Castanopsis chrysophylla (Dougl.) A. DC. Giant Chinkapin

Fagaceae Beech family

Arthur McKee

Giant chinkapin *(Castanopsis chrysophylla)*, also called golden chinkapin, giant evergreen-chinkapin, and goldenleaf chestnut, is an interesting hardwood species in a landscape dominated by coniferous forests. Over much of its range, giant chinkapin shows several growth forms; it grows in a wide variety of habitats but is rarely a dominant component of any stand. In certain portions of its range, it can be an undesirable competitor of commercial species during early stages of stand development. Ecologically and taxonomically, it remains a poorly understood species.

Habitat

Native Range

The natural range of giant chinkapin (figs. 1, 2) extends from San Luis Obispo County in California to Mason County in west–central Washington *(14)*. In California, it grows primarily in the Coast Ranges, with a disjunct population in the Sierra Nevada in El Dorado County *(8)*. In Oregon, it is found in the Coast Ranges as far north as Benton County, and throughout the Cascade Range. Giant chinkapin is represented in Washington by two disjunct populations in Mason and Skamania Counties *(13)*. Shrub forms of the species are found throughout its range. The tree form is primarily distributed from Lane County, OR, south to Marin County, CA. It is found from near sea level in the Coast Ranges of Oregon and California to over 1525 m (5,000 ft) in elevation in the Cascades. Although giant chinkapin is generally thought of as a mid- to low-elevation species, the shrub form can be found along the crest of the Cascade Range in Oregon from 1525 to 1830 m (5,000 to 6,000 ft) *(5)*.

Climate

The generally mild climate over the range of giant chinkapin is characterized by winter precipitation and summer drought. Rainfall ranges from an annual mean of less than 510 mm (20 in) in southern California to more than 3300 mm (130 in) in the Cascades in Oregon. Much of the winter precipitation in the higher elevations of the Cascades occurs as snow. Little rain falls from June to September, and the duration and intensity of drought increase in the southern portion of the range, which has a Mediterranean climate.

The tree form of the species occurs in the warm but relatively moist portion of the climatic conditions within which it grows. Although the shrubby form is found throughout the species range, it achieves greatest coverage in the more extreme climates of xeric sites and higher elevations.

Soils and Topography

Giant chinkapin is found in a wide variety of topographic positions, from valley bottom to ridgetop, and on a wide range of soils. It achieves the highest cover in the northern portion of its range on Inseptisols and Entisols. In the southern portion of its range, highest cover is found on Inceptisols, Ultisols, and Alfisols. A partial list of parent materials includes basaltic, dioritic, sedimentary, metasedimentary, and serpentinaceous types. Giant chinkapin is ubiquitous in some portions of its range, such as the central part of the Cascades in Oregon, where it is a minor shrubby component of many forest stands on a range of soils. It achieves maximum size and cover, however, on sites that have relatively deep soils that apparently are deficient in nutrients *(17)*.

In other portions of its range, giant chinkapin may be quite restricted, or its different growth forms may be found in markedly contrasting topographic and soil conditions. Nowhere is the latter more evident than in the Siskiyou and Klamath Mountains of southwestern Oregon and north coastal California, where the shrub form achieves greatest cover on dry, sterile, rocky ridgetops and southerly facing slopes in chaparral associations. The tree form is found on northerly aspects on benches and broad ridges with deep soils and more moderate moisture stresses *(12)*.

Over much of the range of giant chinkapin, a general pattern emerges of a species that is at its competitive best on sites that are relatively infertile and droughty.

Associated Forest Cover

Pure stands of giant chinkapin are uncommon and rarely exceed 10 ha (25 acres). The species is a minor component in a wide range of forest communities and in its shrub form is a component of chaparral communities. Common tree associates in the Cascade

