APN 8

Arboricultural Practice Notes

Trees in focus

Trees Bleeding

by Derek Patch[1]

Arboricultural Advisory and Information Service

(Based on an unpublished paper by Jane Dow[2])

Summary

Liquids flowing from trees generally cause distress to the observer. The flow frequently follows damage to the plant's tissue. The cause of the damage, which can be living or none-living, should be determined before remedial or preventative action is decided upon.

Bleeding to Death?

A liquid running out of a tree raises spectres of imminent death. This perception is based on our knowledge of animals having a finite quantity of blood in their bodies. If the flow of blood from a wounded animal is not stopped quickly, the animal's heart will pump the veins and arteries 'dry' leading to death. ***Trees are different!*** They do not have hearts, veins or arteries, but the plant's parts are interdependent. Also the amount of liquid available to plants is potentially extremely large being the water available in the soil which is periodically replenished principally by rainfall.

Another difference is that trees do not rely on a single organ (lungs) to absorb oxygen and a liquid (blood) in which the oxygen combines with the haemoglobin in the red blood cells to be transported to the extremities of the body where it is needed for muscle movements and other cell activities. Instead a tree is able to absorb air, which includes oxygen, through the leaves, and the bark, including the bark encasing the roots. All parts of the tree are independent of other parts for the supply of oxygen.

So why do trees bleed? Does bleeding affect the tree and how can it be prevented or treated? Does bleeding serve as an indicator of declining health and vigour in a tree? Are there cases where liquid flowing from a tree is not damaging?

Why do Trees Bleed?

A tree is naturally a closed hydraulic system. Water is absorbed from the soil by the roots in a process called osmosis and it moves through the plant to the leaves where a small quantity is combined with carbon dioxide and made into sugars (photosynthesis). The bulk (possibly 99%) of the water absorbed from the soil evaporates from the leaves into the atmosphere - the process of transpiration (Binns 1980).

Movement of water from the soil into the roots, from the roots to the leaves and into the air around the leaves is driven by two 'pumps' - one in the roots and the other in the leaves. These pumps are connected by fine tubes (xylem vessels in broadleaved trees, tracheids in conifers) extending throughout the tree from the roots, through the trunk and branches to the leaves. In many tree species these tubes are visible, through a magnifying glass, in a cross (transverse) section through a twig.

However, water rises up through the tree only in the outer edge of the woody material (the xylem) - probably in a band around a trunk no more than 25mm wide; the rest of the trunk is mainly dead and serves as structural support for the tree. The water, which is called sap, is a solution of mineral salts that have also been absorbed from the soil.

In late winter/early spring the sap is enriched with sugars being transported from storage in the roots to the shoots where they are used to provide energy necessary for shoot growth and leaf expansion.

Osmosis depends on water moving from a weak solution (water and minerals in the soil) through a semi-permeable membrane (the cell wall) into a more concentrated solution (sap in the cells). This process continues until the concentrations of the two solutions are the same. Water entering the roots in this way creates a pressure within the tree which forces water into the xylem vessels which extend up within the tree's trunk. Movement of water up through the plant is assisted by capillary action in the very fine xylem vessels which connect the roots to the trunk, branches and eventually to the leaves.

[1] AAIS, Alice Holt Lodge, Wrecclesham, Farnham, Surrey, GU10 4LH

[2] Formerly Merrist Wood College.

AAIS

THE TREE ADVICE TRUST

Evaporation of water from the leaves is the second pump (a suction pump). This loss of water occurs as vapour through small pores (stomata) that are particularly abundant on the undersides of the leaves. As water evaporates from a leaf more water is pulled into the leaf from the twigs, branches and trunk and ultimately the roots. The leaves will wilt if water evaporating from leaves is not replaced by water absorbed by roots from the soil, as can occur in a period of drought. A prolonged imbalance between evaporation from the leaves and absorption at the roots results in the wilted leaves browning, withering and ultimately dying, so reducing the tree's water needs. In young recently planted trees this could lead to death, but in mature trees a timely rain shower may be sufficient to rehydrate the wilting leaves or at least replenish the soil moisture sufficiently to allow normal root activity to resume.

On warm days, when the air is dry (the relative humidity is low) and a gentle breeze is blowing, evaporation from leaves can be very rapid with considerable quantities of water being drawn through the tree (figures of 1000 litres per day have been quoted for mature Oak trees). But conversely on cool damp days (high relative humidity) with little or no air movement, loss of water to the atmosphere will be slow; it may even stop.

