and LS +/- concolorous. 24
- 24 a Lamina without or with only 1 to a few intercalary veins. 25
- b Lamina with numerous intercalary veins. 27

25 a	Lamina apex acute to acuminate AND teeth acute.	<i>Q. lancifolia</i>	
	b Lamina apex rounded to acute AND teeth slightly acute to obtuse or almost reduced to their tips and/or absent in mature growth.		26
26 a	Lamina margin with tiny reduced teeth, mature growth with entire leaves. Petiole 2-5 mm (rarely more), thick.....	<i>Q. elliptica</i>	
	b Lamina margin with obtuse to acute teeth. Petiole 5-10 mm, slender.	<i>Q. glabrescens</i>	
27 a	Lamina lanceolate to oblanceolate, apex acute to acuminate.	<i>Q. leiophylla</i>	
	b Lamina lanceolate to elliptic or obovate, apex rounded to acute.	<i>Q. polymorpha</i>	
28 a	Lamina ovate-oblong to narrowly elliptic.		29
	b Lamina elliptic to obovate or oblanceolate.		30
29 a	Lamina margin with forward-directed teeth (8-15 acute teeth/side).	<i>Q. serrata</i>	
	b Lamina margin with sideward-directed teeth.	<i>Q. castaneifolia</i>	
30 a	Shoot densely persistent pubescent AND lamina LS stellate pubescent.		31
	b Shoot glabrous or soon so (lamina LS variable).		35
31 a	Secondary veins 12-18/side.		32
	b Secondary veins ≤ 12 /side.		33
32 a	Apex obtuse to acute. Lamina dentate, teeth obtuse to acute (usually height \leq width) directed forward to sideward. (Cupule scales recurved).	<i>Q. dentata</i> subsp. <i>yunnanensis</i>	
	b Apex acute to acuminate. Lamina dentate, teeth acute (often with height $>$ width) directed more forward. (Cupule scales erect and appressed).	<i>Q. griffithii</i>	
33 a	Petiole 10-20 mm.	<i>Q. macranthera</i>	
	b Petiole ≤ 10 mm.		34
34 a	Lamina auriculate at base, up to 30(-50) cm long.	<i>Q. dentata</i>	
	b Lamina cuneate to subrounded at base, up to 15(-17) cm long.	<i>Q. fabri</i>	
35 a	Lamina acutely double serrate-dentate at least in part (teeth at apex often curved inward).	<i>Q. pontica</i>	
	b Lamina not double serrate-dentate.		36
36 a	Petiole < 10 mm.		37
	b Petiole > 10 mm or variable in length 5-35 mm.		40
37 a	Margin acutely dentate.		38
	b Margin obtusely dentate.		39
38 a	Margin with sideward-directed teeth, secondary veins 10-16/side.	<i>Q. crispula</i>	
	b Margin with forward-directed teeth, secondary veins ≤ 10 /side.		39

- 39 a Secondary veins 9-12/side, intercalary veins usually absent (3-30 × 1-17 cm).
..... *Q. mongolica*
- b Secondary veins <9/side, intercalary veins often present (2-12 × 2-6 cm).
..... *Q. wutaishanica*
- 40 a Lamina LS +/- floccose near midvein (glabrescent to glabrous, Margin sinuate-dentate
with 6-12 coarse obtuse teeth/side). *Q. canariensis*
- b Lamina LS NOT floccose near midvein (finely stellate-pubescent or glabrescent or
simple-pubescent on veins). 41
- 41 a Margin acutely sinuously serrate-dentate, sinuses usually small and shallow <5 mm
deep. 42
- b Margin coarsely acutely to obtusely dentate, sinuses often >5 mm deep. 43
- 42 a Deciduous tree, lamina LS stellate-pubescent AND simple-pubescent on veins.
..... *Q. serrata*
- b Evergreen rhizomatous shrub (1-4 m), lamina LS scattered stellate-pubescent.
..... *Q. sadleriana*
- 43 a Secondary veins always ≤10/side AND teeth <10/side. 44
- b Secondary veins at least in part of the laminae 10-16/side OR teeth >10/side. 45
- 44 a Lamina LS greyish to whitish stellate pubescent (4-8 obtuse teeth/side and 3-7(-10) often
irregularly placed and diverging secondary veins). *Q. bicolor*
- b Lamina LS apparently glabrous, minutely stellate pubescent but with greenish colour
coming through (7-10 teeth/side and usually straight and +/- equidistant secondary veins).
..... *Q. prinoides*
- 45 a Lamina (at least juvenile leaves) LS erect ≤4 rayed stellate-pubescent (≥15× LENS).
..... *Q. michauxii*
- b Lamina (at least juvenile leaves) LS appressed 6-10 rayed stellate-pubescent, with or
without single hairs near midvein (≥15× LENS). 46
- 46 a Lamina LS single pubescent near midvein AND appressed stellate pubescent between
the secondary veins (sinuate dentate with obtuse teeth). *Q. montana*
- b Lamina LS appressed stellate pubescent AND not single pubescent near midvein. .. 47
- 47 a Margin sinuate-dentate with obtuse teeth. *Q. aliena*
- b Lamina coarsely dentate with obtuse to acute teeth. *Q. muehlenbergii*

B3

TEETH WITH SPINY PROJECTIONS:

