An Interesting Hybrid Oak Population in Southeastern Colorado and Adjacent Areas

Allan Taylor[1] and *Tim Buchanan*[2]
[1]787 17th Street
Boulder, Colorado, USA 80302
e-mail tayloralro@comcast.net
[2]737 Blue Mesa Avenue
Fort Collins, Colorado, USA
e-mail tebuchanan@hotmail.com

Farmers and ranchers in southeastern Colorado in Las Animas and Baca Counties have long been aware of unusually large oak trees growing in the bottomlands along creeks in the local "canyons," which are more properly gulches or draws in the context of the High Plains. Cottonwood (Creek) Canyon, located in western Baca County, is perhaps the best known of these.

On the drier, rocky hillsides above and away from the creeks are a different set of oaks entirely, short, twisty, and scrubby, certainly "scrub oaks" in the classical sense. These scrub oaks, which vary from short shrubs to trees up to 15 or more feet high, have been designated as *Quercus* x *undulata* (Tucker 1961-1971). These oaks are characterized generally by smallish, somewhat holly-like, sometimes prickly gray-green leaves which are very unlike the deeply-sinused, dark green leaves which most people associate with oaks. The acorns are also small, with shallow, rather smooth caps, often but not always on peduncles.

The large trees are another matter: they DO have typical "oak leaves," with deep sinuses. The leaves are a rich green and can be quite large ranging from 8.5-15 cm length and 4.5-10 cm width with up to 5-7 lobes per leaf, and some have a blunt terminal lobe with an obovate to elliptical leaf blade in outline (Figure 1). The acorns are rather large, and virtually always have a smooth cap without fringes. Since the leaves in particular do not match those of any of the more familiar oaks of the area—*Q. gambelii* to the west and north, *Q. macrocarpa*, *Q. stellata* to the south and east, there has always been speculation as to just what they could be.

Figure 1. Foliage of an apparent *Q. macrocarpa* x *Q. gambelii* in Cottonwood Creek Canyon, Baca County located in SE Colorado.

Figure 2. Examples of the single-stem (left) and multi-stem (right) clumping oaks in Cottonwood Creek Canyon in Southeastern Colorado. Size and form of trees suggests hybridization between *Q. gambelii* and *Q. macrocarpa*.

The mystery was finally solved by Jack Maze, in his doctoral dissertation working under John Tucker at UC-Davis. Maze concluded, after studying similar populations in nearby Union County in northeastern New Mexico, that the trees represent a stable population of hybrids between *Q. gambelii* and *Q. macrocarpa* (Maze 1968). Indeed, the aspect of the mature tree is very much like *Q. macrocarpa*: moderately tall (10 or more meters), with the large limbs, open, spreading head, and many, though not all with a single-stemmed habit (Figure 2). The leaves, on the other hand, are more like the gambel parent, except for that blunt apical lobe suggestive of *Q. macrocarpa* ancestry. Where the hybrid tree consists of more than one stem, *Q. gambelii* parentage appears to be responsible.

There are several questions raised by the presence of these hybrids, chiefly, how and where did they originate? At the present time there are no individuals of either putative parent species in the immediate area of southeastern Colorado and northeastern New Mexico where the hybrids occur. There are many individuals of *Q. gambelii* farther west at higher altitudes, closer to the Front Range of the Rocky Mountains in Colorado and to the Sangre de Cristo Mountains in New Mexico, in both mountain and contiguous high plains environments. *Quercus gambelii* is typically a mountain plant, which grows as a tree or shrub either with a single trunk or as a clump which derives from basal and root suckers from a single original tree. Plains-dwelling trees do not differ from the mountain forms, and tend to be found along streams flowing east out of the mountains. Good examples can be viewed near Colorado City, along Greenhorn Creek, or a short distance farther south, along Apache Creek, both in Huerfano County, which is in the first tier of counties north of Las Animas and Baca Counties. (Most of the land near I-25 in Huerfano County is private, so inspection of trees should be done where access is not restricted.) Trees can also be found farther north along Plum Creek in Douglas County near Castle Rock. Good examples of *Q. gambelii* also occur in Colfax County, New

Figure 3. Left: (*Q. gambelii* in leaf), Roxborough State Park, Douglas County, southwest of Denver. Right: (*Q. gambelii* clump out of leaf), Glenwood Canyon, Garfield County, Colorado, near Glenwood Springs.

