

A TEACHING TOOL: A KEY TO SELECTED FAGACEAE

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ABSTRACT

Commentary on teaching identification of oaks, beeches and chestnuts is presented along with a key to selected Fagaceae utilized as a teaching tool for teaching students ornamental plant identification at North Carolina State University.

I have taught ornamental plant identification (HS 211 Ornamental Plants I) for twenty-three years each fall. One group of plants that traditionally provides students difficulty are the Fagaceae Dumort - including oaks (*Quercus* L.), beeches (*Fagus* L.) and chestnuts (*Castanea* Mill.). Students have problems in identification of members of this family because of similarities of leaves and fruits. North Carolina State University (NCSU) is fortunate to have a number of fagaceous species represented on the campus, in residential property located in nearby neighborhoods, and at the JC Raulston Arboretum. Student identification skills and retention has increased since I developed and began utilizing the Fagaceae key presented herein as a teaching/learning tool in HS 211. The objective of this article is to make the key available to other teachers who may wish to utilize it for teaching these plants at their institutions.

METHODS

Species from the Fagaceae selected for inclusion in this key came from three primary sources. First are those species readily available on the NCSU campus. Second, the North Carolina Association of Nurserymen (NCAN) and North Carolina Association of Landscape Contractors (NCLA) have developed a certification program that

includes passing a plant identification exam of common landscape plants. Both NCAN and NCLA have a list of plant material and those fagaceous species from this list are included in HS 211. Third, some additional species of Fagaceae were included that were represented in residential property in neighborhoods adjacent to NCSU. The JC Raulston Arboretum has an extensive collection of Fagaceae utilized for review of taxa (*Castanea*, *Fagus* and *Quercus*) previously covered in labs. Table 1 provides a list of species included in the key.

A number of references (Dirr 1975; Elias 1980; Griffiths 1994; Krussman 1978; Rehder 1940) were utilized to develop a taxonomic foundation of Fagaceae identification. Live material was examined at the U.S. National Arboretum in Washington, DC. and experience obtained through teaching students, nurserymen and landscapers through Plant Certification Workshops and visits to numerous additional gardens strengthened this foundation.

RESULTS AND DISCUSSION

The Fagaceae (beech family) are an important group of shade trees in the landscape. Members of the beech family bear alternate, simple, toothed leaves with pinnate venation. Male flowers are clustered in catkins. These characters are similar to those in other families (e.g., Betulaceae Gray, Ulmaceae L.) creating challenges for beginning students. Field recognition traits are useful as a starting point for identification. For instance, the veins will extend beyond the leaf margin in a short, stubby projection or a long, slender, hair-like structure (bristle). Fruits are one-seeded nuts surrounded basally or enclosed entirely by an involucre of imbricated bracts.

Identification techniques in the course placed emphasis on vegetative structures as young trees grown in nurseries and sold in garden centers often have not reached sexual maturity. Thus fruits typically

are not available. Oaks consistently cause the greatest problem for students. Hybridization between species results in intermediate traits. Also, seedlings, juvenile plants and suckers of the root stock will exhibit the greatest variability in morphology, often exhibiting traits associated with hybridization. Students are encouraged to utilize mature leaves on older branches for species determination. However, sometimes it is difficult to accurately identify specific individuals in cultivation due to hybridization.

TABLE 1. List of fagaceous species included in the key.