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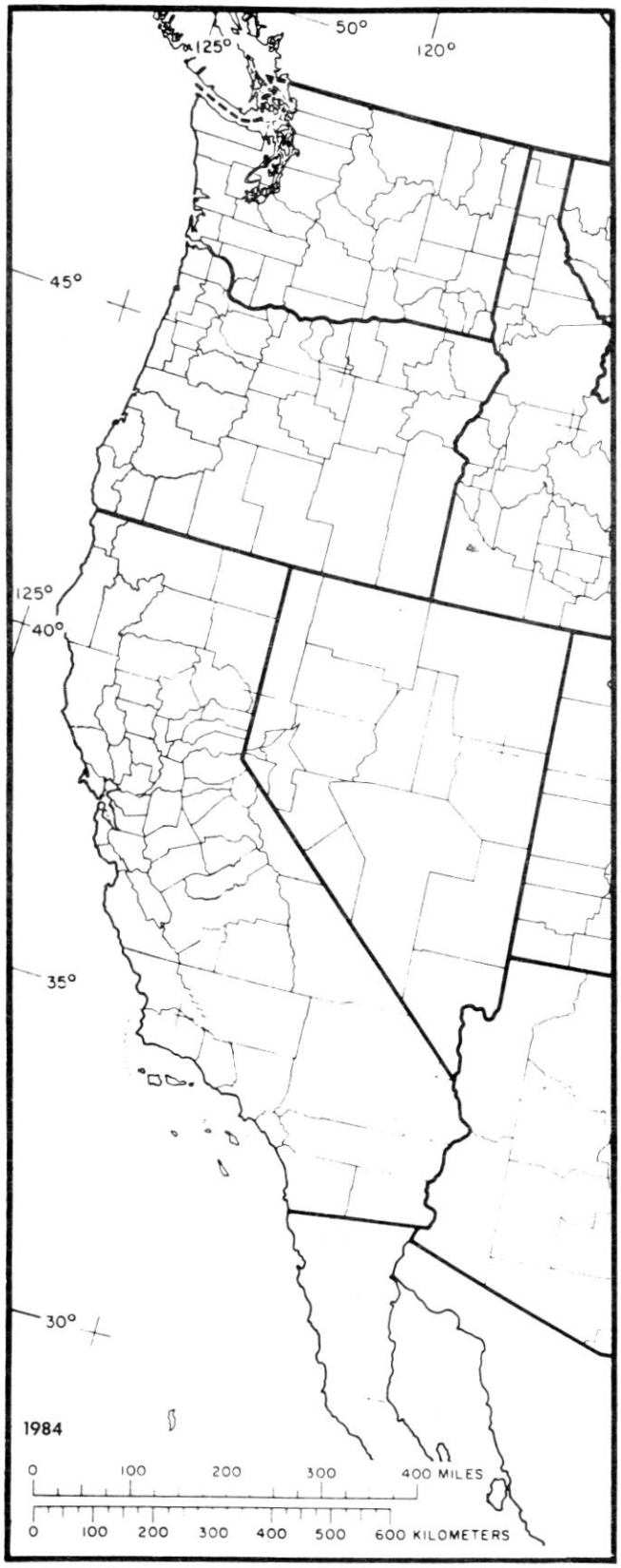

Figure 1—*The native range of giant chinkapin.*

Figure 2—*Giant chinkapin approximately 35 years old.*

Range are Douglas-fir *(Pseudotsuga menziesii)*, incense-cedar *(Libocedrus decurrens)*, sugar pine *(Pinus lambertiana)*, western hemlock *(Tsuga heterophylla)*, white fir *(Abies concolor)*, ponderosa pine *(Pinus ponderosa)*, Pacific madrone *(Arbutus menziesii)*, and Shasta red fir *(Abies magnifica* var. *shastensis)*. In southwestern Oregon, Douglas-fir, western white pine *(Pinus monticola)*, incense-cedar, sugar pine, Pacific madrone, and ponderosa pine continue to be associates, with the additional species: tanoak *(Lithocarpus densiflorus)*, California black oak *(Quercus kelloggii)*, knobcone pine *(Pinus attenuata)*, Port-Orford-cedar *(Chamaecyparis lawsoniana)*, and canyon live oak *(Quercus chrysolepis)*. Redwood *(Sequoia sempervirens)* is added to the list in north coastal California.

As a result of the wide ecological amplitude of both shrub and tree forms, giant chinkapin is found in many Society of American Foresters forest cover types *(3)*. It is most important in terms of size and

cover in certain communities in the following types: Pacific Douglas-Fir (Type 229), Douglas-Fir–Western Hemlock (Type 230); Port Orford-Cedar (Type 231); Sierra Nevada Mixed Conifer (Type 243), and Pacific Ponderosa Pine–Douglas-Fir (Type 244).