In districts where mists are common the droplets of water forming the mist may be deposited on the leaves of trees and other plants. Such water may aggregate into drops and run drip from the leaf and add to the soil water. However, some of this water may be absorbed into the leaf where it can be used by the tree in photosynthesis.

When the above ground parts of a deciduous tree are leafless during the dormant season, evaporation of water from the tree virtually stops, but roots do not become dormant - whenever the soil temperature rises above freezing roots can be active. In evergreens, shoot growth may cease but water will continue to be lost from the leaves. Roots must be able to absorb water to replace that lost from the leaves. It is important to all types of tree, therefore, that water can move, by osmosis, from the soil into the roots throughout the winter. This movement of water from the soil into roots continues until the weight of the column of water within the tree is the same as the force (osmotic pressure) that can be exerted by the root 'pump' assisted by the capillary force of the xylem vessels.

The resultant pressure of water within the roots ensures that water carrying channels in the tree are full and primed to supply water needed to swell the buds, leaves and shoots as soon as the air temperature rises and shoot growth begins in spring.

Once there is positive water pressure in the tree, damage to the tree, for example as a result of pruning, may release the pressure and allow sap (usually a colourless watery liquid) to escape - the tree will 'bleed' (plates 1 & 2). The flow may continue for many weeks since liquid loss from the wound will release the internal pressure and again allow water to enter the roots from the soil. This process can continue as long as there is water in the soil available to the tree's roots, but it usually stops when there are new leaves on the tree because evaporation from the leaves releases the water pressure within the tree.

Life and Limb

In animals, 'bleeding' is most obvious when wounding breaks the skin. Bleeding following wounding is not inevitable in trees - not all wounds 'bleed' and not all species of tree bleed. For example, evergreen trees are less likely than deciduous trees to bleed from pruning wounds. This is because water evaporates from the leaves of evergreens throughout the year when atmospheric conditions are suitable, as a result the liquid pressure from the root 'pump' is being released through the leaves.

A tree's response to wounding varies with the time of year the wound occurs. In most broadleaved species the serious risk of bleeding is in winter and early spring (December through to April) before the buds open and internal water pressure is high.

As water is carried from roots to leaves in the xylem vessels (in the wood) of the tree a wound that simply removes the bark (a graze) does not lead to bleeding. However with evergreen conifers wounds that have removed the bark but not damaged the underlying wood may result in a flow of sticky resin rather than a watery liquid of sap. This is the tree's attempt to protect exposed wood from attack by fungi and insect pests.

Where damage to the wood breaks the capillaries (the xylem vessels) carrying water to the leaves there can be release of the sap.

The most extreme form of damage is felling the tree. You might expect water to 'fountain' from a freshly cut stump because of pressure from the roots forcing water upwards. That is not the case. In a freshly felled tree the pressure may be sufficient to make the surface of the cut stump 'weep' a clear liquid. (Some time after felling a tree a stump that has been colonised by wood rotting fungi or bacteria may become coated with a coloured or translucent slime.)

The commonest cause of bleeding in broadleaved trees is, therefore, pruning to remove branches - an operation that cuts across the xylem vessels. If winter and early spring pruning of some species is avoided, the risk of bleeding is reduced and the human distress, caused by sight of an apparently unstoppable flow of

Plate 1. Sap dripping from a fresh pruning wound. This may continue until the tree has become fully leafed.

