

Quercus velutina Lam. Black Oak

Fagaceae Beech family

Ivan L. Sander

Black oak (*Quercus velutina*) is a common, medium-sized to large oak of the eastern and mid-western United States. It is sometimes called yellow oak, quercitron, yellowbark oak, or smoothbark oak. It grows best on moist, rich, well-drained soils, but it is often found on poor, dry sandy or heavy glacial clay hillsides where it seldom lives more than 200 years. Good crops of acorns provide wildlife with food. The wood, commercially valuable for furniture and flooring, is sold as red oak. Black oak is seldom used for landscaping.

Habitat

Native Range

Black oak (figs. 1, 2) is widely distributed from southwestern Maine west in New York to extreme southern Ontario, southeastern Minnesota, and Iowa; south in eastern Nebraska, eastern Kansas, central Oklahoma, and eastern Texas; and east to northwestern Florida and Georgia (18,19).

Climate

In the area over which black oak grows, mean annual temperature ranges from about 7° C (45° F) in the north to 20° C (68° F) in east Texas and north-central Florida. Annual precipitation is less than 760 mm (30 in) per year on the northwestern fringe of black oak's range and 2030 mm (80 in) in the southern Appalachians. The frost-free season averages 140 days in southern Wisconsin and 260 days in southeast Texas (6).

Black oak grows best in the Central States where the climate is moderate, with an average annual temperature of 13° C (55° F), precipitation of 1020 to 1270 mm (40 to 50 in), and a frost-free season of about 180 days (6).

Soils and Topography

In southern New England, black oak grows on cool, moist Orthod Spodosols. Elsewhere it occurs on warm, moist soils including Udalf Alfisols, Udoll Mol-lisols, Udult Ultisols, small areas of Udipsamment Entisols, Dystrichrept Inceptisols, and in extreme

northeastern Ohio and northwestern Pennsylvania on Fragiochrept Inceptisols.

The most widespread soils on which black oak grows are the Udalfs and Udolls (30). These soils are derived from glacial materials, sandstones, shales, and limestone and range from heavy clays to loamy sands with some having a high content of rock or chert fragments. Black oak grows best on well-drained, silty clay to loam soils.

Black oak grows on all aspects and slope positions. It grows best in coves and on middle and lower slopes with northerly and easterly aspects. It is found at elevations up to 1200 m (4,000 ft) in the southern Appalachians (6).

The most important factors determining site quality for black oak are the thickness and texture of the A horizon, texture of the B horizon, aspect, and slope position (2,4,13,20). Other factors may be important in localized areas. For example, in northwestern West Virginia increasing precipitation to 1120 mm (44 in) resulted in increased site quality; more than 1120 mm (44 in) had no further effect (2). In southern Indiana, decreasing site quality was associated with increasing slope steepness (13).

Near the limits of black oak's range, topographic factors may restrict its distribution. At the western limits black oak is often found only on north and east aspects where moisture conditions are most favorable. In southern Minnesota and Wisconsin it is usually found only on ridgetops and the lower two-thirds of south- and west-facing slopes (6).

Associated Forest Cover

Black Oak (Society of American Foresters Type 110) is the forest cover type that designates pure stands of the species or those in which it makes up more than 50 percent of the stand basal area. Black oak is a major associate in White Oak-Black Oak-Northern Red Oak (Type 52), and a component in the following forest cover types (8):

Northern Forest Region

- 14 Northern Pin Oak
- 51 White Pine-Chestnut Oak
- 60 Beech-Sugar Maple

Central Forest Region

- 40 Post Oak-Blackjack Oak
- 42 Bur Oak
- 43 Bear Oak
- 44 Chestnut Oak
- 45 Pitch Pine

The author is Research Forester (retired), North Central Forest Experiment Station, St. Paul, MN.