CUSPIDATE TO MUCRONATE, OR SPINULOSE TO SPINOSE

- 01 a Rhizomatous shrub, usually <1(-2) m, leaves dimorphic oblanceolate and entire or obovate and 1-5 teeth/side. *Q. minima*
- b Shrub to three without these characters. 02
- 02 a Lamina LS glabrous or pubescent only in vein axils or on basal part. 03
- b Lamina LS AND/OR US uniformly pubescent with a layer of hairs, sometimes very minute and only observed with a 10x LENS!!! (except shade leaves and previous year leaves). 26
- 03 a Lamina US secondary AND tertiary veins deeply impressed. 04
- b Lamina US venation not or only secondary veins deeply impressed. 05
- 04 a Lamina convex, base +/- cordate. *Q. rugosa*
- b Lamina planar to undulate, base (obtuse-) cuneate. *Q. oleoides* subsp. *sagraeana*
- 05 a Plant with numerous characteristic short shoots inserted at straight angle on larger branches. *Q. emoryi*
- b Plant without such characteristic short shoots. 06
- 06 a Lamina, average >8 cm (6-16 x 2-6 cm) AND LS secondary venation +/- equidistant AND intercalary veins rare, loosely tomentose-pubescent, early disappearing and easily detachable with soft touch. *Q. engleriana*
- b Lamina average ≤7 cm (some longer laminae may occur), IF lamina longer then NOT with previous combination of characters. 07
- 07 a Lamina LS +/- (whitish-) blue-green, waxy and/or +/- yellowish pubescent, glabrescent. *Q. chrysolepis*
- b Lamina LS green AND/OR US slightly darker, OR concolorous. 08
- 08 a Lamina LS with secondary veins poorly visible at least in part of the leaves (difficult to obtain accurate counts without 10x LENS). 09
- b Lamina LS with all secondary veins clearly visible. 15
- 09 a Lamina small, up to 1-3(-4) x 1,8 cm AND margin with 2-6 teeth/side or entire. 10
- b Lamina larger >3 cm AND/OR with 5-12(-more) teeth/side. 11
- 10 a Shoot pubescent (lamina 1-3(-4) x 0,5-1,8 cm, with 2-6 spinulose teeth/side or entire). *Q. toumeyi*
- b Shoot glabrescent to glabrous. 11

- 11 a Current year shoot olive green to pale brown. Lamina US yellowish to slightly glaucous green. *Q. hinckleyi*
- b Current year shoot reddish brown to brown. Lamina US +/- dark green. *Q. dumosa*
- 12 a Margin dentate on lamina apical 2/3. 13
- b Margin dentate from base to apex. 14
- 13 a Margin crenulate-dentate with tiny teeth and sinuses <1mm. *Q. phillyreoides*
- b Margin spinulose-dentate with teeth ≥1 mm. *Q. baronii*
- 14 a Lamina 3-6 × 2-3 cm, spinulose-dentate with 5-12 teeth/side, +/- concolorous green (petiole and shoot glabrous, young growth can have some stellate down, soon glabrous, secondary veins <10 pairs, apex acute, lamina strongly undulate). *Q. coccifera*
- b Lamina 1-3 × 0,5-2 cm, spinulose-dentate with 2-6 teeth/side or entire (often lobed), +/- discolorous with LS greyish green. *Q. berberidifolia*
- 15 a Secondary veins ≤5/side. *Q. agrifolia*
- Lamina LS with stellate-pubesence not only confined to the vein axils but also more spread over the surface, sometimes very dense. *Q. agrifolia* var. *oxyadenia*
- b Secondary veins ≥5/side. 16
- 16 a Small rhizomatous shrub <2 m. Lamina with lowest teeth apexes usually situated >1 cm above base. Secondary veins 4-8/side, teeth 5-7/side. *Q. lusitanica*
- b Shrub to tree, without these characters. 17
- 17 a Lamina with mucronate teeth on apical 1/2-3/4. 18
- b Lamina with mucronate teeth from base to apex. 20
- 18 a Lamina ≤7 × 2 cm AND margin with +/- tiny teeth ≤2 mm. *Q. baronii*
- b Lamina often >7 × 2 cm AND margin with larger teeth >2 mm. 19
- 19 a Lamina base rounded to (unequally) subcordate. LS intercalary veins poorly visible. *Q. floribunda*
- b Lamina base rounded to cuneate. LS intercalary veins clearly visible. *Q. oleoides* subsp. *sagraeana*
- 20 a Secondary veins 6-12(-more)/side. 21
- b Secondary veins <7/side. 23
- 21 a Lamina L/W 3/1-4/1, apex acuminate. *Q. tungmaiensis*
- b Lamina L/W 2/1, apex rounded to acute. 22
- 22 a Lamina +/- undulate, apex obtuse to rounded (secondary veins 6-12/side, 3-8 × 3-6 cm). *Q. rehderiana*
- b Lamina +/- planar, apex acute (secondary veins 6-10/side, 3-7 × 2-5 cm). *Q. wislizeni*
- 23 a Lamina US scattered stellate-pubescent (LS yellowish-rusty pubescent in vein axils). *Q. hintoniorum*
- b Lamina US without scattered stellate pubescence. 24