Mexico (just south of Las Animas County, Colorado), east of Raton, along Yankee Canyon all the way to the top and in places across Johnson Mesa, a high table land which rises to over 8,600 feet above sea level. Evidently pure individuals of *Q. gambelii* also occur in Toll Gate Canyon, south of Branson, Colorado and east of Folsom, New Mexico, both located at the eastern end of Johnson Mesa (Figure 3).

When one examines the Colorado vanguard trees, however, it is possible to discern in some of them the same traits characteristic of the clear hybrid populations farther to the southeast: primarily the larger leaf with the blunt tip and an obovate leaf outline. The present authors have discovered oaks which we consider to be the same hybrid as far north and west as Phantom Canyon, in Fremont County, and Castle Rock, in Douglas County (Figure 4). One specimen found in Cottonwood Creek Canyon and one much farther northwest along Plum Creek just south of Denver both produce acorn caps with a fringed top (Figure 5). It seems clear that there has been gene flow out of the southeastern part of the state, establishing in effect a mixed population of putatively pure *Q. gambelii* and hybrids of the latter with *Q. macrocarpa*.

To answer the how and where of the original hybridization, it is best to raise the issue also of when. It seems to us most likely that *Q. macrocarpa* x *Q. gambelii* hybridization occurred during or at the end of the Pleistocene or early in the Holocene, when the areas where hybrids now grow was cooler and wetter (Bement et al 2007). Indeed, at the end of the Pleistocene Epoch (14,000-12,000 years BP), the Great Plains south of the glacial front harbored a spruce forest as far south as Kansas, and the plains farther south were covered by deciduous forest (Trimble 1980). Remnants of this broadleaf forest still exist in mesic canyons in the Southern Plains and near the summit of the Quartz Mountains in Oklahoma and in some of the different mountain ranges in the Big Bend country of West Texas. Other remnant populations in Nebraska and South Dakota are noted below.

Figure 4. Apparent *Q. macrocarpa* x *Q. gambelii* specimen growing along Greenhorn Creek near Colorado City, Colorado at the base of the Front Range.

Gambel's oak would have extended much farther east and south at that time, and bur oak would have been present farther west at that time than at present. (The closest bur oak populations to the area in question at the present time are in western Oklahoma, east of the Texas Panhandle.) It seems likely that bur oaks would have been present at that time in the northern Texas Panhandle, in the Canadian River drainage, and so could have reached the territories in northeastern New Mexico where the hybrids are attested. As to the Colorado hybrid population, the Cimarron River Valley seems to be a likely avenue for the two oak species to have come into contact, if indeed both species were not dispersed generally throughout the area.

The same process certainly occurred in the Central Plains, since the same hybrid is found in the Black Hills of South Dakota (Maze 1968). In this case the hybrids co-occur with "pure" *Q. macrocarpa*, but *Q. gambelii* is totally missing. Its earlier presence is attested, however, by the presence on hybrids of an obligate parasite of *Q. gambelii*, the wasp *Cynips insulensis*.

As the climate of the early Holocene became warmer and drier during and after the Altithermal (Antevs 1955) some seven thousand years ago, the forests and lightly-wooded savannas of the Great Plains disappeared, and along with them one or both of the sympatric parent species of the *Q. macrocarpa* x *Q. gambelii* hybrids, leaving behind in the zones of hybridization a mixed-race progeny evidently better adapted to the newer conditions.