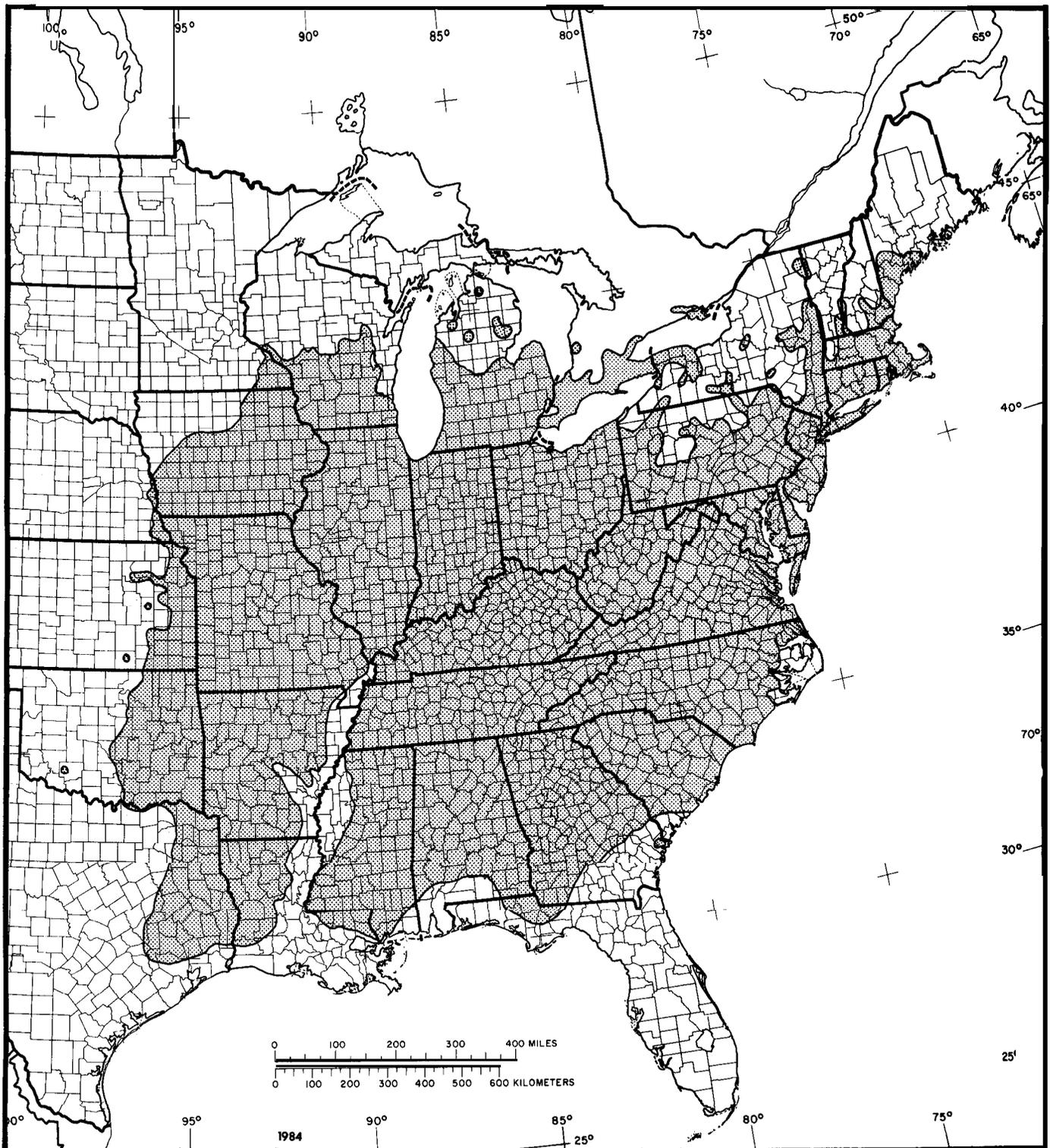


Figure 1-The native range of black oak.

- 46 Eastern Redcedar
- 53 White Oak
- 55 Northern Red Oak
- 57 Yellow-Poplar
- 58 Yellow-Poplar-Eastern Hemlock
- 59 Yellow-Poplar-White Oak-Northern Red Oak

Southern Forest Region

- 75 Shortleaf Pine
- 76 Shortleaf Pine-Oak
- 78 Virginia Pine-Oak
- 79 Virginia Pine
- 80 Loblolly Pine-Shortleaf Pine
- 82 Loblolly Pine-Hardwood

Other tree associates of black oak include pignut hickory (*Carya glabra*), mockernut hickory (*C. tomentosa*), bitternut hickory (*C. cordiformis*), and shagbark hickory (*C. ovata*); American elm (*Ulmus americana*) and slippery elm (*U. rubra*); white ash (*Fraxinus americana*); black walnut (*Juglans nigra*) and butternut (*J. cinerea*); scarlet oak (*Quercus coccinea*), southern red oak (*Q. falcata*), and chinkapin oak (*Q. muehlenbergii*); red maple (*Acer rubrum*) and sugar maple (*A. saccharum*); black cherry (*Prunus serotina*); and blackgum (*Nyssa sylvatica*) (5).