<i>Scientific name</i>	<i>Common name</i>	<i>Scientific name</i>	<i>Common name</i>
<i>Castanea dentata</i>	american chestnut	<i>Quercus michauxii</i>	swamp chestnut oak
<i>Castanea mollissima</i>	chinese chestnut	<i>Quercus montana</i>	
<i>Castanea pumila</i>	allegheny chinquapin	syn. <i>Q. prinus</i>	chestnut oak
<i>Fagus grandifolia</i>	american beech	<i>Quercus myrsinifolia</i>	chinese evergreen oak,
<i>Fagus sylvatica</i>	european beech		ringcup oak
<i>Quercus acuta</i>	japanese evergreen oak	<i>Quercus nigra</i>	water oak
<i>Quercus acutissima</i>	sawtooth oak	<i>Quercus pagoda</i>	cherrybark oak
<i>Quercus alba</i>	white oak	<i>Quercus palustris</i>	pin oak
<i>Quercus bicolor</i>	swamp white oak	<i>Quercus phellos</i>	willow oak
<i>Quercus coccinea</i>	scarlet oak	<i>Quercus prinoides</i>	dwarf chinquapin
<i>Quercus falcata</i>	spanish oak, southern red oak	<i>Quercus robur</i> <i>Quercus rubra</i>	english oak red oak
<i>Quercus glauca</i>	blue evergreen oak	<i>Quercus shumardii</i>	shumard oak
<i>Quercus hemisphaerica</i>	laurel oak	<i>Quercus stellata</i>	post oak
<i>Quercus imbricaria</i>	shingle oak	<i>Quercus suber</i>	cork oak
<i>Quercus laurifolia</i>	laurel oak	<i>Quercus texana</i>	
<i>Quercus lyrata</i>	overcup oak	syn. <i>Q. nuttallii</i>	nuttall oak, oklahoma oak
<i>Quercus macrocarpa</i>	bur oak	<i>Quercus velutina</i>	black oak
<i>Quercus marilandica</i>	blackjack oak	<i>Quercus virginiana</i>	live oak
<i>Quercus muehlenbergii</i>	yellow chestnut oak		

Analogies

Analogies are useful teaching techniques in the field, especially for oaks. Students have commented that they understand these analogies easily and find them useful in segregating the species of oaks. Leaf silhouettes in the oaks can be described using the following analogies. The sawtooth oak (*Q. acutissima* Carruth) is described as resembling an old ship with oars extending into the water. The scarlet oak (*Q. coccinea* Munchh.) is described as resembling the side of a lobster with the claws (upper lobes) enclosing its prey (sinus). The southern red or spanish oak (*Q. falcata* Michx.) has the midrib apical curvature that resembles a scythe. The shingle oak (*Q. imbricaria* Michx.) resembles a willow leaf that became a Japanese sumo wrestler, becoming very broad in the middle. The blackjack oak (*Q. marilandica* Michx.) resembles the liberty bell when one inverts the leaf. The water oak (*Q. nigra* L.) is described as resembling an ice cream cone or a tear drop when inverted. The pin oak (*Q. palustris* Munchh.) resembles a sky diver in flight with his arms and legs (lobes) extended. The willow oak (*Q. phellos* L.) resembles a willow leaf or taffy pulling (pulled on each end for a narrow strand tapered at both ends). The post oak (*Q. stellata* Wangenh.) leaf held above the head resembles a plane flying overhead with the upper three lobes resembling wings & cockpit and the lower lobes resembling the tail. The base of the leaf resembles the rear of a squid with the lateral lobes the two long tentacles and the terminal lobe the head and beak.

Fruit cupule analogies can also be useful. The sawtooth oak (*Q. acutissima*) cupule is described as resembling a bird's nest with projecting twigs. The white oak (*Q. alba* L.) appears to be a skin covered with warts. The scarlet oak (*Q. coccinea*) is described as a baby (nut) enclosed by a comforter or blanket (cupule). The Chinese evergreen oak (*Q. myrsinifolia* Bl.) has the scales fused into concentric rings, thus the cupule can be twisted by the instructor to resemble a spinning top.