Common shrub species found in association with giant chinkapin in the Cascades in central Oregon are Pacific rhododendron *(Rhododendron macrophyllum)*, salal *(Gaultheria shallon)*, Oregongrape *(Berberis nervosa)*, Pacific dogwood *(Cornus nuttallii)*, and baldhip rose *(Rosa gymnocarpa)*. Shrub associates in the Cascades in southern Oregon include: California dewberry *(Rubus ursinus)*, baldhip rose, common snowberry *(Symphoricarpos albus)*, salal, and ocean-spray *(Holodiscus discolor)*. In southwestern Oregon, common shrub associates are: canyon live oak, huckleberry oak *(Quercus vaccinifolia)*, poison-oak *(Rhus diversiloba)*, Oregongrape, baldhip rose, California hazel *(Corylus cornuta* var. *californica)*, California dewberry, and a number of manzanita *(Arctostaphylos)* species. Low shrub and herb species that are common associates include: modest whipplea *(Whipplea modesta)*, common prince's-pine *(Chimaphila umbellata)*, American twinflower *(Linnaea borealis)*, bracken *(Pteridium aquilinum)*, and common beargrass *(Xerophyllum tenax)*.

Life History

Reproduction and Early Growth

Flowering and Fruiting—Giant chinkapin is monoecious, with unisexual staminate and pistillate flowers on the same plant. The staminate flowers form dense catkins 2.5 to 7.6 cm (1 to 3 in) long. One to three pistillate flowers are borne within an involucre at the base of the staminate catkin or separately along the stem. Pollination is adapted to wind, but bees frequent the flowers and probably aid in pollination, much to the dismay of beekeepers, for it imparts a bad taste to the honey in a mast year.

The fruit matures in the fall of the second growing season and contains one to three hard-shelled nuts within a very spiny golden brown bur 15 to 25 mm (0.6 to 1.0 in) broad, colloquially referred to as "porkypine eggs." The nuts are relatively large—1,800 to 2,400/kg (830 to 1,100/lb) *(11)*.

The phenology of flowering, fruit ripening, and seed dispersal varies widely over the range of giant chinkapin: flowering (February to July), fruit ripening (August to October), seed dispersal (fall). Three years of phenological records at the H. J. Andrews Experimental Forest in Oregon show local phenology to be less varied: flowering (mid-June to mid-July), fruit ripening (mid-August to early September), and seed dispersal (peaking in late September, but prolonged into early December).

Seed Production and Dissemination—Vigorously growing giant chinkapin produce some seed every year with mast years occurring at 2- to 5-year intervals. Understory shrubs of the species flower infrequently. Sound seeds are produced by vigorous trees, apparently of seed origin, that are 40 to 50 years old, but the age of the first seed production is probably much less. Six-year-old stump sprouts have produced some sound seeds.

The production of sound seeds can be greatly reduced locally by insects. In a sample of seeds at three locations in the H. J. Andrews Experimental Forest, two sites had less than 15 percent of the seeds infested, but at the third site nearly 100 percent of the seeds had been attacked by insects.

The primary agents of dissemination of giant chinkapin seed are gravity, squirrels, and birds, not necessarily in that order of importance. Vertebrates are undoubtedly important vectors. Several species of birds feed on nuts, and clumps of young seedlings not originating from sprouts implicate squirrels in caching food.

Seedling Development—Reported germination ranges from 14 to 53 percent *(11)*; one study found it to have the poorest rate of germination of all hardwoods in the Klamath Province of southwestern Oregon and northern California *(15)*. Germination is hypogeal and takes place in 16 to 24 days. Although the rate of germination was not increased by cold stratification, which suggested that germination and establishment in the fall are possible, no such germination was observed during 3 years of study at the H. J. Andrews Experimental Forest. Natural seedlings of giant chinkapin which ranged from 15 to 45 cm (6 to 18 in) in height were found only in relatively open stand conditions in the Experimental Forest. The individuals appeared to have germinated under a light leaf mulch in partial shade. The tallest was 12 years old and the shortest 4, but the height-age relationship was poor. In the northern Coast Ranges of California, the best seedling establishment occurs on mesic sites without dense layers of understory vegetation *(12)*.

