



Arboriculture Research Note

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ELMS RESISTANT TO DUTCH ELM DISEASE

by D A Burdekin and K D Rushforth [Revised by J F Webber, Pathologist, Forest Research¹]

Summary A brief history of elm breeding research and its current status is described.

Background

1. Dutch elm disease was first recorded in a number of European countries after the First World War and there is now evidence that the disease may have originated in the Himalayas where it appears to have a low incidence of damage. By the 1940's, in Britain, the disease had declined to the point of only causing occasional 'flare ups', and was regarded largely as an endemic problem of little importance. However, in the late 1960's a new epidemic developed causing devastation on a scale far greater than before; it also caused enormous damage elsewhere in Europe, southwest and central Asia and in North America.
2. It is now clear that the Dutch elm disease fungus responsible for the first epidemic differs in many respects from the form of the fungus responsible for the later epidemics, in particular the latter has turned out to be much more aggressive. The causal agent of the two epidemics is now recognised to be two separate species: *Ophiostoma ulmi* (formerly known as *Ceratocystis ulmi*) responsible for the first epidemic in the 1920/30s and *Ophiostoma novo-ulmi*, the cause of the current pandemics.
3. Few tree species rivalled the elms (English elm (*Ulmus procera*) in southern Britain, and Wych elm (*U. Glabra*) in the north, but also a number of varieties) in their versatility and impact on the landscape. Elms were particularly used in streets and parks in coastal towns because of their high tolerance to salt spray. Thus over the years there has been a demand for elms resistant to the disease leading to the establishment of selection and breeding programmes in a number of countries. The earliest breeding programme started in the Netherlands in the 1930's and the Dutch have since played a major role in elm breeding. Similar programmes have also been established in North America, the former USSR and Italy. As a high level of resistance to the Dutch elm disease pathogens is present in some Asiatic elms, such as *Ulmus pumila* and *U. parvifolia*, these species have often been hybridised with the susceptible European and North American elms in an attempt to combine resistance with familiar tree form.

In Europe, the fungus has an effective vector in the form of the native Elm bark beetles (*Scolytus scolytus*, and *S. multistriatus*) which lay their eggs under the bark of weakened and sickly Elm trees. Adult beetles emerging from a tree infected with Dutch elm disease carry the fungal spores and introduce them into the twigs of other, usually healthy trees during a period of maturation feeding. The fungal spores 'germinate' and the fungus blocks the xylem by growing in the vessels of the

wood and the characteristic symptoms of the disease (yellowing, wilting and withering of leaves leading to early leaf fall, and the presence of ‘shepherd’s crook’ formations at the ends of the dead twigs) develop. The infected tree is thus weakened and rendered attractive to adult beetles as breeding sites. Repeated infections by the fungus can debilitate and eventually kill mature trees.

Infections by *Ophiostoma ulmi* have tended to develop through the host tree fairly slowly with periods of recovery when incidents of reintroduction of the fungus into a tree is scarce, because of weather conditions or a failure of the beetle population. However, the more aggressive strain of the fungus (*O.novo-ulmi*) was introduced to Britain it is thought from North America proved capable of killing mature trees in a single season.

In some areas few mature Elm trees have survived, probably as a result of geographic isolation. In hedgerows many suckers have grown from roots and although these young trees appear to have resistance to Dutch elm disease there is no scientific evidence to confirm it as English elms originate in Britain vegetatively from root suckers. These have genetic compositions identical to the parent tree that was lost to the disease.