Stories

In addition, stories are provided in the lecture. Students find these useful in remembering the scientific name, potential landscape use or aiding identification. For example, the water oak (*Q. nigra*) is a bottomland species (useful in wet soils in landscapes) and was named for the black-color (*nigra* in Latin) when one looked down into the shallow depth of the water with organic matter beneath. The willow oak (*Q. phellos*) is mistaken for a pin oak (*Q. palustris*) in western parts of North Carolina because of the narrow leaf with a “pin” at its apex. The bark of red oak (*Q. rubra* L.) resembles ski trails, and the wood was used for railroad ties and shoring mine tunnels. Shumard oak (*Q. shumardii* Buckl.) is found in swamps and stream bottoms, thus gear must be carried on the Shumard’s shoulders to wade through the water, giving the obovate leaf a “top heavy” appearance. Our pioneers used the post oak (*Q. stellata*) in wooded Indian country as a post office, leaving messages to those following. The U.S. government stripped the bark from cork oaks (*Q. suber* L.) on southern plantations during World War II when Germans forces cut off supplies of cork. The leaf of the live oak (*Q. virginiana* Mill.) has recurved margins, and when inverted, resembles a dugout or canoe that will float when placed on water.

Nuttall oak problem

The nuttall oak (*Q. texana* Buckl., syn. *Q. nuttallii* Palmer) appears to me as probably the most confused oak in the nursery trade. NCAN and NCLA had the shumard oak (*Q. shumardii*) listed on their certified list of plants (Hayter & Shear 1982). Then the shumard oak was replaced with the nuttall oak (as *Q. nuttallii*) in the late 1980's (Hayter & Shear 1991). Shumard oaks began appearing in nurseries and garden centers labeled as the nuttall oak. In addition, this oak traditionally had been confused with the pin oak (*Q. palustris*), with either species sometimes bearing the name of the other. In my opinion, few oaks labeled as *Q. nuttallii* are identified correctly as this oak is poorly represented in the nursery trade. Most

"nuttall" oaks are actually *Q. shumardii* or sometimes *Q. palustris*. The correct name of *Q. texana* for the nuttall oak (Dorr & Nixon 1985) is relatively unknown in the nursery trade.

Fagaceae key

The following key to Fagaceae was developed for the Raleigh, North Carolina area. The key is a working tool, an aid to assist in identification. Teachers may use or modify this key for their teaching program. Students provided with only taxa characterization in class exhibited great difficulty in species segregation. Once this key was provided and utilized in class, students demonstrated greater correct identification for these species as compared to students in earlier classes.

Key to select species of Fagaceae

1. Branchlets lack terminal bud; leaves with 15-27 parallel veins extending beyond margin; male flowers in erect or spreading catkins; involucre cupule large, spinose; nuts 1-3, subglobose, pointed at apex [*Castanea*]2.
 - 1.' Branchlets with terminal buds; leaves with 5-14 parallel veins or veins penninerved (arising from central midrib); male flowers in pendent catkins or heads; involucre cupule small, muricate, or with small scales; nuts 1 or 2, oblong, cylindrical or triangular4.
2. Leaves small, acute, 7-15 cm long x 2.5-5 cm wide, vein pairs 14-18, tomentose below; burr (cupule) 3-4 cm diam.; nuts 1, rounded..... *Castanea pumila*
 - 2.' Leaves large, acuminate, 14-25 cm long x 4-9 cm wide, vein pairs 22-27, glabrous below at maturity or pubescence primarily on veins; burr (cupule) 5-8 cm diam.; nuts 2-3, flattened on at least one side3.
3. Leaf base cuneate to rotund, lower surface glabrous; winter buds glabrous; nuts 2-3.5 cm long..... *Castanea dentata*

