MESQUITE ECOLOGY

R.J. ANSLEY, J.A. HUDDLE and B.A. KRAMP, Texas Agricultural Experiment Station, Vernon, TX 76384

Abstract: Mesquite (genus *Prosopis*) are woody legumes which inhabit arid and semiarid regions throughout the southwestern U.S.A., Mexico, South America, northern Africa and eastern Asia. The two principle species found in the southwestern U.S., honey mesquite (*P. glandulosa*) and velvet mesquite (*P. velutina*), occur in a variety of growth forms, ranging from decumbent shrubs to 25 ft. tall trees. Increases in mesquite density since the late nineteenth century have been attributed to man's influence, either through suppression of natural fires or dissemination of mesquite seed by the herding and migration of domestic livestock. This paper summarizes mesquite geographical distribution, seed ecology, growth and development, rooting and water use patterns, and effects on other plant species, wildlife and soils. Once viewed strictly as a noxious plant that needed to be eradicated, recent data indicate potential benefits of mesquite if managed as a savanna, or a mosiac of grasslands and thickets.

Mesquite (genus *Prosopis*) is a thorny shrub or tree of the legume family which occurs naturally in arid and semiarid areas of North and South America, northern Africa, and eastern Asia. Most of the over 40 species of mesquite are native to South America, which is thought to be the area of origin for mesquite (Burkhart and Simpson 1977). The two species of concern in the southwestern U.S. are honey mesquite (*P. glandulosa*) and velvet mesquite (*P. velutina*). Honey mesquite is found mainly in Texas, New Mexico and northern Mexico, with plants occurring in California, Oklahoma, Kansas and Louisiana. Velvet mesquite occurs mainly in southern Arizona, but is also found in California and northern Mexico.

Although the geographical distribution of mesquite in the southwestern United States has remained stable, densities within stands have increased since the late nineteenth century. This trend has been attributed to man's influence, either through suppression of natural fires or dissemination of mesquite seed by the herding and migration of domestic livestock (Archer 1989).

Historical accounts differ as to original density and distribution of mesquite in Texas. Bartlett (1854) described much of Texas rangeland as open grasslands with scattered large mesquite (i.e., a mesquite savanna). Marcy (1866) described some upland areas of central Texas as "covered with groves of mesquite trees", and an area in the lower Texas panhandle as "one continuous mesquite flat, dotted here and there with small patches of open prairie". These observations indicate honey mesquite was a natural part of the Texas vegetation complex prior to white settlement and, apparently in some instances, occurred as dense stands.

Seed ecology and seedling establishment

Mesquite reproduce only by seed and not vegetatively. Honey mesquite seed are borne in pods (i.e., legumes) which are about 8-12 inches long and contain 10-30 seeds per pod. Most pods that fall to the ground are destroyed by insects or fungi or are consumed by animals. Seed deposited in the soil on an Arizona site remained viable for up to 10 years, especially when seed were within the pod (Tschirley and Martin 1960). Longevity of seed viability is probably shorter in higher rainfall areas.

Unlike many legumes, mesquite pods do not split open at maturity. This feature allows foraging animals that ingest seed in the process of consuming the pod, which is high in sugars, to disperse seed away from the parent tree (Fisher et al. 1959, Mooney et al. 1977). Cattle and many wildlife species including deer, coyotes, javelina, feral hogs, rodents, and rabbits consume and fecally distribute mesquite seed.

Germination of mesquite seeds occurs principally during early spring and late fall when soil moisture is favorable. Maximum emergence of honey mesquite occurs when seeds are planted at 0.25 inch depth and soil temperature is near 80° F (Scifres and Brock 1972). A substantial proportion of the carbohydrate in the embryo is devoted to root system development (Mooney et al. 1977), and many young mesquite plants which appear to be seedlings may actually be 3-4 years old. The amount of standing herbaceous biomass affects germination and establishment of honey mesquite (Bush and Van Auken 1990). Conversely, Brown and Archer (1989) found that honey mesquite were capable of establishing from seed in thick swards of grass. Pulses of maximum mesquite seedling establishment appear to be episodic and are related to periods of drought or overgrazing when competing plant cover and vigor are reduced (Archer 1995).

Germination is enhanced when seed are scarified by passage through animal digestive tracts (Archer 1989). Fecal-deposited seed have an immediate source of nutrients in the dung which may enhance seedling survival. However, large-sized fecal deposits, especially those from cattle may dry more rapidly than the surrounding soil and actually inhibit seedling survival. Kramp et al. (1997) found that 40% of fecal sites of both cattle and deer that were initially observed to have emerging mesquite seedlings eventually produced at least one established seedling.

Emerging seedlings are killed if clipped (or grazed) below the cotyledons (Scifres and Hahn 1971). It is hypothesized that stem tissue near or just above the cotyledonary node eventually forms the underground "bud zone" which produces resprouts when above-ground parts are removed or damaged. The rate at which the cotyledonary node (and future bud zone) becomes buried determines how long mesquite seedlings are susceptible to above-ground perturbation. The cotyledonary node may extend to 1.5 inches above ground on seeds that germinate on the soil surface and extend the root radicle into the soil (Fig. 1). The node is closer to the ground on seedlings emerging from buried seed.

