

urban tree manager, and the commercial arborist as the key person needed to implement the tree preservation plan.

In Central Park, the partnership between the urban tree manager and the commercial arborist who is sensitive to landscape and park use as well as to trees is recognizable and a vital part of the

restoration process.

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SUMMER BRANCH DROP¹

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Abstract. Apparently sound limbs occasionally break out of mature trees during calm summer weather. Species of at least 19 genera are susceptible. This is particularly puzzling since normally limbs would be lighter in weight during times of high transpiration. High xylem pressure and/or weakening of the cell wall bonding in the xylem accompanied by increased limb weight may be responsible.

Seemingly healthy limbs up to a meter in diameter occasionally break out of mature trees during or following hot calm summer afternoons (Australia, South Africa, and the United States) (Harris 1972) or during calm weather following a heavy summer rain which terminates a period of increasing soil dryness (England) (Rushforth 1979). In California this type of limb failure occurs on both native and planted trees as well as in ir-

rigated and unirrigated landscapes. People have been seriously injured and property damaged by falling branches. The failure of the top forty feet of a mature *Eucalyptus globus* in Los Angeles in 1977 seriously crippled a child and resulted in a recent out-of-court settlement of \$1,625,000.

Trees Affected

Limb failure has been reported on species of 19 genera, Table 1. Kellogg (1882) first reported the phenomenon on *Quercus lobata* in the coastal mountain ranges of central California. Young and vigorous maturing trees of susceptible species seem to be less prone to branch failure while over-mature and senescent trees may shed branches repeatedly (Rushforth 1979).

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Most commonly, breakage occurs 1 to 4 m from the branch attachment on long limbs that extend to or beyond the tree canopy. Sometimes a branch may fail at its attachment. Less frequently, the main leader or the entire top may fail. No outward appearance has been associated with impending branch failure; the wood at many breaks appears sound while some or much of the wood at other breaks may be brash (breaks are short and at right angles to the axis of the branch) or decayed. Brash or decayed wood may predispose branches to the possibility of failure, but does not account for failure occurring under the conditions that it does.

This phenomenon was thought to be confined to times of high temperature in arid regions, such as Australia, South Africa, and southwestern United States, because, until this year, no one could be found who was familiar with this problem in the midwestern or eastern United States. However, summer branch drop has been reported in England (Rushforth 1979) and is serious enough for the Royal Botanic Garden at Kew to post a large sign at each entrance warning visitors that "The older trees; particularly beech and elm, are liable to shed large branches without warning." In arranging for this presentation, Cal Bundy recalled branches dropping out of two American elms in Peoria, Illinois in 1959 or 60. At the 1982 American Society of Consulting Arborists meeting, a reported tree failure of red oak in New York could have been related to summer branch drop.

Possible Explanations

Limb failure on hot afternoons is an anomaly since tree trunks normally shrink in the afternoons (Kozlowski and Winget 1964). I have observed limbs rise as well as shrink indicating that transpiration has exceeded water uptake and that limbs are lighter in the afternoon. This is further borne out since most of the breaks are relatively dry; this would be due to moisture tension in the xylem drawing water into the wood on each side of the break.

Just the opposite is often the case. After a break, water has been observed "flowing" from both sides of a fracture. Many report that the limb "exploded" and dropped quickly with no warning. Kellogg (1882) stated "Often late in the season

when the hot sun broils and steams the sap, as it were, internally, an ax struck into it (mature *Quercus lobata*) hisses like a legion of little safety valves; and sometimes, most unaccountably, it is said to burst with a loud explosion, and strong limbs that had hitherto withstood centuries of storms, in the calm airs of late summer and early autumn crash unexpectedly down, the fracture disclosing not the least cause of weakness." These observations indicated the xylem to be under pressure, at least in these instances.

Two possibilities could account for this pressure: 1) Wetwood bacteria have created gas pressures up to 60 psi (4.2 kg/cm²) in elm trunks (Carter 1969). Such infections are common in several species subject to limb breakage. 2) Under calm conditions, transpiration may be greatly reduced due to high humidity within tree

Table 1. Trees reported to be susceptible to summer branch drop.

Species most often reported in Britain (Rushforth 1979).

Quercus spp.
Populus spp.
Salix spp.
Ulmus procera
Castanea sativa
Fagus sylvatica
Fraxinus excelsior
Aesculus hippocastanum

Genera most often reported in California

Eucalyptus
Quercus
Ulmus
Pinus
Cedrus
Fraxinus
Platanus

Species also reported in California.

Ailanthus altissima
Erythrina caffra
Ficus microcarpa
Olea europaea
Grevillea robusta
Sequoiadendron giganteum
Sophora japonica

canopies. Root pressure could then increase the moisture content of branches, thereby increasing their weight and internal sap pressure.

Another theory tied to calm weather would be due to reduced transpiration (high humidity in tree canopy), the reduced flow of water in the xylem would allow the branch temperature to increase and in turn could increase the production of ethylene and other substances. These could begin to weaken the cell wall cementation, an accelerated development of brashness, if you will. This increased weakening coupled with the increased weight of a limb due to increasing leaf surface and fruit and reduced transpiration could result in branch failure.

If wood actually weakens under hot, calm, conditions, the process must be reversible or new wood must form rapidly enough to strengthen branches in order for them to withstand the increased weight of rain on the foliage and the strain of wind storms that may follow.

Suggested precautions

1. Warn people of potential hazard or rope off areas near hazardous trees as done at Kew. This would be most important from late spring to early fall.
2. In areas to be frequented by people, do not plant species known to be susceptible to this problem.
3. On mature trees, shorten and lighten long horizontal branches and open up the tree so humidity is less likely to build up.
4. Keep trees vigorous and healthy; however, this may be self defeating since potentially

susceptible branches would become longer and heavier, but hopefully stronger.

5. Inspect susceptible trees for externally visible defects, removing low-vigor limbs that have decay or cavities. An entire tree should be removed if decayed and of low vigor.

Request for Information

Please send information concerning any suspected cases of summer branch drop, giving: species, approximate DBH, approximate diameter of limb or trunk at break, the time and date, location of tree, maximum temperatures for the day of the accident and the five preceding days, wind conditions at time of break, estimate of damage caused, and other information that may be pertinent. Send to the author at the address below.

Literature Cited

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