- 3.' Leaf base rotund to truncate, lower surface pubescent on veins; winter buds pubescent; nuts 3-6 cm long*Castanea mollissima*
4. Buds elongate, awl-shaped; bark smooth; involucre cupule mucronate, enclosing nuts; nuts 2 (3), triangular; leaves with 5-14 parallel veins; male flowers in heads [*Fagus*]5.
- 4.' Buds short with many imbricate scales, typically clustered near twig apex; bark flakey or furrowed; involucre cupule scaly, subtending the nut; nuts 1, oblong to cylindrical; leaves penninerved, rarely with parallel veins; male flowers in pendant catkins [*Quercus*]6.
5. Leaves serrate with 9-14 pairs of veins, veins extending beyond margin; involucre cupule about 2 cm, with straight to recurved prickles.....*Fagus grandifolia*
- 5.' Leaves entire to remotely denticulate with 5-9 pairs of veins, veins commonly stopping at margin; involucre cupule 2.5 cm with upright prickles*Fagus sylvatica*
6. Leaves evergreen7.
- 6.' Leaves deciduous, tardily deciduous or semi-evergreen.....13.
7. Involucre cupule with scales fused into rings [ringcup or asian evergreen oak group]8.
- 7.' Involucre cupule with scales appressed or elongated.....10.
8. Leaves entire, acuminate, 4-6 cm broad*Quercus acuta*
- 8.' Leaves bristled-toothed, acute, 2-4.5 cm broad.....9.
9. Leaves lanceolate, 2-3 mm wide; vein pairs 9-13; margin toothed from base to apex; involucre cupule glabrous, enclosing lower third of nut*Quercus myrsinifolia*
- 9.' Leaves elliptic-oblong to ovate-oblong, 3-4.5 cm wide; vein pairs 6-9; margin toothed from middle to apex; involucre cupule

- downy, enclosing half to two-thirds of nut *Quercus glauca*
10. Leaves coriaceous, downy beneath.....11.
- 10.' Leaves thin coriaceous, glabrate beneath (hairs in axillary tufts when present)12.
11. Leaves narrow elliptic to oblong, 4-12 cm, obtuse; margin revolute, entire (rarely few spiny teeth in middle); vein pairs 7-10; petiole 4-6 mm; cupule scales tightly appressed.....*Quercus virginiana*
- 11.' Leaves ovate to ovate-oblong, 3-7 cm, acute; margin scarcely revolute with 4-5 pairs of teeth (rarely nearly entire); vein pairs 5-7; petiole (3) 7-17 mm *Quercus suber*
12. Leaves thin, rhombic (elongate diamond-shaped) to broadly ovate to obovate, apex obtuse, base cuneate *Quercus laurifolia*
- 12.' Leaves coriaceous, narrowly ovate to oblanceolate, apex acute to acuminate, lobes lacking or occasionally shallowly 3-lobed near apex, base rotund*Quercus hemisphaerica*
13. Leaf margin entire, or slightly toothed or shallowly lobed above the middle.....14.
- 13.' Leaf margin always toothed or lobed from base to apex.....18.
14. Leaves widest near apex, tapering to a long base; apex obtuse to shallowly 3-lobed to occasionally 5-lobed; veins prominently 3 at expansion point*Quercus nigra*
- 14.' Leaves widest near the middle, gradually tapering to a short base; apex broadly acute (occasionally shallowly 3-lobed in *Q. hemisphaerica*); veins penninerved, not 3-veined above15.
15. Terminal bristle always present; leaves elliptic-lanceolate; mature leaves 2.5-5 times longer than wide.....16.
- 15.' Terminal bristle lacking or occasionally present; leaves rhombic or narrowly obovate or oblanceolate.....17.

16. Leaves 2.5-5 cm wide *Quercus imbricaria*
 16.' Leaves 0.5-2.5 cm wide.....*Quercus phellos*
17. Leaves thin, rhombic (elongate diamond-shaped) to broadly ovate to obovate, apex obtuse, base cuneate..... *Quercus laurifolia*
 17.' Leaves coriaceous, narrowly ovate to oblanceolate, apex acute to acuminate, lobes lacking or occasionally shallowly 3-lobed near apex, base rotund *Quercus hemisphaerica*
18. Leaves toothed, non lobed 19.
 18.' Leaves lobed from base to apex24.
19. Leaf margin with elongate bristles per tooth; vein pairs 12-16; involucre cupule with scales elongate, spreading to recurved
 *Quercus acutissima*
 19.' Leaf margin with teeth lacking bristles; vein pairs 6-12; involucre cupule with scales appressed20.
20. Teeth 4-8 per leaf side21.
 20.' Teeth 9-12 per leaf side22.
21. Leaves 10-15 cm long; teeth 6-8, irregularly rounded; acorns stalked *Quercus bicolor*
 21.' Leaves 5-10 cm long; teeth 3-7, blunt to slightly pointed; acorns sessile *Quercus prinoides*
22. Teeth pointed and incurved *Quercus muhlenbergii*
 22.' Teeth rounded23.
23. Petiole yellowish; leaves glabrous below
 *Quercus montana* [syn.= *Q. prinus*]
 23.' Petiole greenish; leaves downy below.....*Quercus michauxii*
24. Lobes rounded to obtusely pointed, never bristle-tipped; inner