24 a	Lamina LS pubescent on midvein basal part.	<i>Q. spinosa</i>
b	Lamina LS glabrous.	25
25 a	Lamina US secondary veins deeply impressed.	<i>Q. gilliana</i>
b	Lamina US secondary veins not impressed.	<i>Q. wislizeni</i>
26 a	Lamina LS completely covered by dense tomentose pubescence, leaf surface not visible.	27
b	Lamina LS leaf surface clearly visible through the pubescence.	44
27 a	Lamina often convex.	28
b	Lamina undulate or planar.	29
28 a	Lamina 5-20 × 3-13 cm, secondary veins 8-12/side, LS very reticulate.	<i>Q. rugosa</i>
b	Lamina 1,5-6 cm long and broad, secondary veins 4-8/side, LS not reticulate.	<i>Q. alnifolia</i>
29 a	Lamina LS yellowish to rich golden brown pubescent, at least so for the current year leaves.	30
b	Lamina LS greyish, or whitish to beige (and later tanning), at least so for the current year leaves.	34
30 a	Lamina up to 12 × 8 cm <u>AND</u> margin flat.	<i>Q. semecarpifolia</i>
b	Lamina up to 9 × 5 cm <u>AND</u> margin revolute.	31
31 a	Lamina small sized: width ≤3 cm <u>AND</u> up to 5 × 3 cm.	<i>Q. pannosa</i>
b	Lamina medium sized: at least in part of the leaves >3 cm width <u>AND/OR</u> partly up to 9 × 5 cm.	32
32 a	Lamina US tertiary veins clearly impressed visible to the naked eye.	<i>Q. guajavifolia</i>
b	Lamina US tertiary veins not impressed, at least not visible to the naked eye.	33
33 a	Infructescence often present, conspicuously long: 5-15 cm.	<i>Q. longispica</i>
b	Infructescence rarely present + pedicel shorter: ≤4 cm.	<i>Q. aquifolioides</i>
34 a	Secondary veins ≥8/side.	35
b	Secondary veins ≤8/side.	39
35 a	Lamina apex acute to acuminate.	<i>Q. leucotrichophora</i>
b	Lamina apex obtuse to acute.	36
36 a	Lamina apex obtuse to acute.	<i>Q. alentejana</i>
b	Lamina apex acute.	37
37 a	Lamina LS tertiary venation poorly visible (margin regularly acutely dentate, teeth ≤3 mm).	<i>Q. ilex</i>
b	Lamina LS tertiary venation clearly visible to the naked eye.	38

- 38 a Lamina margin coarsely dentate, teeth 3-5 mm. *Q. lanata*
b Lamina margin serrate-dentate, teeth ≤ 3 mm. *Q. franchetii*
- 39 a Lamina US tertiary venation clearly visible to the naked eye (margin with 3-5 large teeth/side). *Q. greggii*
b Lamina US tertiary venation poorly visible. 40
- 40 a Lamina LS pubescence spreading in a thick layer. 41
b Lamina LS pubescence appressed in a thin layer. 42
- 41 a Shrub or small tree. Lamina apex obtuse, LS remarkably velvety greyish tomentose-pubescent and remarkably soft to the touch. *Q. senescens*
b Low shrub 15 cm-1 m (rarely more). Lamina apex acute and spinose, LS less densely pubescent. *Q. monimotricha*
- 42 a Lamina margin spinulose- to spinose-dentate and extremely prickly to the touch, older leaves (almost) entire but often spinose-dentate at apex. *Q. baloot*
b Lamina margin mucronate- to weakly spinulose-dentate, older leaves (almost) entire and often mucronate at apex. 43
- 43 a Lamina LS secondary veins often forking before ending in teeth or margin (LENS).
..... *Q. rotundifolia*
b Lamina LS secondary veins ending in teeth, rarely forking. *Q. suber*
- 44 a Lamina LS yellowish to brownish pubescent, at least so for the youngest leaves. 45
b Lamina LS whitish (later tanning) or grey pubescent. 52
- 45 a Lamina spinulose dentate over whole length, 2-5 x 2-4 cm. *Q. palmeri*
b Lamina not spinulose dentate. 46
- 46 a Lamina elliptic, 2-12 x 1,5-8 cm or more. *Q. semecarpifolia*
b Lamina predominantly obovate, or at least with apex much broader than base. 47
- 47 a Lamina US with secondary venation not or slightly impressed, tertiary venation not impressed (average ≤ 7 cm). *Q. potosina*
b Lamina US with secondary and tertiary venation impressed. 48
- 48 a Lamina 2-7 x 2-5 cm, margin with 3-4 (-6) large teeth/side. 49
b Lamina usually $>7 \times 5$ cm, margin usually with >5 often tiny teeth/side at least in part of the leaves. 50
- 49 a Secondary veins ≥ 6 /side. Lamina LS indumentum persistent. *Q. greggii*
b Secondary veins ≤ 6 /side. Lamina LS indumentum glabrescent (easy detachable).
..... *Q. hypoxantha*
- 50 a Lamina usually convex. *Q. rugosa*
b Lamina planar. 51