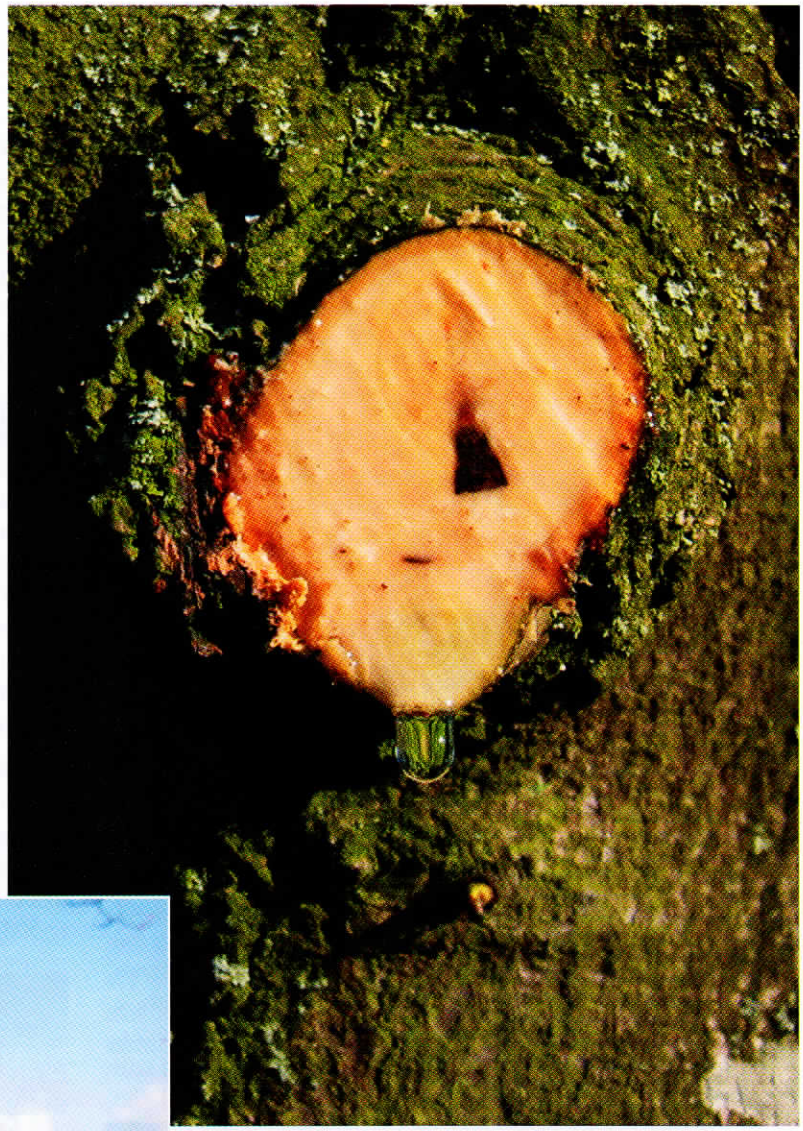

Plate 2. Sap dripping from a fresh pruning wound. The persistant wetness below the wound could kill the bark creating a strip wound.

sap 'bleeding' from wounds, avoided.

Tree species, and a few notable shrubs that are susceptible to bleeding, and also the time of year to prune them to avoid bleeding are listed in **Table 1**.

Bleeding from a pruning wound, indicates that there is life in the roots and positive root activity. However, wounds that become infected with bacteria and/or fungi may produce damaging exudations (plate 3).

Bleeding *per se*, therefore, has little impact on the tree, although if the liquid flow is persistent and runs down the bark of a branch or trunk (plate 4) the bark may be killed. A strip wound will then form but it is unlikely to be visible until the dead bark has fallen off the tree.

Stopping the Flow - Will a Plaster Do?

A natural reaction to having a bleeding tree, and the knowledge that we caused the bleeding, is both concern for the well-being of the tree and a desire to stop the flow - particularly as it may continue for several weeks or even months. Experience has shown that any form of treatment applied to dress or seal a bleeding wound (e.g. paints, bandages or any other form of covering) and so staunch the flow will be displaced by the pressure of liquid in the tree. Even attempting to cauterise the exposed wood with a blow-lamp may only slow the flow of liquid; however, this is not a recommended procedure as the heat will enlarge the wound by killing live tissue around the edge of the wound. As with animals, the flow of liquid following wounding may be beneficial in flushing the damaged tissue and keeping out damaging pathogens (Shigo 1989). Eventually, usually when the buds have burst and the leaves have expanded, bleeding will stop naturally, but avoidance is better than trying to patch over the damage!

Don't prune trees at the wrong time of year!

What About Wounds to Roots?

While there is clear evidence that water moves primarily upwards in the xylem, investigations involving injections into trees have demonstrated that there is some downwards movement in the wood (Tattar and Tattar 1999). Furthermore the work of Insley (1979) on the desiccation of nursery stock demonstrated that water could be drawn out of a tree through roots exposed to drying conditions.

If roots are damaged will water flow out of the tree as occurs when a downspout is unblocked? That does not happen, but there may be some slight weeping in some species at some times of the year. This is likely to be far less damaging to the tree than is the loss of roots!