- wall of nut glabrous25.
 24.' Lobes acuminate pointed; inner wall of nut pubescent29.
25. Leaf surface whitish below, green above.....26.
 25.' Leaf surface subconcolorous, greenish below and above28.
26. Leaves glabrous below; cupule covering lower fourth to third of nut..... *Quercus alba*
 26.' Leaves pubescent below; cupule covering half to most of nut ...
27.
27. Leaves 7-15 cm wide; terminal lobe much larger than the others; cupule covering most or all of nut; acorn 2-5 cm long
*Quercus macrocarpa*
 27.' Leaves 2.5-10 cm wide; terminal lobe not much larger than others; cupule covering half to two-thirds of nut; acorn 1.5-2.5 cm long.....*Quercus lyrata*
28. Lobes 3-5 with deep sinuses, roughly resembling a cross; leaves downy below; basal auricles large, broadly cuneate (squid fin-like)
 *Quercus stellata*
 28.' Lobes 7-10 with shallow sinuses; leaves glabrate; basal auricles small, spreading *Quercus robur*
29. Lobes 3-5, terminal, with sinuses shallow (deeper in seedlings on strong vigorous water shoots)30.
 29.' Lobes 5-9, pinnate, with deep sinuses31.
30. Leaves oblanceolate to spatulate, 1.5-6 cm wide; leaf base long-cuneate; abaxial pubescence of axillary tufts of hairs; cupule covering one fourth to a third of the nut*Quercus nigra*
 30.' Leaves broadly obovate, 5.5-11 cm wide; leaf base long-rotund to subcordate; abaxial pubescence downy*Quercus marilandica*
31. Abaxial leaf surface downy pubescence downy32.

- 31.' Abaxial leaf surface glabrate with axillary tufts of hair34.
32. Leaves greenish-yellow beneath; terminal lobe non-falcate
.....*Quercus velutina*
- 32.' Leaves grayish beneath; terminal lobe falcate33.
33. Lobes 3-5 with deep sinuses *Quercus falcata*
- 33.' Lobes 5-11 with shallow sinus*Quercus pagoda*
34. Axillary tufts of hair small and inconspicuous with a quick
glance35.
- 34.' Abaxial axillary tufts of hairs large and conspicuous with a
quick glance36.
35. Sinuses shallow; center of leaf around midrib 2.5-5 cm wide;
lobes free and open; cupule covering lower 1/4-1/3 of nut, scales
dull, light chestnut brown *Quercus rubra*
- 35.' Sinuses deep; center of leaf around midrib 0.5-1.3 cm wide;
upper lobes sometimes overlapping, enclosing sinus; cupule cover-
ing 1/3-1/2 of nut, scales glossy, dark reddish-brown.....
..... *Quercus coccinea*
36. Leaves 7-9 lobed; scales of cupule with loose spreading apices;
juvenile leaves downy beneath.....*Quercus velutina*
- 36.' Leaves 5-7 lobed; scales of cupule appressed at apex; juvenile
leaves lack down.....37.
37. Leaves broadly elliptic, broadest in the middle; acorn about 1
cm*Quercus palustris*
- 37.' Leaves obovate, broadest above the middle; acorn 1.5-2.5 cm..
.....38.
38. Leaves 10-18 cm long; base broadly cuneate to truncate; lobes
broad *Quercus shumardii*

- 38.' Leaves 5-12 cm long; base narrow cuneate; lobes narrow.....
..... *Quercus texana* [syn. = *Q. nuttallii*]

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