Common small tree associates of black oak include flowering dogwood (*Cornus florida*), sourwood (*Oxydendrum arboreum*), sassafras (*Sassafras albidum*), eastern hophornbeam (*Ostrya virginiana*), redbud (*Cercis canadensis*), pawpaw (*Asimina triloba*), downy serviceberry (*Amelanchier arborea*), and American bladder-nut (*Staphylea trifolia*). Common shrubs include *Vaccinium* spp., mountain-laurel (*Kalmia latifolia*), witch-hazel (*Hamamelis virginiana*), beaked hazel (*Corylus cornuta*), spicebush (*Lindera benzoin*), sumac (*Rhus* spp.), and *Viburnum* spp. The most common vines are greenbrier (*Smilax* spp.), grape (*Vitis* spp.), poison-ivy (*Toxicodendron radicans*), and Virginia creeper (*Parthenocissus quinquefolia*) (5).

Life History

Reproduction and Early Growth

Flowering and Fruiting-Black oak is monoecious. The staminate flowers develop from leaf axils of the previous year and the catkins emerge before or at the same time as the current leaves in April or May. The pistillate flowers are borne in the axils of the current year's leaves and may be solitary or occur in two- to many-flowered spikes. The fruit, an acorn that occurs singly or in clusters of two to five, is about one-third enclosed in a scaly cup and matures in 2 years. Black oak acorns are brown when mature



Figure 2—Black oak.

and ripen from late August to late October, depending on geographic location (28).

Seed Production and Dissemination-In forest stands, black oak begins to produce seeds at about age 20 and reaches optimum production at 40 to 75 years. It is a consistent seed producer with good crops of acorns every 2 to 3 years. In Missouri, the average number of mature acorns per tree was generally higher than for other oaks over a 5-year period, but the number of acorns differed greatly

from year to year and from tree to tree within the same stand (6).

The number of seeds that become available for regenerating black oak may be low even in good seed years. Insects, squirrels, deer, turkey, small rodents, and birds consume many acorns. They can eat or damage a high percentage of the acorn crop in most years and essentially all of it in poor seed years (6,26).

Black oak acorns from a single tree are dispersed over a limited area by squirrels, mice, and gravity (28). The blue jay may disperse over longer distances (7).

Seedling Development-Black oak will be present to the same extent in newly reproduced stands as it was as advance reproduction before harvest cutting. New seedlings established at or just before harvest cutting grow too slowly to compete with sprouts of other tree species and other vegetation (25,27). To compete successfully in new stands black oak stems must be 1.2 to 1.5 m (4 to 5 ft) tall and have well-developed root systems. Success in reproducing black oak depends on creating conditions within mature stands that will result in seedling establishment and conditions favoring their survival and growth (1,26).

Black oak acorns germinate in the spring following seedfall. Germination is hypogeal (25,28). Most favorable conditions for germination occur when the acorns are in contact with or buried in mineral soil and covered with a light layer of litter. Acorns on top of the litter generally dry excessively during early spring and lose their viability before temperatures are favorable for germination. The primary root generally grows vigorously following germination (6,26). Seedlings can survive droughty conditions, but growth is slow or even ceases altogether. Black oak seedlings are more drought tolerant than northern red oak seedlings and about the same as white oak seedlings (29).

Light intensity appears to be critical to the survival and growth of black oak seedlings. Light intensity under forest stands is often very low at the level of the new seedlings (about 15 cm or 6 in). In Missouri, light intensity at this level in forest stands was 10 percent or less of that in nearby open areas. The black oak seedlings in this study averaged 9 cm (3.5 in) tall at age 4, the same as they averaged at age 1 (26).

Black oak seedlings that survive seldom remain true seedlings for more than a few years because drought, low light intensity, fire, animals, or mechanical agents kill the tops. Then, one or more dormant buds near the root collar produce new

sprouts. This dieback and resprouting process can occur several times; thus the roots of black oak saplings may be 10 to 20 years older than the tops (27). Growth of black oak sprouts, like that of seedlings, is slow under forest stands. In Missouri, sprouts grew only 6 cm (2.4 in) in 4 years (26).

Shoot elongation of black oak is episodic. Multiple shoot-growth flushes occur in both seedlings and sprouts when light, temperature, and moisture conditions are favorable. Only one growth flush occurs on stems growing in a shaded understory. Periods of active shoot growth are followed by distinctive rest periods, during which most of the annual root elongation occurs (22).

Vegetative Reproduction-About 95 percent of the black oaks in newly reproduced stands created by clearcutting or final overstory removal are sprouts, either from advance reproduction or from stumps of cut trees (27). New sprouts from advance reproduction develop from dormant buds near the root collar when the old stems are cut or damaged during logging. These new sprouts grow rapidly and their height growth is related to the size of the old stem; the larger the old stem, the faster a new sprout will grow (23,24).