Weeping Leaves

Early on a summer morning, particularly following a warm, calm humid night, trees may be found with droplets of water on their leaf edges. This is not a

Table 1. Trees and Shrubs Susceptible to Bleeding.

Generally pruning should be avoided during the period January - April, the recommended pruning time is shown.

Common name	Botanical name	Avoid	Recommended pruning time
Beech	*Fagus* species		Late summer
Birch	*Betula* species	Winter - early spring	Late summer - autumn
False acacia	*Robinia* species		mid - late summer
Honey locust	*Gleditsia* species	Spring	mid - late summer
Hornbeam	*Carpinus betulus*	Early spring	Late summer - autumn
Japanese pagoda tree	*Sophora* species	Spring	Late summer
Kentucky coffee tree	*Gymnocladus dioica*	Late winter - early spring	July
Laburnum	*Laburnum* species	Spring	Late summer
Magnolia	*Magnolia* species		Late July - early August
Maples (except Field maple)	*Acer* species	Late winter - spring	Late summer - autumn
Poplar	*Populus* species		Early winter
Sumach	*Rhus* species		Just before leaf fall
Walnut	*Juglans* species	Winter - spring	Late July - early August
Wingnut	*Pterocarya* species	Autumn	Late summer
Climbers			
	Parthenocissus species		December
Vines	*Ampelopsis* species		December

Information extracted from Brown (1977)

result of wounding. It is an indication of excess water pressure within the tree resulting from the soil conditions favouring rapid absorption from the soil while evaporation from the leaves is slow. This occurs during periods of high atmospheric humidity. In areas with a temperate climate the phenomenon, which is known as *guttation*, is particularly associated with species of trees with toothed leaf margins (e.g. willow (*Salix* species), Wych elm (*Ulmus glabra*), ash (*Fraxinus* species), elder (*Sambucus* species). Guttation is more common in tropical plants and can often be seen in some house plants including Phellodendron, the Rubber plant (*Ficus benjamini*) and Swiss cheese plants. Plant cells (hydathodes) forming points at the ends of leaf veins (the conducting tissue of a leaf) are formed into a structure which releases excess water when under pressure. As the day warms the air temperature around the leaves rises, humidity of the air falls and, particularly if a breeze develops, the drops of moisture dry up.

Hidden Damage

Removal of a branch or felling a tree create an obvious wound, which can be identified as the source of 'bleeding'. Other less obvious causes of damage can also result in liquid weeping from a tree and may be useful as an indicator of hidden problems. Exudation from 'hidden damage' can indicate that a tree is in poor health and its physical strength may have been seriously reduced.

Between Wood and Bark

Insects boring into the bark and wood of trees create wounds to which the tree will respond by trying to isolate the cause. In conifers, the tree's defence is to produce resin which may run from holes in the bark created by the insects. This resin solidifies as white 'tears' on the bark. A healthy tree can, in fact, produce sufficient resin to swamp and kill the insect causing the damage. (Amber is fossilised resin and insects may be found trapped in it). Resin tubes form on the bark of Spruce (*Picea* species) damaged by the Giant spruce bark beetle *Dendroctonus micans* (Strouts and Winter 2000).

Bark and wood boring insects are frequently found colonising unhealthy trees (e.g. pine trees (Pinus species) that have been planted into the landscape as semi-mature specimens) (Winter 1991). In such trees the resin defence system may be inadequate to stop the insects causing the damage. Continued insect activity can further weaken the tree. If the trunk is girdled by the tunnelling the beetle will contribute to the tree's death.

Occasionally, conifers may have a copious flow of resin down the bark of the trunk or at the base of main branches. This condition occurs particularly on Douglas fir (*Pseudotsuga menzesii*), but has also been seen on Sitka spruce (*Picea sitchensis*) and Lodgepole and Monterey pines (*Pinus contorta* and *P. radiata*). The cause of this phenomenon is unknown but it can be associated with gradual decline of the tree; it may be drought related but it is non-fungal in origin. (Strouts and Winter 2000)

Resin bleeding can also occur at the base of trees as a result of severe attacks by root pathogens such as Honey fungus (*Armillaria* species) and *Heterobasidion annosum* and may be an indication of advanced butt-rot. On Scots pine (*Pinus sylvestris*) resin bleeding is associated with attack by the Pine stem rust fungus *Peridermium pini*. In this case, the copious resin flow rapidly becomes blackened, the stem is girdled and the top of the tree dies (Gregory and Redfern, 1998). This can be confused with girdling caused by squirrels (*Sciurus* species) on the main stem or branches high in the crown.