- 51 a Lamina LS midvein and secondary veins usually stellate-pubescent. *Q. subspathulata*
 b Lamina LS dispersed stellate-pubescent ⚠ doubtful - is this so? ⚠. *Q. obtusata*
- 52 a Intercalary veins usually absent. 53
 b Many leaves with intercalary veins. 63
- 53 a Lamina spinulose- to spinose-dentate (texture often very thick). 54
 b Lamina mucronulate-dentate to mucronate-dentate (texture firm). 56
- 54 a Lamina LS with secondary veins poorly visible (1-4 × 1-2,5 cm, spinulose-dentate with 5-6 teeth/side or entire). *Q. aucheri*
 b Lamina LS with secondary veins clearly visible. 55
- 55 a Lamina margin spinulose- to spinose-dentate and extremely prickly to the touch, older leaves (almost) entire but often spinose-dentate at apex. *Q. baloot*
 b Lamina margin mucronate- to weakly spinulose-dentate, older leaves (almost) entire and often mucronate at apex. *Q. rotundifolia*
- 56 a Lamina dentate with large +/- triangular teeth, 3-5(-more) mm, sometimes. *Q. ithaburensis*
 b Lamina dentate with small acute teeth, ≤3 mm. 57
- 57 a Lamina often with >8 teeth/side. 58
 b Lamina with ≤7 teeth/side (rarely more on vigorous juvenile growth). 59
- 58 a Lamina obovate to elliptic, planar to undulate, secondary veins 7-8(-10)/side. *Q. dolicholepis*
 b Lamina elliptic to lanceolate, convex to double convex along midvein, secondary veins 8-12/side. *Q. tomentella*
- 59 a Lamina LS remarkably velvety greyish tomentose-pubescent (fading yellowish-grey and less thick later), soft to the touch. *Q. senescens*
 b Lamina LS greyish stellate-pubescent in a much thinner degree. 60
- 60 a Secondary veins ≤5/side. *Q. agrifolia* var. *oxyadenia*
 b Secondary veins 5-11/side. 61
- 61 a Small rhizomatous shrub <2 m. Lamina with lowest teeth apexes usually situated >1 cm above base. Secondary veins 4-8/side, teeth 5-7/side. *Q. lusitanica*
 b Shrub or tree without these characters. 62
- 62 a Bark corky. Secondary veins (4-)5-8/side. *Q. suber*
 b Bark not corky. Secondary veins (7-)8-11/side. *Q. ilex*
- 63 a Lamina variable: entire and/or dentate with ≥5 teeth/side. 64
 b Lamina variable: entire and/or dentate with ≤5 teeth/side. 68

- 64 a Low shrub 15 cm-1 m (rarely more) **AND** mature lamina 1-4 x 0,5-3 cm, venation US deeply impressed. *Q. monimotricha*
- b Tree or shrub **AND** lamina 2-8 cm long (or more), **OR/IF** shrub then lamina venation US slightly or not impressed. 65
- 65 a Lamina LS secondary veins poorly visible (difficult to obtain accurate counts without 10x LENS). 66
- b Lamina LS secondary veins raised and clearly visible. 67
- 66 a Lamina US glabrous to glabrescent. *Q. berberidifolia*
- b Lamina US persistent stellate-pubescent. *Q. durata*
- 67 a Secondary veins 4-6/side, LS scattered pubescent but vein axils very pubescent. *Q. hintoniorum*
- b Secondary veins 6-8/side, LS and vein axils uniformly pubescent. *Q. alentejana*
- 68 a Lamina US secondary and tertiary venation deeply impressed. *Q. greggii*
- b Lamina US not or only secondary venation deeply impressed. 69
- 69 a Lamina usually cuspidate-dentate in apical part with 2-3 teeth/side. *Q. acrodonta*
- b Lamina dentate from base to apex or partly entire, or entire. 70
- 70 a Lamina base cuneate to obtuse and decurrent along petiole. *Q. pacifica*
- a Lamina base not decurrent. 71
- 71 a Lamina US dull blue- or grey-green. 72
- b Lamina US dark green, often shiny dark green. 76
- 72 a Lamina US +/- rough to the touch and +/- rugose. *Q. arizonica*
- b Lamina US smooth or bullate. 73
- 73 a Lamina 1-3 x 0,6-1,5 cm, spinulose-dentate to entire. *Q. toumeyii*
- b Lamina 2-8 x 0,6-4 cm, mucronate-dentate to entire. 74
- 74 a Lamina LS loosely pubescent and often glabrescent. *Q. oblongifolia*
- Differing in minor characters like larger, deeper and more tuberculate cupule scales. *Q. engelmannii*
- b Lamina LS densely persistent pubescent, visible with 10x LENS. 75
- 75 a Terminal bud with persistent stipules. Lamina apex acute, sometimes obtuse, petiole 3-10 mm. *Q. grisea*
- b Terminal bud wit caducous stipules. Lamina apex rounded to acute, petiole 2-5 mm. *Q. mohriana*
- 76 a Lamina spatulate, largest width clearly above the middle. *Q. tinkhamii*
- b Lamina oblong elliptic, largest width in the middle (a few spatulate leaves may be present). 77

- 77 a Lamina base obtuse to (sub-)cordate or rarely broadly cuneate to (sub-)cordate. 78
 b Lamina base cuneate to obtuse. 80
- 78 a Lamina US smooth, on juvenile growth often with 1-2 teeth/side near apex (shrub <1(-3) m). *Q. microphylla*
 b Lamina US and/or LS rugose and often rough to the touch. Dentate margins with 3-5(-more) teeth/side. 79
- 79 a Lamina strongly undulate, LS and US rugose often rough to the touch. *Q. pungens*
 b Lamina planar or only slightly undulate/convex, US +/- rough to the touch and +/- rugose. *Q. arizonica*
- 80 a Secondary veins ≤6/side. *Q. vaseyana*
 b Secondary veins ≥6/side. 81
- 81 a Lamina apex mucronate. *Q. brandegeei*
 Lamina apex obtuse to rounded without mucro. 82
- 82 a Lamina LS stellate-pubescent (acorns single) ⚠. *Q. virginiana*
 Scarcely different, lamina in general more lanceolate than oblanceolate. *Q. fusiformis*
 b Lamina LS stellate- and simple-pubescent with erect hairs (acorns in two's) ⚠. *Q. geminata*