Stumps of black oaks sprout less frequently than those of northern red, scarlet, and chestnut oaks and with about the same frequency as those of white oak (25). A Missouri study showed that sprouting frequency for black oak stumps is related to site index, tree age, and stump diameter. Small stumps from young trees on good sites sprout most frequently while large stumps from old trees on poor sites sprout least frequently (16). Black oak stump sprouts grow rapidly: in Missouri the height of dominant and codominant stems averaged 3.5 m (11.4 ft) at age 5. The probability that a stump with a living sprout 1 year old will have at least one dominant or codominant sprout at age 5 is predictable from stump diameter and ranges from near 1.0 for 7.6 cm (3 in) stumps to about 0.15 for 76 cm (30 in) stumps. Black oak stump sprouts may be a valuable component of newly reproduced stands, particularly if they originate at ground level. The low-origin sprouts are less susceptible to rot entering from the parent stump than the high-origin sprouts. Many develop into trees of good quality (27).

Sapling and Pole Stages to Maturity

Growth and Yield-Black oak becomes physiologically mature at about 100 years of age, some individuals living 150 to 200 years. On the best sites black oak trees may reach 46 m (150 ft) in

height and 122 cm (48 in) in d.b.h., but most mature trees are 18 to 24 m (60 to 80 ft) tall and 61 to 91 cm (24 to 36 in) in d.b.h. (6).

Average diameter growth of black oak for a range of ages, sites, and stand conditions in the Central States was about 5 mm (0.2 in) per year for 10 years. In West Virginia, dominant black oaks grew faster in diameter than scarlet, chestnut, and white oaks but slower than northern red oak (6).

Average growing space requirements for oaks in even-aged stands in which black oak is a major component have been determined by Gingrich (9). Competition for growing space in these stands begins at the level of stocking where the total available space is equal to the total of the maximum requirement of all the trees in the stand. This level of stocking is about 60 percent of the maximum stocking a site can support and is the lowest level of stocking at which the stand will fully utilize the site. The maximum amount of growing space a black oak tree can use is 33.3 m² (358 ft²) for a tree 20 cm (8 in) in d.b.h. and 115 m² (1,233 ft²) for a tree 51 cm (20 in) in d.b.h. The minimum growing space required for trees is 13.5 m² (145 ft²) and 64.8 m² (697 ft²), respectively.

Yields of unthinned, 80-year-old stands with black oak as a major component range from 75.6 m³/ha (5,400 fbm/acre) on poor sites (site index 16.8 m (55 ft) at base age 50 years) to 175.0 m³/ha (12,500 fbm/acre) on good sites (site index 22.9 m or 75 ft). Yields can be increased substantially by thinning regularly. At age 70, stands that are first thinned at age 20, with subsequent thinning at about 10-year intervals, yield from 102.9 m³/ha (7,350 fbm/acre) on poor sites to 278.3 m³/ha (19,880/acre) on good sites (10).

Rooting Habit-No information available.

Reaction to Competition-Black oak is classed as intermediate in tolerance to shade. It is less tolerant than many of its associates such as white and chestnut oaks, hickories, beech (*Fagus grandifolia*), maples, elm, and blackgum; it is more tolerant than yellow-poplar (*Liriodendron tulipifera*), black cherry, and shortleaf pine (*Pinus echinata*); and it is about the same as northern red oak and scarlet oak. Seedlings usually die within a few years after being established under fully stocked overstories. Most black oak sprouts under mature stands develop crooked stems and flat-topped or misshapen crowns. After the overstory is removed, only the large stems are capable of competing successfully. Seedlings are soon overtopped. The few that survive usually remain in the intermediate crown class (6,24,27).

Even-aged silvicultural systems satisfy the reproduction and growth requirements of black oak better than the all-aged or uneven-aged selection system (1,27). Under the selection system, black oak is unable to reproduce because of inadequate light. Stands containing black oak that are managed under the selection system will gradually be dominated by more shade-tolerant species.

Black oak responds well to release if the released trees are in the codominant or above-average intermediate crown classes. The best response is obtained if release cuttings or thinnings are begun before a stand is 30 years old. Trees in stands older than 30 years that have always been fully stocked generally have small crowns that have been restricted too long. These are unable to make efficient use of the growing space provided by release or thinnings. Thus response is not as good as in younger stands (25).