Dutch breeding programme

4. The first resistant cultivar, ‘Christine Buisman’, was released in 1936 and was a selection of *Ulmus carpinifolia*. It was a failure as it was found to be susceptible to the Coral spot fungus (*Nectria cinnabarina*) which can cause severe cankering. Its growth rate and wind resistance also were unsatisfactory. This highlighted the need for breeding programmes to take account of additional factors, such as resistance to other diseases and climatic influences, form and appearance, in addition to selecting for resistance to Dutch elm disease.
5. Two further cultivars were released in the 1960s. ‘**Commelin**’², a cross of *U. x hollandica* ‘Vegeta’ with *U. carpinifolia*, was considered to be suited to rural situations, fast growing, well shaped and with moderate resistance to diseases and wind damage. ‘**Groeneveld**’ (*U. carpinifolia* x *U. glabra*) also has desirable characters but its slower growth made it more suited to urban conditions. Within a few years of their release both cultivars were being grown on a wide scale in Holland. They were introduced in relatively small numbers into other European countries, including Britain.
6. The Dutch breeding programme received a setback in 1973 when the aggressive form of Dutch elm disease that we now know as *O. novo-ulmi* was identified in Britain and then in other European countries. It soon became clear to British and Dutch scientists that ‘Commelin’ and, to a lesser extent, ‘Groeneveld’, were susceptible to *O. novo-ulmi*. The Dutch programme was re-appraised and other promising elm clones and hybrids were tested against the aggressive form of Dutch elm disease.
7. In 1975 three new clones were released to the Dutch nursery trade. Unlike the earlier releases, which were derived from elms of wholly European origin, the new clones included a Himalayan elm *U. wallichiana*, in their parentage. *U. wallichiana* is a large, rough leaved

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² For details of availability of clones named in this Note see Appendix 1.

elm, related to *U. glabra*. The three clones were 'Lobel', 'Dodoens', and 'Plantijn'. These all have the same female parent, first cross of *U. glabra* 'Exoniensis' x *U. wallichiana*.

'Lobel' is a fastigate, small crowned, small leaved tree, somewhat similar in appearance to the fastigate hornbeam (*Carpinus betulus* 'Fastigiata'). It is resistant to sea winds. The male parent is a self-crossing of *U. x hollandica* 'Bea Schwarz'.

'Dodoens', which is a self-pollated seedling of the *U. glabra* 'Exoniensis' x *U. wallichiana* cross, is a strong, fast growing tree reminiscent of 'Exoniensis' in appearance.

'Plantijn' is a fast growing tree with a broad erect branched crown. The branchlets and leaves are somewhat greyish. It is very tolerant of sea winds. The male parent of this clone was a seedling from a cross between two selected *U. carpinifolia*.

More recently, a fourth Dutch clone '**Clusius**' has been released which has the same parents as 'Lobel', but a slightly greater degree of resistance to Dutch elm disease than the other three clones. Its appearance is similar to 'Lobel' but it has larger leaves and better diameter growth, with good resistance to wind damage.

8. All four clones are moderately resistant to Dutch elm disease caused by *O. novo-ulmi*. They are more resistant than 'Commelin' and probably very similar to 'Groeneveld'. All require some pruning in their formative years to produce a clean stem and to develop a good crown.

North American breeding programmes

9. To find a replacement for the American white elm (*U. americana*), breeding programmes have been established at various centres in the United States and Canada. Several clones have been released so far.

'**Sapporo Autumn Gold**' was a seedling from open pollination of *U. pumila* in Japan. There is little doubt, following detailed testing and experimentation at the University of Wisconsin, Madison, that it is an F₁ hybrid of *U. pumila* with *U. japonica* (Syn. *U. davidiana* var. *japonica*). It can reach 12 m in height within 15 years and forms a densely foliated upright vase shaped crown. Small trees, i.e. whips, tend to become rather 'bushy' and so careful pruning is necessary in the early years to produce a clean stem. Mature leaves are deep green turning pale yellow in autumn, hence the name.

'**Regal**' was also selected at Wisconsin and has a similar level of resistance to 'Sapporo'. It is derived from a pollination of 'Commelin' with *U. pumila* x *U. carpinifolia* 'Hoersholmiensis' (of Danish origin). 'Regal' has an upright, columnar form, slightly resembling 'Commelin'. Apical dominance is said to be very strong and its upright form may make it a suitable choice for urban planting.

10. The same breeding programme has released the 'American Liberty' elms described as a multiclone variety which comprises six clones with similar phenotypes, suitable for use in urban areas.