GROUP C

LAMINA LOBED

C1

LOBES WITH APEX AND TEETH ARISTATE

- 01 a Lobes and sinuses shallow and remarkably wide = margin often +/- 'wavy' (in part of the leaves $<1/4$ of horizontal distance lobe apex to lamina midvein). 02
- b Lobes longer, sinuses deeply U- to V-shaped (at least in part of the leaves $>1/4$ of horizontal distance lobe apex to lamina midvein). 03
- 02 a Petiole 5-25 mm. *Q. arkansana*
- b Petiole ≤ 5 mm. *Q. myrtifolia*
- 03 a Lamina LS +/- uniformly stellate-pubescent. 04
- b Lamina LS glabrous to very sparsely pubescent OR pubescent in vein-axils only. ... 08
- 04 a Lobes (1-) $2(-3)$ /side. 05
- b Lobes 3-4(-more)/side. 06
- 05 a Lamina 10-30 \times 5-16 cm. Lobes narrow elongate, laterals often falcate. *Q. falcata*
- b Lamina 5-12 \times 3-9 cm. Lobes triangular, length \leq width. *Q. ilicifolia*
- 06 a Lobes 4-7/side, usually entire with only 1 arista at lobe apex. *Q. macrolepis*
- b Lobes 3-5/side, usually coarsely dentate to secondary lobed, with 2-several aristae/lobe. 07
- 07 a Lamina base truncate, large lobes with secondary lobes. *Q. kelloggii*
- b Lamina base cuneate, large lobes entire to dentate. *Q. pagoda*
- 08 a Lobes $<1/2$ of horizontal distance lobe apex to lamina midvein. 09
- b Lobes $>1/2$ of horizontal distance lobe apex to lamina midvein. 13
- 09 a Lamina with 12-50 aristae, petiole 25-50 mm. *Q. rubra*
- b Lamina with ≤ 20 aristae, petiole ≤ 30 mm. 10
- 10 a Petiole ≤ 9 mm. *Q. nigra*
- b Petiole variable 5-30 mm. 11

- 11 a Lamina leathery, evergreen, lobes and/or teeth in apical half. *Q. acatenangensis*
 b Lamina papery, deciduous, lobes and/or teeth in apical 2/3. 12
- 12 a Most laminas with 1-9 aristae and largest lobe ≤1,5 cm deep. Base cuneate. *Q. canbyi*
 b Most laminas with 8-20 aristae and largest lobe >1,5 cm deep. Base cuneate to subrounded. *Q. gravesii*
- 13 a Lamina with largest lobes often at or emerging from base, often typical presence of deeply 3-lobed 'turkey-feet' laminas with narrow falcate lateral lobes. *Q. laevis*
 b Lamina with largest lobes situated towards apex or +/- in the middle, never basal. ... 14
- 14 a Lamina length ≤ width, at least in part of the leaves. 15
 b Lamina length ≥ width. 18
- 15 a Midvein length ≤10 cm. *Q. buckleyi*
 b Midvein length variable from 7-20 cm. 16
- 16 a Tree, habit with lower branches weeping, middle branches +/- horizontal and upper branches ascending. *Q. palustris*
 b Tree with habit different. 17
- 17 a Lobes 2-4, with 11-48 aristae, midvein length 7-14 cm. *Q. acerifolia*
 a Lobes 2-5, with 9-24 aristae, midvein length 7-20 cm. *Q. texana*
- 18 a Petiole 5-25 mm. 19
 b Petiole 20-70 mm. 22
- 19 a Lamina 3-lobate (1 terminal and 2 lateral lobes), or with 3 largest lobes towards apex and a few much smaller ones towards base. *Q. marilandica*
 Lamina 3-lobate. *Q. marilandica* subsp. *marilandica*
 Lamina with 3 major lobes and up to 3 more smaller lobes/side. *Q. marilandica* subsp. *ashei*
 b Lamina 4-10-lobate, with lobes more equal or largest lobes +/- in the middle. 20
- 20 a Base truncate to obtuse or subcordate **AND** largest lobes with secondary lobes. *Q. kelloggii*
 b Base variable cuneate to attenuate or cuneate to subrounded. Largest lobes without secondary lobes. 21
- 21 a Lamina base cuneate to attenuate. *Q. georgiana*
 b Lamina base broadly cuneate to subrounded. *Q. gravesii*
- 22 a Lamina LS axillary pubescence absent or pale and minute (some pubescence along midvein may occur). 23
 b Lamina LS axillary pubescence prominent. 26
- 23 a Lobes 2-4/side. 24
 b Lobes 3-5/side. 25

- 24 a Lamina midvein length ≤ 16 cm. *Q. coccinea*
 b Lamina midvein length ≤ 13 cm, otherwise questionable vegetatively distinguishable from the previous one). *Q. ellipsoidalis*
- 25 a Petiole reddish at base. Largest lobes toothed, sides straight. *Q. rubra*
 b Petiole yellowish. Largest lobes secondary lobed, sides curved. *Q. kelloggii*
- 26 a Tree habit with lower branches weeping, middle branches +/- horizontal and upper branches ascending. *Q. palustris*
 b Tree habit different, often most part of branches ascending. 27
- 27 a Bud pubescent. Lamina LS glabrous to scattered stellate pubescent. *Q. velutina*
 b Bud glabrous or slightly pubescent at apex. 28
- 28 a Bud pale greyish to yellowish. *Q. shumardii*
 b Bud brownish to reddish. 29
- 29 a Lamina with 9-24 aristae, base cuneate. *Q. texana*
 b Lamina with 13-45 aristae, base truncate to obtuse or subcordate. *Q. kelloggii*