Vegetative Reproduction—Giant chinkapin sprouts prolifically when cut or injured. Light understory fires cause vigorous basal sprouting. Even intense broadcast burns will not prevent basal sprouts from rapidly regrowing. Height growth of the sprouts can be rapid, outstripping young conifer growth for

several years. Because of its aggressive sprouting ability, giant chinkapin is a problem for forest management on many sites.

The species is well adapted to a regime of frequent fires, which is reflected in the chaparral shrub form. Also, over much of the northern portion of the range of giant chinkapin, the tree form occupies ridgetop positions with other fire-adapted species. Its ability to exist with the potentially taller conifers may be the result of both its sprouting ability and relatively high fire frequency.

Sapling and Pole Stages to Maturity

Growth and Yield—Giant chinkapin is rarely a dominant species in a stand, and it is often an understory shrub or small tree of poor form. Growth and yield data are therefore nearly nonexistent for giant chinkapin despite its ability to develop a bole of good form and height in dense stands on optimum sites. The following information was obtained from unpublished data of the USDA Forest Service and Oregon State University.

Giant chinkapin provided 11 percent of the total stemwood volume of about 700 m^3/ha (50,000 fbm/acre) in an 80-year-old stand in the Coast Ranges of Oregon; the stand was site III for Douglas-fir. The mean diameter at breast height (d.b.h.) of stems greater than 15 cm (6 in) for giant chinkapin was 34 cm (13.4 in). The largest giant chinkapin in the stand were codominants about 27 m (90 ft) tall.

In two stands about 100 years old in the Cascades of Oregon, giant chinkapin made up 11 and 21 percent of the total stemwood volume. The two sites were site III and IV for Douglas-fir and had estimated volumes of about 800 and 550 m^3/ha (57,100 and 39,300 fbm/acre). In the site III stand, giant chinkapin stems greater than 10 cm (4 in) in d.b.h. averaged 20 cm (7.8 in) in d.b.h. Their mean diameter increment for the previous 10-year period was 1.8 mm (0.07 in) per year.

The average d.b.h. of giant chinkapin stems greater than 10 cm (4 in) in d.b.h. in the second stand on the poorer site was larger—30 cm (11.8 in). The mean annual diameter increment for the previous 10-year period was also slightly larger—2 mm (0.08 in) per year.

Because of the species' ability to resprout, individual genets of giant chinkapin could be several centuries old. The species is susceptible to heart-rotting fungi, which makes aging of large, old trees difficult. At the H. J. Andrews Experimental Forest in Oregon, the maximum age was found to range from 130 to 150 years. In the northern Coast Ranges of California maximum ages were estimated to range between 400 and 500 years, with the oldest trees on the more xeric habitats *(12)*.

Rooting Habit—No information available.

Reaction to Competition—The competitive ability of giant chinkapin appears to be improved relative to its associates on nutritionally poor sites with high moisture stress. The shrub form is quite tolerant of shade. The tree form is less tolerant of shade and is probably most accurately classified as intermediate in tolerance, comparable to incense-cedar or sugar pine with which it is often found. Chinkapin does not attain the height of many of its associates, is often overtopped in mature stands of conifers, and declines in importance during later stages of succession. Over much of its range, some disturbance—such as fire, logging, or windstorm—is required for giant chinkapin to remain an important component of the forest on most sites. Under relatively droughty, infertile conditions, it can be a very aggressive and undesirable species during early succession. This is the aspect of giant chinkapin that is perhaps best known by foresters. Considerably more research has been conducted on how to rid sites of giant chinkapin than on how to promote its establishment and growth.

The most effective site preparation methods for controlling giant chinkapin have been scarification by tractor or spraying and burning. Neither slash burning nor hand scalping is effective, and herbicides produce only moderate results *(1,2,7)*.

Because giant chinkapin is usually found mixed with other undesirable species, broad-spectrum herbicides, such as 2,4-D and triclopyr ester, have been used most frequently *(1,2,7)*. Formulations of triclopyr ester have proven the most successful for both aerial and ground applications, including basal and stem treatment *(1,2)*. The registration status of herbicides is subject to change. Consultation with local extension agents is advised when considering herbicide use.