'**American Liberty**' elms have been derived from controlled pollinations between parents with some resistance to *O. novo-ulmi*. The original parent trees were the survivors of more than 60,000 American elm seedlings collected from many locations over the northern range of *U. americana* and tested for resistance to Dutch elm disease. 'Liberty' elms are hardy trees with an upright vase shape and vigorous growth habit. Leaf size, shape, bark texture and colour are generally typical of North American white elm. Although they show moderate resistance to Dutch elm disease their resistance to *O. novo-ulmi* is inferior to 'Sapporo Autumn Gold'.

11. Over the years, at least ten hybrid elms have also been released from the breeding programme of the US National Arboretum, Washington DC. Probably the best known amongst these are 'Urban elm', 'Homestead' and 'Pioneer', while the most recent releases are 'Valley Forge' and 'New Harmony'.

'**Urban elm**' is a selection from a cross between an early Dutch hybrid of *U. hollandica* 'Vegeta' x *U. carpinifolia* and the Siberian elm (*U. pumila*).

'**Homestead**' is a cross between *U. pumila* and a complex hybrid of two Dutch elms, (*U. hollandica* 'Vegeta' x *carpinifolia*) x *U. pumila* x *U. carpinifolia*). It has rapid growth, produces a pyramidal crown, and has excellent tolerance to environmental stresses so performs well in city conditions. It also has a high level of resistance to *O. novo-ulmi*.

'**Pioneer**' is the result of a hybrid cross between two European elm species (*U. glabra* x *U. carpinifolia*). Its globe shaped crown is dense and provides deep shade. It is somewhat less resistant than 'Homestead'.

'**Valley Forge**' and '**New Harmony**' are both America elms resulting from a 20 year intensive programme of screening and breeding *U. americana*. They have high levels of disease resistance although neither is 'immune' to Dutch elm disease; 'Valley Forge' is slightly more resistant of the two. Both cultivars have an upright, arching crown with a full dense leaf canopy. Suitable for urban plantings, recreation and industrial parks, these cultivars were being propagated in the USA with the expectation of a wider release in the next 3-5 years. These cultivars are not currently available in Britain – see Appendix).

12. In the early 1980's the Canadians released three selections of *U. japonica* named 'Jacan', 'Thompson' and 'Mitsui Centennial' with adequate hardiness for use in the prairie regions of central Canada.

'**Jacan**' elm is a selection with an attractive crown form and possible suitability for urban locations.

'**Thompson**', is a single trunked tree with a vase-shaped crown and strong wide angled crotches. The mature bark is dark grey and fissured while young twigs are greenish-brown above and lighter beneath, sometimes corky protuberances develop.

'**Mitsui Centennial**' is considered to be superior to 'Jacan' in disease resistance but similar in appearance.

Appraisal of the clones

13. There are now a number of elm clones available with varying degrees of resistance to Dutch elm disease. However, most of them do not have the familiar appearance and form of the elms that once dominated the British countryside before the ravages of Dutch elm disease. Since 1980, trial plantings of various new elm clones produced by both the American and Dutch breeding programmes have been laid out in several EC countries. These plantings enable the characteristics of selections to be assessed, e.g. crown shape, foliage, resistance to frost and to attack by elm bark beetles (*Scolytus* sp.) and other insects, while growing under differing site conditions. The main trial in Britain is situated at Westonbirt Arboretum, near Tetbury, Gloucestershire, where replicated plots of the four Dutch clones, planted in 1980/81, are to be found. There are also trial plantings of the Dutch clones and American selections at the Forest Research Station, Alice Holt Lodge.
14. Although some of these clones have a high level of resistance to Dutch elm disease, they are not immune. If a tree does become diseased there may be dieback in part of the crown, and this may develop from year to year so that eventually the tree is killed. Also, since it is too early for a full judgement to be made on the suitability of these elms to British conditions, it

would be unwise to plant large numbers of them, especially in single blocks or avenues. Instead, they could be used in conjunction with other genera in mixed planting schemes.

Further Information.

Brasier, C. (1997) New Horizons in Dutch Elm Disease Control. In *Report on Forest Research 1996*. Forestry Commission, Edinburgh.