C2

LOBES AND TEETH +/- SOFT

WITH OR WITHOUT SMALL NON-SPINY PROJECTIONS

- 01 a Lamina with 1-5 lobes (teeth)/side. 02
b Lamina with >5 lobes always present (= laminas with >5 lobes (teeth)/side, or variably 3-9 lobes (teeth)/side). 13
- 02 a Lamina variable: both entire and with 1-3 lobes or teeth/side on the same (shoot) plant (lamina obovate, sometimes elliptic, petiole short). 03
b Lamina more regularly lobed, rarely unlobed. 04
- 03 a Midvein length up to 14 cm. Lamina both entire and with 1-3 variably small lobes or teeth/side on the same (shoot) plant. *Q. sinuata*
b Midvein length up to 8 cm. Lamina entire and/or more regularly lobed, lobes broad and shallow. *Q. chapmanii*
- 04 a Lamina with 1-3(-4) lobes/side AND usually 2 clearly major lobes (sub-)oppositely placed. 05
Lamina with 2-5 lobes/side, OR IF fewer, then all lobes +/- equally sized, or not oppositely placed nor major lobes situated in apical part. 08
- 05 a Shoot glabrous. *Q. margaretta*
b Shoot pubescent. 06
- 06 a Secondary veins >5/side. Rhizomatous deciduous or sub evergreen shrub <3 m or small tree <6 m. *Q. boyntonii*
b Secondary veins 3-5/side, deciduous tree. 07
- 07 a Shoot Ø 2-3 mm. Lamina with 1-3 lobes/side (LS glabrous or scattered stellate-pubescent). *Q. similis*
b Shoot Ø 3-5 mm. Lamina with 1-2 lobes/side. *Q. stellata*
- 08 a Lamina +/- oblanceolate or narrowly elliptic, 1-4 lobes/side +/- equally sized and irregularly placed in apical 2/3. Base cuneate to attenuate. *Q. austrina*
b Lamina elliptic to obovate or oblong, 2-5 lobes/side. Base cuneate, truncate to auriculate. 09
- 09 a Lamina LS glabrous. 10
b Lamina LS pubescent at least on venation. 11
- 10 a Lamina base cuneate. Petiole up to 25 mm. *Q. alba*
b Lamina base auriculate. Petiole up to 8 mm. *Q. robur*

- 11 a Lamina LS with appressed stellate hairs. *Q. lobata*
b Lamina LS with at least erect simple hairs and erect stellate hairs. 12
- 12 a Lamina +/- planar. Petiole 10-20 mm AND terminal bud ≤ 3 mm. *Q. gambellii*
b Lamina +/- undulate. Petiole 2-12 mm (some larger possible), terminal bud variable 2-10 mm. *Q. garryana*
- Tree. Bud pale yellowish brown. *Q. garryana* var. *garryana*
- Shrub or multistemmed small tree. Bud brownish.
- Lamina LS with 4-6-armed stellate hairs. *Q. garryana* var. *breweri*
- Lamina LS with 6-8-armed stellate hairs. *Q. garryana* var. *semota*
- 13 a Lamina with intercalary veins lacking (a few laminas with 1 intercalary vein may occur). 14
b Lamina usually with 1 or several intercalary veins. 17
- 14 a Petiole and midvein on lamina LS densely yellowish to brownish pubescent. 15
b Petiole and midvein on lamina LS glabrescent or almost so. 16
- 15 a Lamina up to 18 cm long. Petiole often ≥ 15 mm. *Q. macranthera*
b Lamina up to 30(-50) cm long. Petiole ≤ 12 mm. *Q. dentata*
- 16 a Lamina base often auriculate (acorns on stalks 3-11 cm long!!!). *Q. hartwissiana*
b Lamina base cuneate to +/- rounded, rarely +/- auriculate (acorns sessile!!!). *Q. petraea*
- 17 a Lobes 6-13/side. 18
b Lobes 3-8/side. 19
- 18 a Lobes $\geq 1/2$ way towards lamina midvein AND leaves usually crowded at shoot end. *Q. frainetto*
b Lobes $1/3$ - $1/4$ way towards lamina midvein, leaves not crowded at shoot end. *Q. liebmannii*
- 19 a Lobes $< 1/3$ way towards midvein (horizontally measured). 20
b Lobes $> 1/3$ way towards midvein or at least so for several lobes/side. 22
- 20 a Lamina LS glabrous except along basal midvein part. *Q. glabrescens*
b Lamina LS stellate-pubescent at least on venation. 21
- 21 a Mature lamina 14 x 8 cm. *Q. laeta*
a Mature lamina 25 x 12 cm. *Q. peduncularis*
- 22 a Petiole ≤ 8 mm AND bud not stipulate (leaves often crowded at shoot end. Lobes 5-7(-9)/side, base auriculate). *Q. robur*
b Petiole > 8 mm, IF variable 5-15 mm, then terminal bud stipulate. 23
- 23 a Lamina base broadly cuneate to cuneate, or cuneate to attenuate. 24
b Lamina base (sub-)auriculate, rounded, subtruncate, to broadly cuneate. 27