Wright et al. (1976) observed that honey mesquite less than 2-3 years old were killed by fire, apparently because the bud zone meristem was still exposed. Older mesquite tolerate fire or other disturbances by resprouting from the bud zone if above ground parts are destroyed or damaged. In a recent north Texas study, Weltzin et al. (1997) found that prairie dogs maintain open sites by "suppressing" but not killing young mesquite through herbivory. Removal of the prairie dogs led to rapid development of the mesquite plants.

To some degree, fire probably held mesquite density in check in pristine times (Archer 1989). Fire is known to have occurred periodically on rangelands prior to settlement, although frequencies are unknown. Fires are presumed to have been ignited naturally by lightning, in early spring (March) or mid- and late-summer (July-September), when grasses were dry and highly combustible. Indians also used fire to manipulate bison movement. Settlement of southwest grasslands by Europeans led to a reduction of fire frequency either from direct suppression of wildfires or overgrazing by livestock, which reduced the grass fuel necessary to carry fires. Recent studies indicate that repeated summer or winter fires failed to kill adult mesquite (Ansley et al. 1995), suggesting that if fire played a role in regulating mesquite encroachment, it affected the plant at the seed or seedling growth stage.

Growth and development

Depending on the site and climate, honey mesquite can grow to approximately 25 feet in height with main support stems as much as 2 feet in diameter. Seedlings develop as single to few-stemmed plants unless the top is removed and resprouting occurs. Foraging animals such as rabbits or prairie dogs can remove tops of young seedlings. Currently, most disturbance of above-ground parts, especially in adult mesquite, has been caused by human efforts to control plants through chaining, shredding, spraying topkilling herbicides or burning (Jacoby and Ansley 1991).

The annual growth cycle of mesquite begins during April and May with a period of leaf emergence and twig elongation. This process is completed within six weeks, followed by a period of radial stem growth. Vegetative growth subsides by mid-June with the onset of summer drought, but new leaves may be produced later in the growing season if moisture is abundant (Mooney et al. 1977). Mesquite leaves are deciduous, bipinnately compound with 12 to 20 leaflets per leaf. Total per plant leaf area of 5 to 15 ft tall adult mesquite ranges from 150 to 500 ft^2 (one leaf surface) (Heitschmidt et al. 1988, Ansley et al. 1992). Leaf area index (LAI; canopy cover/total leaf area) is usually near 1.0 to 1.5.

Flowering begins shortly after leaf development. During flowering, trees are covered with thousands of blooms. However, few of these actually produce pods. Pod production of 8 to 12 ft. tall honey mesquite sampled near Vernon in 1993 and 1995 ranged from 100 to 1500 per tree (Ansley, unpubl. data). Pod production varies per plant and per year.

Rooting characteristics and water use patterns

Mesquite has been defined as a deep-rooted, water-using "phreatophyte" which avoids drought (Mooney et al. 1977). This characterization is based primarily on research in the Sonoran desert of California, an area of 3-inch annual precipitation, but which has unlimited water occurring at about 15 ft depth. In higher rainfall areas, such as that in north and central Texas, mesquite rely more on shallow lateral roots which extend as much as 50 ft from the plant (Fisher et al. 1959). In a study in north Texas, severing the lateral roots of adult mesquite trees significantly reduced transpiration by as much as 50%

when compared to unsevered trees (Ansley et al. 1991a). Mesquite that rely mainly on lateral roots grow deeper roots during drought and compete successfully with grasses by using soil moisture in subsoil layers (Heitschmidt et al. 1988, Ansley et al. 1991b).

Adult honey mesquite (8-12 ft. tall) in north Texas were found to use up to 20 gallons of water per day during ideal mid-summer growing conditions and adequate soil moisture (Ansley et al. 1991a). Water use by mesquite in southern California was about 15 gallons per day (Nilsen et al. 1983). Reduction of mesquite has increased watershed yield on some sites, but not on others (Carlson et al. 1990). On some sites compensatory grass growth restricts off-site water yield following mesquite control.

Effects on other species and soils

The mesquite canopy exerts a profound influence on neighboring vegetation, soils, subcanopy microclimate, wildlife, and insect populations. High densities of mesquite (>25% canopy cover) suppress grass growth and may reduce understory species diversity. Many studies have shown that grass production increases following control of mesquite (Dahl et al. 1978, Bedunah and Sosebee 1984). However, response is highly variable and dependent on many factors such as density of mesquite prior to treatment, effectiveness of treatment, soil type, and precipitation. In south Texas, mesquite colonizes grasslands, then serves as a nurse plant for other shrub species that establish in its understory (Archer 1989).