Broadleaved trees do not normally bleed from insect damage to the bark. An exception is elm (*Ulmus* species) where trees suffering from Dutch elm disease (caused by *Ophiostoma* species) or drought are attacked by Elm bark beetles (*Scolytus* species), which results in copious flows of sugary sap which attracts wasps, ladybirds and other insects (Gibbs and Greig 1977).

Tarry Spots

On broadleaved trees, particularly Beech (*Fagus sylvatica*), but also Horse chestnut (*Aesculus hippocastsanum*), Oak (*Quercus* species) and Alder (*Alnus* species), black exudations of sap, known a 'tarry spots', occur on the lower trunks. These may be particularly noticeable on trees suffering from water stress, or damage to the roots by pathogens such as Honey fungus (*Armillaria* species). A characteristic feature of the fungus Phytophthora *ramorum*, which has recently been recorded in Britain, causes bleeding tarry spots on the trunks of trees, particularly the Red oaks (*Quercus* species).

Tarry spots on the trunks of declining Oaks may become colonised by Buprestid beetles which themselves can cause extensive damage to the host tree. On Beech the tarry spots may be associated with the Beech bark disease syndrome (Strouts and Winter 2000)

Weeping Cankers & Bacterial Wetwood

Pathogens may also cause exudations to occur through the bark. For example, one symptom of an attack by *Phytophthora cactorum* and *P. citricola* is the

Plate 3. A pruning wound that has become infected with a fungus/bacterium.

Plate 4. A wound may be a single puncture as with the nail holding this number tag. The flow started within minutes of the nail being driven through the bark.

formation of bleeding cankers particularly on Horse chestnuts and Limes (Strouts 1981 and 1995). A similar condition, probably also caused by a bacterium is weeping canker of Caucasian lime (*Tilia* x *euchlora*) (Gibbs 1992). Similarly, bacterial diseases, for example Fireblight (*Erwinia amylovora*) and Cherry canker (*Pseudomonas mors-prunorum*), induce bleeding from stems and branches - a whitish viscous liquid, and an amber coloured gum respectively (Strouts and Patch 2000; Strouts and Winter 2000).

A condition known as bacterial wetwood can also produce watery exudations, some are foul smelling, but others are frothy with a smell of fermentation which attracts insects such as wasps (Rishbeth 1982). These exudations may occur on the trunk or main branches of broadleaved trees, particularly Horse chestnuts, Limes (*Tilia* species) and Elms. This condition is often associated with dieback in the crown of the tree.

The most appropriate action to take for each of these 'hidden damages' should be determined by assessment of the tree as a whole, possible causes of stress, location of the damage and the risk the tree poses to people and property.

Leaves Under Attack

In summer, trees of many species may appear to be creating a mist of fine sticky droplets. This does not constitute 'bleeding' in the sense of the other examples. The droplets are 'honeydew' produced by insects that feed by sucking sap from trees - most noticeably aphids on the leaves, but also woolly aphids and scale insects (e.g. Horse chestnut scale (*Pulvinaria regalis*)) on the thinner bark of branches and trunks. Conifers are also affected by sucking insects (e.g. the Cypress aphid (*Cinara cupressi*) on Leyland cypress which also secrete honeydew.) (Winter 1989)

Honeydew contains small amounts of sugars and a trace of amino acids; the greatest proportion is water (Carter 1992). Evaporation of the water during warm dry weather results in a sticky film forming. Because of the sugars, honeydew is collected by honeybees and made into honey which is as desirable in parts of Europe as is heather honey in Britain!

In the case of honeydew being a problem, control of the responsible insect may be the most appropriate solution, but it is generally impractical on large trees. As honeydew is mainly a very weak sugar solution it can be washed away, while it is fresh, using warm soapy water. However, if honeydew is allowed to persist on a surface it can be colonised by sooty moulds which make the surface look very dirty.

Bleeding - is it Life Threatening?

Sap bleeding from a wound and guttation from leaves are not usually harmful to the tree. Both exudations contain a weak solution of sugars being transported from roots to all parts of the tree (e.g. trunk, branches and twigs) where they are needed if the tree is to grow. However, the quantities of sugar are very small and their loss, even over a period of weeks, should not adversely affect a healthy tree. Repeated wounding, as occurs when birch or maple trees are tapped for their sap (a practice used by wine makers and in the production of maple syrup respectively), could eventually exhaust the store of sugars, the energy reserve of the tree, weaken the tree and contribute to its death.