- 24 a Lamina regularly deeply lobed. Lobes uniform, oblong. *Q. alba*
 b Lamina irregularly lobed, sometimes polymorphic. Lobes variable in shape, often +/- spatulate and toothed. 25
- 25 a Lamina extremely polymorphic AND lobes and sinuses irregularly/very diversely shaped and sized even often on the same lamina. *Q. cerris*
 b Lamina irregularly lobed, slightly polymorphic. 26
- 26 a Uppermost lobes/teeth rounded. Shoot often with cork-wings. *Q. macrocarpa*
 b Uppermost lobes/teeth acute. Shoot without cork-wings. ... *Q. lyrata*
- 27 a Lamina ovate oblong. 28
 b Lamina obovate or elliptic. 29
- 28 a Lamina extremely polymorphic, lobes and sinuses irregularly/very diversely shaped and sized even often on the same lamina. *Q. cerris*
 b Lamina not polymorphic, lobes and sinuses +/- regularly and similarly shaped and sized. *Q. look*
- 29 a Lamina US (+/-) glabrous, LS thinly stellate-pubescent to glabrescent. *Q. dalechampii*
 b Lamina US +/- stellate-pubescent, LS stellate-pubescent, sometimes velvety to the touch. 30
- 30 a Lobes often finger like elongate and rather narrow, sometimes touching. 31
 b Lobes not finger like, acute to rounded at the same plant, never touching. 32
- 31 a Lobes 5-8 often touching. Basal sinuses often reaching midvein. *Q. vulcanica*
 b Lobes 3-8 rarely touching. Basal sinuses not reaching midvein. *Q. pyrenaica*
- 32 a Lobes 4-9/side, irregularly placed and unequally shaped and sized on the same lamina. Terminal bud and usually several lateral buds with persistent linear filiform stipules. *Q. cerris*
 b Lobes 4-7/side, more regularly placed, shaped and sized. Only terminal bud sometimes with persistent linear stipules. *Q. pubescens*

C3

LOBES AND TEETH WITH SPINY PROJECTIONS:

CUSPIDATE TO MUCRONATE, OR SPINULOSE TO SPINOSE

- 01 a Lobes and teeth obtuse with spinulose apex. *Q. douglasii*
b Lobes and teeth acute with spinulose apex. 02
- 02 a Lobes and teeth ≥ 5 /side, often with lobes dentate. 03
b Lobes and teeth ≤ 5 /side, lobes or teeth entire. 06
- 03 b Lamina >4 cm, LS with secondary veins obvious. *Q. ithaburensis*
b Lamina small $<3(-4)$ cm, LS with secondary veins less visible. 04
- 04 a Lamina often convex, US long persistent stellate-pubescent. *Q. durata*
b Lamina undulate, US often glabrous or glabrescent (often so in our climate). 05
- 05 a Lamina US green. *Q. berberidifolia*
b Lamina US greyish- or bluish-green. *Q. john-tuckeri*
- 06 a Lamina planar (sometimes slightly undulate), US glaucous or greyish green. Base cordate to rounded. *Q. turbinella*
b Lamina undulate, US green. Base cuneate to rounded. 07
- 07 a LS and US clearly rough to the touch by rough hairs (or hair bases). *Q. pungens*
b LS and US soft to the touch. *Q. vaseyana*

Taxa treated in this identification key.

- Q. acatenangensis*
Q. acerifolia
Q. acherdophylla
Q. acrodonta
Q. acuta (Cyclobalanopsis)
Q. acutifolia
Q. acutissima
Q. afares
Q. affinis
Q. agrifolia
Q. agrifolia var. *oxyadenia*
Q. alba
Q. alentejana
Q. aliena
Q. alnifolia
Q. aquifolioides
Q. argyrotricha (Cyclobalanopsis)
Q. arizonica
Q. arkansana
Q. aucheri
Q. augustinii (Cyclobalanopsis)
Q. austrina
Q. baloot
Q. baronii
Q. benthamii
Q. berberidifolia
Q. bicolor
Q. boyntonii
Q. brandegeei
Q. brantii
Q. buckleyi
Q. canariensis
Q. canbyi
Q. candicans
Q. castanea
Q. castaneifolia
Q. cerris
Q. chapmanii
Q. chenii
Q. chrysolepis
Q. coccifera
Q. coccinea
Q. conspersa
Q. costaricensis
Q. crassifolia
Q. crassipes
Q. crispifolia
Q. crispipilis
Q. crispula
Q. cupreata
Q. dalechampii
Q. delavayi (Cyclobalanopsis)
Q. delgadoana
Q. dentata
Q. dentata subsp. *yunnanensis*
Q. depressa
Q. deserticola
Q. dolicholepis
Q. douglasii
Q. dumosa
Q. durata
Q. durifolia
Q. eduardii
Q. ellipsoidalis
Q. elliptica
Q. emoryi
Q. engelmannii
Q. engleriana
Q. eugeniiifolia
Q. fabri
Q. faginea
Q. faginea subsp. *broteroi*
Q. falcata
Q. floribunda
Q. frainetto
Q. franchetii
Q. furfuracea
Q. fusiformis
Q. galeanensis
Q. gambellii
Q. garryana
Q. garryana var. *breweri*
Q. garryana var. *garryana*
Q. garryana var. *semota*
Q. geminata
Q. gentryi
Q. georgiana
Q. germana
Q. gilliana
Q. gilva (Cyclobalanopsis)
Q. glabrescens
Q. glauca (Cyclobalanopsis)
Q. gravesii
Q. greggii
Q. griffithii
Q. grisea
Q. guajavifolia
Q. guliemitrelesei
Q. hartwissiana
Q. hemisphaerica
Q. hinckleyi
Q. hintonii
Q. hintoniorum
Q. hondae (Cyclobalanopsis)
Q. hypargyrea (Cyclobalanopsis)
Q. hypoleucoides
Q. hypoxantha
Q. ilex
Q. ilicifolia
Q. imbricaria
Q. incana
Q. infectoria
Q. infectoria subsp. *veneris*
Q. inopina
Q. insignis
Q. intricata
Q. irazuensis
Q. ithaburensis
Q. john-tuckeri
Q. kelloggii
Q. laeta
Q. laevis
Q. lamellosa (Cyclobalanopsis)
Q. lanata
Q. lancifolia
Q. laurifolia
Q. laurina
Q. leiophylla
Q. leucotrichophora
Q. libani
Q. liboensis (Cyclobalanopsis)
Q. liebmannii
Q. lobata
Q. longinux (Cyclobalanopsis)
Q. longispica
Q. look
Q. lusitanica
Q. lyrata
Q. macranthera
Q. macrocarpa
Q. macrolepis
Q. margaretta
Q. marilandica
Q. marilandica var. *ashei*