Ten years following release in an Arkansas study, diameter growth of 50-year-old black and northern red oak trees averaged 40 percent more than that of unreleased trees. Although the rate of diameter growth increased throughout the 10-year period, response was greater and more apparent in years 5-10.

Dormant buds are numerous on the boles of black oak trees. These buds may be stimulated to sprout and produce branches by mechanical pruning or by exposure to greatly increased light, as by thinning heavily or creating openings in the stand. Dominant trees are less likely to produce epicormic branches than those in the lower crown classes (6,25).

Damaging Agents-Wildfires seriously damage black oak trees by killing the cambial tissue at the base of the trees. This creates an entry point for decay fungi, and the end result is loss of volume because of heart rot. Trees up to pole size are easily killed by fire and severe fires may even kill sawtimber. Many of the killed trees sprout and form a new stand (6). However, the economic loss may be large unless at least some of it can be salvaged.

Oak wilt (*Ceratocystis fagacearum*) is a potentially serious vascular disease of black oak that is widespread throughout the eastern United States. Trees die within a few weeks after the symptoms first appear. Usually scattered individuals or small groups of trees are killed, but areas several hectares (acres) in size may be affected. The disease is spread from tree to tree through root grafts and over larger distances by sap-feeding beetles (*Nitidulidae*) and the small oak bark beetle (6).

Shoestring root rot (*Armillaria mellea*) attacks black oak and may kill trees weakened by fire, lightning, drought, insects, or other diseases. A root rot,

Phytophthoru cinnamomi, may kill seedlings in the nursery Cankers caused by *Strumella* and *Nectria* species damage the boles of black oak but seldom kill trees. Foliage diseases that attack black oak are the same as those that typically attack species in the red oak group and include anthracnose (*Gnomonia quercina*), leaf blister (*Taphrina* spp.), powdery mildews (*Phyllactinia corylea* and *Microsphaera alni*), oak-pine rusts (*Cronurtium* spp.), and leaf spots (*Actinopelte dryina*) (13).

Tunneling insects that attack the boles of black oak and cause serious lumber degrade include the carpenterworm (*Prionoxystus robiniae*), red oak borer (*Enaphalodes rufulus*), the twolined chestnut borer (*Agrilus bilineatus*), the oak timberworm (*Arhenodes minutus*), and the Columbian timber beetle (*Corthylus columbianus*) (3).

The gypsy moth (*Lymntria dispar*) feeds on foliage and is potentially the most destructive insect. Although black oaks withstood a single defoliation, two or three defoliations in successive years killed many trees in New Jersey (17). Other defoliators that attack black oak and may occasionally be epidemic are the variable oakleaf caterpillar (*Heterocumpu munteo*), the orangestriped oakworm (*Anisota senatoria*), and the browntail moth (*Euproctis chrysorrhoea*).

The nut weevils (*Curculio* spp.), gall-forming cynipids (*Callirhytis* spp.), filbertworm (*Melissopus latiferreanus*), and acorn moth (*Valentinia glandulella*) damage black oak acorns.

Special Uses

Black oak acorns are an important food for squirrels, white-tail deer, mice, voles, turkeys, and other birds (11). In Illinois, fox squirrels have been observed feeding on black oak catkins (14). Black oak is not extensively planted as an ornamental, but its fall color contributes greatly to the esthetic value of oak forests.

Genetics

Although races of black oak have not been identified, a study of 14 populations from southern Indiana to northern Michigan revealed morphological differences. Northern populations had smaller acorns with less cup cover, lighter yellow inner bark, smaller winter buds, and a more branching growth form than southern populations (21).

Black oak hybridizes readily with other species in the subgenus *Erythrobalanus*. The following named hybrids with *Quercus velutina* are recognized (19): *Q.*

coccineu (*Q. x fontunu* Laughlin); *Q. ellipsoidalis* (*Q. x pulaeolithicolu* Trel.); *Q. falcata* (*Q. x pinetorum* Moldenke); (*Q. x willdenowiana* (Dippel) Zabel); *Q. ilicifoliu* (*Q. x rehderi* Trel.); *Q. imbricuriu* (*Q. x leana* Nutt.); *Q. incuna* (*Q. x podophylla* Trel.); *Q. murilandicu* (*Q. x bushii* Sarg.); *Q. nigra* (*Q. x demarei* Ashe); *Q. palustris* (*Q. x vugu* Palmer & Steyerma.); *Q. phellos* (*Q. x filialis* Little); *Q. rubra* (*Q. x huwkinsiue* Sudw.); *Q. shumardii* (*Q. x discreta* Laughlin).

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