These conclusions are tentative, and will require additional research to either support or refute the hypothesis regarding the process of hybridization suggested here. DNA testing would certainly confirm that hybridization has occurred, and which species are involved, but paleo-climate information will be required to explain the mechanics. Information on the latter question known to the authors (e.g. Bell 1984; Dick-Peddie 1993) makes the hypothesis outlined above seem likely, but further suggestions and discussion would be very welcome.

Figure 5. Acorns from putative *Q. macrocarpa* x *Q. gambelii* displaying long awn-like scales at the top of the acorn cup. This characteristic is common in *Q. macrocarpa* but not in *Q. gambelii*. Left: Plum Creek specimen near Castle Rock in central Colorado. Right: Cottonwood Creek Canyon specimen in SE Colorado.

Another question requiring investigation about the *Q. macrocarpa* x *Q. gambelii* hybrids in the southeastern Colorado area is that there is so little apparent introgression between them and the local *Q.* x*undulata* hybrids; both populations are thoroughly intermixed where the two occur together. There appears to be some sort of barrier to free interbreeding (limited interbreeding is attested) between these two groups, but this barrier is for the moment unknown.

Still to be evaluated for evidence of hybridization are a couple of relict populations of bur oak in western Nebraska. These are Bur Oak Canyon in Hitchcock County in southwestern Nebraska, on the Kansas state line about 65 miles east of the Colorado state line, and the small Cunningham Creek population in Dawes County, in the Nebraska Pine Ridge south and west of Chadron, Nebraska. The Niobrara River Valley needs to be carefully examined also, particularly at its western end.

The authors have discovered one tree in Bur Oak Canyon which shows great affinity with putative *Q. macrocarpa* x *Q. gambelii* hybrids, although most of the trees in the canyon are much more like typical bur oaks (if a species as variable as *Q. macrocarpa* can be said to have "typical" members!). The suspected hybrid has leaves which are morphologically highly similar to those of Q. *gambelii*, and the acorn has a cup which is smooth, not fringed with long awn-like scales at the top of the cap, and which covers a third or less of the top of the acorn (Figure 6). Certainly these acorns are very different from the acorns on Q. macrocarpa-like trees only 20 feet away! Moreover, the acorns on this tree ripen much earlier in the season than the acorns on most of the trees in Bur Oak Canyon, again a trait characteristic of *Q. gambelii*. If *Synips insulensis* also occurs in the western Nebraska populations of *Q. macrocarpa*, there should be no further doubt that the populations are basically hybrid, regardless of appearances.

Figure 6. Specimen in Bur Oak Canyon located in SW Nebraska displaying *Q. gambelii* characteristics. Note the shallow cup on the mature acorns that doesn't have a fringe at the top of the acorn cup. Many other oaks in the canyon are *Q. macrocarpa*, and have a distinct fringe on the top of the cup. *Q. gambelii* doesn't have a fringed acorn cup.

References

Antevs, Ernst. 1955. Geologic-climatic dating in the West. American Antiquity 20:317-335.

Bell, Robert E., ed. 1984. Prehistory of Oklahoma. Orlando: Academic Press.

Bement, Leland C. et al. 2007. Paleo-environmental reconstruction and bio-stratigraphy, Oklahoma Panhandle, USA. Quaternary International 169-170:39-50.

Dick-Peddie, William A. 1993. New Mexico vegetation: past, present, and future. Albuquerque: University of New Mexico Press.

Maze, Jack. 1968. Past hybridization between *Quercus macrocarpa* and *Quercus gambelii*. Brittonia 20:321-333.

Trimble, Donald E. 1980. The geologic story of the Great Plains. Geological Survey Bulletin 1493. Washington: U.S. Government Printing Office.

Tucker, John M. (et al.) 1961-1971. Studies in the *Quercus undulata* complex I-V. American Journal of Botany 48:202-208; 329-339; 50:699-708; 57:71-84; 58:329-341.

Photos courtesy of the authors Allan Taylor and Tim Buchanan.