Q. marilandica var. *marilandica*
Q. mexicana
Q. michauxii
Q. microphylla
Q. minima
Q. miquihuanensis
Q. mohriana
Q. mongolica
Q. monimotricha
Q. montana
Q. morii (Cyclobalanopsis)
Q. muehlenbergii
Q. myrsinifolia (Cyclobalanopsis)
Q. myrtifolia
Q. neglecta (Cyclobalanopsis)
Q. nigra
Q. ningangensis (Cyclobalanopsis)
Q. oblongifolia
Q. obtusata
Q. oglethorpensis
Q. oleoides subsp. *sagraeana*
Q. oxyodon (Cyclobalanopsis)
Q. pacifica
Q. pagoda
Q. palmeri
Q. palustris
Q. pannosa
Q. parvula
Q. peduncularis
Q. peninsularis
Q. petraea
Q. phellos
Q. phillyreoides
Q. planipocula
Q. polymorpha
Q. pontica
Q. potosina
Q. prinoides
Q. pubescens
Q. pumila
Q. pungens
Q. pyrenaica
Q. rapurahuensis
Q. rehderiana
Q. robur
Q. rotundifolia
Q. rubra
Q. rugosa
Q. rysophylla
Q. sadleriana
Q. salicifolia
Q. salicina (Cyclobalanopsis)
Q. saltillensis
Q. sapotifolia
Q. sartorii
Q. schottkyana (Cyclobalanopsis)
Q. semecarpifolia
Q. senescens
Q. serrata
Q. serrata var. *brevipetiolata*
Q. sessilifolia (Cyclobalanopsis)
Q. shumardii
Q. similis
Q. sinuata
Q. skinneri
Q. spinosa
Q. stellata
Q. stenophylloides (Cyclobalanopsis)
Q. suber
Q. subspathulata
Q. tatakaensis
Q. texana
Q. tinkhamii
Q. tomentella
Q. toumeyii
Q. tristis
Q. trojana
Q. tungmaiensis
Q. turbinella
Q. uxoris
Q. vaciniifolia
Q. variabilis
Q. vaseyana
Q. velutina
Q. virginiana
Q. vulcanica
Q. wislizeni
Q. wutaishanica
Q. xalapensis

Taxa referred to synonymy in this identification key.

Q. acutissima subsp. *chenii* = *Quercus chenii*
Q. bambusifolia Fortune = *Q. glauca*
Q. bambusifolia Hance = *Q. neglecta*
Q. castanea var. *incana* = *Q. afares*
Q. cubana = *Q. oleoides* subsp. *sagraeana*
Q. dilatata = *Q. floribunda*
Q. durandii = *Q. sinuata*
Q. eugeniifolia Hort. and *Q. aff. eugeniifolia* = *Q. delgadoana*
Q. excelsa = *Q. leiophylla*
Q. falcata var. *pagodifolia* = *Q. pagoda*
Q. fruticosa = *Q. lusitanica*
Q. glandulifera = *Q. serrata*
Q. ithaburensis = *Q. macrolepis*
Q. liaotungensis = *Q. wutaishanica*
Q. malacotricha = *Q. dentata* subsp. *yunnanensis*
Q. mongolica var. *grosserrata* = *Q. crispula*
Q. multinervis = *Q. hypargyrea*
Q. nuttallii = *Q. texana*
Q. polycarpa = *Q. petraea* subsp. *iberica*
Q. prinus = *Q. montana*
Q. pseudosemecarpifolia = *Quercus rehderiana*
Q. stenophylla = *Q. salicina*
Q. stranjensis = *Q. hartwisiana*
Q. yunnanensis = *Q. dentata* subsp. *yunnanensis*

Questionable taxa in this key.

Some taxa in cultivation may belong to other related ones, or at least so in part of the plants seen:

Q. fabri: some plants under this name in cultivation, with lamina >17 cm long, >12 veins/side and acute (-acuminate) apex and teeth, may belong to other taxa (e.g. *Q. griffithii*)

Q. marilandica ashei: some plants in cultivation with +/- similar laminas to *Q. marilandica* but with additional small lobes towards base are possibly hybrids.

Q. ningangensis (*Cyclobalanopsis*): some plants in cultivation with lamina <12 veins/side and without stellate pubescence on LS, may belong to *Quercus glauca*, and are not close to *Quercus oxyodon*.

Q. pentacycla (*Cyclobalanopsis*): some plants in cultivation with lamina <12 veins/side and without thin detachable layer on LS, may belong to *Quercus glauca*, and are not close to *Quercus oxyodon*.

Quercus is a large genus, beside the more than 220 in this key at least 50 more species are cultivated in Europe. Most of these are juvenile plants and even after years do not fully show their typical characteristics yet, like *Q. glaucooides*, *Q. laceyi* for example.

Frequently misidentified taxa in this key.

Q. dumosa Hort. = *Q. berberidifolia*

Q. spinosa Hort. = *Q. dolicholepis*

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	cm
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