Mesquite is a nitrogen fixer and may modify soil fertility. Soil nitrogen can be 3 to 7 times greater beneath mesquite canopies than in interspaces between mesquite (Shearer et al. 1983, Tiedemann and Klemmedson 1986). In south Texas, Boutton et al. (1996) found that soil organic carbon (C) and total nitrogen (N) in the 0 to 8 inch soil layer was 44% (2600 vs. 1800 grams C per m^2) and 35% (260 vs. 170 grams N per m^2) greater, respectively, in mesquite groves than in open grasslands. Soil carbon and nitrogen were 3.5 and 3.1 times greater, respectively, in drainage woodlands than in grasslands.

The capacity of mesquite or related woody legumes to fix nitrogen and enrich soil fertility beneath their canopies may significantly alter responses of individual and/or assemblages of herbaceous species beneath canopies. Brock et al. (1978) found that understory vegetation is distributed into zones with taller grass species beneath mesquite canopies and shortgrass in interspaces. Control of mesquite provides regions of enhanced soil N and C which are temporarily exploited by associated grasses. However, in the long-term, mesquite in light densities may enhance recruitment of grasses into the landscape at a greater rate than mesquite-free areas.

While adult mesquite plants are not palatable and are not browsed by mammals (with the possible exception of new regrowth sprouts), they provide cover for many wildlife species, including deer, javelina, turkey, quail and numerous small mammals (Fig. 2). In addition, many species of insects are dependent on mesquite, including the cutworm (*Melipotis* spp.), the twig girdler (*Oncideris* spp.), and Bruchid beetles (Watts et al. 1989).

Mesquite management

Although regarded as a noxious plant because of its interference with livestock production, mesquite has an emerging image as a *resource* which should be managed. Unfortunately, decades of attempts to control mesquite with nonlethal, topkilling treatments (herbicides, mechanical and fire) have altered the structure of many mature stands of few-stemmed trees to multi-stemmed resprout thickets. While these thickets may offer some benefits to wildlife habitat, they generally reduce management options because they negatively impact understory herbaceous species diversity, visibility, and watershed yield.

The decision on whether mesquite will continue to be viewed as a noxious plant or managed as a resource will be made on both economic realities and environmental consciousness. Complete elimination of mesquite is a goal that few landowners have achieved. The concept of complete removal is questionable both economically and environmentally. Mesquite has many benefits to the ecosystem when maintained at moderate densities (i.e., as a savanna) or as a mosaic of thickets, grasslands and savannas (Ansley et al. 1996). Such benefits include enhanced soil fertility, shade for livestock, wildlife habitat, protection for some plant species, modified microclimate for cool-season plant species, and the potential for wood products.

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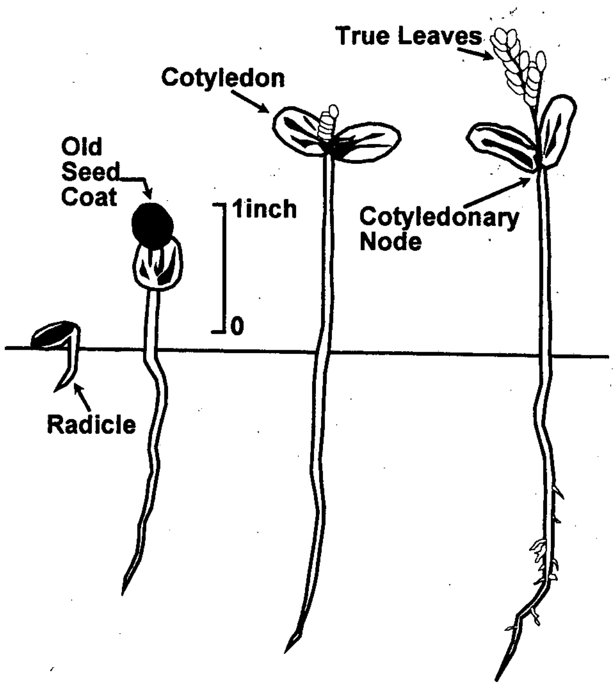

Figure 1. Developmental stages of a mesquite seedling (adapted from Martin and Alexander 1974).

Figure 2. Deer within a mesquite thicket.

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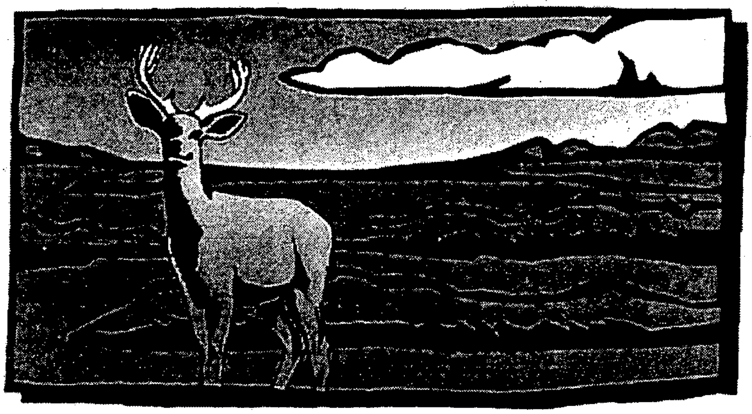

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