Damaging Agents—Few diseases or insects are reported to affect growth and survival of giant chinkapin *(6,9)*, but it is susceptible to heart-rotting fungi, such as *Phellinus igniarius (9)*. It is resistant to chestnut blight *(Cryphonectria parasitica)* despite its close relationship to chestnut. Common leaf fungi appear to do little harm. Twig fungi are reported to be secondary to other agents of damage, and root and butt rots are rare.

Although in general giant chinkapin has few insect pests, seed-infesting species, such as the filbertworm *(Melissopus latiferreanus)*, may play a significant

local role in impeding regeneration. In portions of its range, certain foliage feeders, such as California oakworm *(Phryganidia californica)*, can reduce growth. The roundheaded borer *(Phymatodes aeneus)* is occasionally found in dying branches and thin-barked portions of the bole *(6)*.

Special Uses

A small market exists for giant chinkapin wood for furniture and cabinet stock, paneling, and decorative veneer *(16)*. There are several reasons for its limited use, despite its ability to develop a tall, clear, straight bole under average growing conditions. It rarely occurs naturally in pure stands, being typically a minor hardwood component of predominantly coniferous forests. Also, most mills in the conifer-dominated industry of the Pacific States will not take giant chinkapin because of added inventory problems for little additional volume. Finally, it is one of the most difficult hardwoods in the United States to cure, as it tends to check badly *(16)*, and transportation costs keep it from being moved long distances to the few mills equipped to process it. As a consequence, giant chinkapin is often felled and left on the site or is bucked into firewood.

Giant chinkapin is an important species for wildlife because of the cover and food it provides. Its ability to grow on harsh sites on infertile soils, and to sprout rapidly after fire, also makes it important for soil stabilization in watersheds.

Genetics

If much of the earlier discussion seemed to deal with two or perhaps three species, it may be because the taxonomy of the genus is poorly understood. Only 2 of about 150 species of *Castanopsis* are found in North America. These two are distinct from their Asian relatives, and systematists have created a new genus for them, *Chrysolepis (4,10)*. The American species have a floral morphology that is intermediate to *Castanopsis* and *Lithocarpus*, and it represents the ancient condition of the family Fagaceae. The new scientific names for the American species, with the older names in parentheses, are *Chrysolepis chrysophylla* (Dougl.) Hjelmqvist *(Castanopsis chrysophylla* (Dougl.) A. DC.) for giant chinkapin and *Chrysolepis sempervirens* (Kell.) Hjelmqvist *(Castanopsis sempervirens* Dudl.) for evergreen chinkapin.

The uniqueness of the two species at the genus level does not imply a simple relationship between them. The ranges of the shrub form of giant chinkapin and of evergreen chinkapin overlap from northern coastal California into the Cascade Range of Oregon. The two species probably hybridize where they coexist *(8)*. An apparently continuous intergradation of characters can be found in the Cascades in southern Oregon and in the Siskiyou Mountains.

The two growth forms of giant chinkapin are probably not the result of plastic phenotypic response to site conditions, although they may be in portions of the species range. In the northern Coast Ranges of California, the tree form occupies relatively moist conditions; the shrub form grows on dry, sterile ridgetops in chapparal communities. In the central part of the Cascades of Oregon, the pattern is reversed—the tree form is found primarily in relatively open and dry ridgetop forest communities, and the shrub form is spread through the more mesic forest stands. Only the shrub form is found at high elevations in the Cascade Range.

This variation is due to the probable existence of at least three ecotypes of giant chinkapin: a dry-site chaparral shrub ecotype of southwestern Oregon and northwestern California that probably matches the taxonomic category of *Castanopsis chrysophylla* var. *minor* Benth; a high-elevation ecotype adapted to heavy snowpack, cool temperatures, and short growing seasons found along the Oregon Cascades and in eastern Oregon; and a tree form that occurs in forest stands at lower elevations. The latter ecotype seems well adapted to dry, relatively infertile sites but can and does do well in more mesic conditions that have a history of disturbance by fire.

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