Damage caused by biotic or abiotic factors is potentially more serious because tissue is being killed and/or destroyed and in extreme cases this could kill the tree or render it unsafe.

So What Should Be Done?

Don't panic! Bleeding from a pruning wound has little direct effect on the health of the tree. The human conscience is usually eased by 'doing something', but nothing can be done practically to staunch the flow of liquid emanating from a wound. The bleeding will usually cease naturally once the tree has flushed into leaf.

Avoidance is better than cure! Make sure that you avoid pruning susceptible species at a vulnerable time **(see table 1)**.

With the exception of guttation and honeydew, other liquid flows from trees are likely to be associated with damage the cause of which should be investigated. If there is doubt about the significance of bleeding and the underlying damage for tree health or safety a specialist arboriculturist should be consulted[3].

[3] A list of arboricultural consultants is available from the Arboricultural Association, Ampfield House, Ampfield, Nr. Romsey, Hampshire, SO51 9PA. Telephone: 01794 368717

References and Further Reading

Binns, W. O. (1980) Trees and Water. *Arboricultural Leaflet No. 6.* HMSO, London.

Brown, G. E. (1977). *The Pruning of Trees, Shrubs and Conifers.* 2nd Edition revised and enlarge by Tony Kirkham 2004. Faber and Faber, London.

Carter, C. I. (1992) Lime trees and aphids. *Arboriculture Research Note 104/92/ENT.* Forestry Commission, Farnham.

Gibbs, J. N. (1992) Bleeding canker of Caucasian lime (Tilia x euchlora). *Arboriculture Research Note 111/92/PATH.* Forestry Commission, Farnham.

Gibbs, J. N. and Greig, B. J. W. (1977) Some consequences of the 1975-6 drought for DED in South England. *Forestry Vol. 50* (2).

Gregory, S. C. and Redfern, D. B. (1998) Diseases and disorders of Forest Trees. *Forestry Commission Field Book 16.* TSO, London.

Harris, R. W. (1999). *Arboriculture. Integrated Management of Landscape Trees, Shrubs and Vines.* 3rd Edition, Prentice Hall, New Jersey.

Insley, H. (1979) Damage to broadleaved seedlings by desiccation. *Arboriculture Research Note 8/79/ARB.* Forestry Commission, Farnham.

Rishbeth, J. (1982). Bacterial Wetwood. *Arboriculture Research Note 20/82/PATH.* Forestry Commission, Farnham.

Shigo, A. L. (1986). *A New Tree Biology Dictionary.* Shigo and Trees, Associates, New Hampshire.

Shigo, A. L. (1989). *A New Tree Biology.* 2nd Edition, Shigo and Trees, Associates, New Hampshire.

Strouts, R. G. (1981). Phytophthora Disease of Trees and Shrubs. *Arboricultural Leaflet No. 8.* HMSO, London.

Strouts, R. G. (1995). Phytophthora Root Disease. *Arboriculture Research Note 58/95/PATH.* Forestry Commission, Farnham.

Strouts, R. G. and Patch, D. (2000). Fireblight of Ornamental Trees and Shrubs. *Arboriculture Research and Information Note 151/00/ARB.* The Tree Advice Trust, Farnham.

Strouts, R. G. and Winter, T. G. (2000). Diagnosis of Ill-Health in Trees. *Research for Amenity Trees No. 2.* (Second Edition) TSO, London.

Tattar, T. A and Tattar, S. J. (1999) Evidence for the downward movement of materials injected into trees. *Journal of Arboriculture Vol. 25* (6)

Winter, T. G. (1989) Cypress and Juniper aphids. *Arboriculture Research Note 80/89/ENT.* Forestry Commission, Farnham.

Winter, T. G. (1991) Pine shoot beetles and ball-rooted semi-mature pines. *Arboriculture Research Note 101/91/ENT.* Forestry Commission, Farnham.

ACKNOWLEDGEMENTS

Sincere thanks are offered to colleagues, Trustees of the Tree Advice Trust and members of Forest Research staff who have entered into discussions and commented during the preparation of this Note.

ISSN 1358 - 8249