Gibbs, J. Brasier, C. and Webber, J. (1994) Dutch Elm Disease in Britain. *Research Information Note 25*. Forestry Commission Farnham, Surrey.

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Appendix to:

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Suppliers offering clones named in this Note (June 2005).

Clone	Supplier	Clone	Supplier
'American Liberty'	Not offered	'New Harmony'	Not offered
'Christine Buisman'	Not offered	'Pioneer'	Not offered
'Clusius'	3, 9 and 12	'Plantijn'	4
'Commelin'	3 and 4	'Princeton'	11
'Dodoens'	1, 2, 3, 4, 5, 8, 9 and 13	'Regal'	Not offered
'Groeneveld'	3 and 4	'Sapporo Autumn Gold'	6
'Homestead'	Not offered	'Thompson'	Not offered
'Jacan'	Not offered	'Urban Elm'	Not offered
'Lobel'	2, 4, 7, 8, 10 and 11	'Valley Elm'	Not offered
'Mitsui Centennial'	Not offered		

Supplier

- Ardcarne Garden Centre, Ardcarne, Boyle, Co. Roscommon, Ireland. Tel: 07196 67091
Fax: 01796 67341 ardcarne@indigo.com
- Barcham Trees Plc., Eye Hill Drove, Cambridgeshire, CB7 5XF Tel: 01353 720748
Fax: 01353 723060 e-mail: sales@barchamtrees.co.uk
- Belwood Trees Ltd., Brigton of Ruthven, Meigle, Perthshire, PH12 8RQ Tel: 01828 640219
Fax: 01828 640623 e-mail: belwood@belwoodtrees.co.uk
- Brian Lewington, 9 Meadow Rise, Horam, Heathfield, East Sussex, TN21 OL2 Tel/Fax: 01435 810124. e-mail: BHLewington@aol.com
- Buckingham Nurseries, 14 Tingewick Road, Buckingham, MK18 4AE Tel: 01280 822133
Fax: 01280 815491 e-mail: enquiries@buckingham-nurseries.co.uk
- Dingle Nurseries, Welshpool, Powys, SY21 9JD Tel: 01938 555145 Fax: 01938 555778 e-mail: kerry@dinglenurseries.co.uk

7. Dulford Nurseries, Cullompton, Devon EX15 2DG Tel: 01884 266361 Fax: 01884 266663 e-mail: dulford.nurseries@virgin.net
8. Goscote Nurseries Ltd., Syston Road, Cossington, Leicestershire, LE7 RUZ Tel: 01509 812121 Fax: 01509 814231 e-mail: sales@goscote.co.uk
9. Hellier Nurseries Ltd., Ampfield House, Ampfield, Romsey, Hants, SO51 9PA Tel: 01794 368733 Fax: 01794 368813 e-mail: carolineswam@hellier.co.uk
10. James Coles and Sons (Nurseries) Ltd., The Nurseries, Thurnby, Leicester, LE7 9QB Tel: 0116 2412115 Fax: 0116 2432311 e-mail: sales@james-coles-nurseries.co.uk
11. Knoll Gardens, Hampreston, Staplehill, Nr Wimborne, Dorset, BH21 7ND Tel: 01202 873931 Fax: 01202 870842 e-mail: enquiries@knollgardens.co.uk
12. Specimen Trees, Highlegh Estate Office, Highlegh, Knutsford, Cheshire, WA16 0QS. Tel: 01925 755204 Fax: 01925 756559
13. Walnut Tree Garden Nursery, Flymoor Lane, Rocklands, Attleborough, Norfolk, NR17 1BP Tel: 01953 488163 Fax: 01953 483187 e-mail: info@wtgn.co.uk

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Suppliers offering clones named in this Note

- ‘American Liberty’** Not offered
- ‘Christine Buisman’** Not offered.
- ‘Clusius’** Not offered
- ‘Commelin’** Brian Lewington, 9 Meadow Rise, Horam, Heathfield, East Sussex
TN21 OL2
Tel/Fax: 01435 810124 e-mail: BHLewington@aol.com
- ‘Dodoens’** Walnut Tree Garden Nursery, Flymoor Lane, Rocklands,
Attleborough, Norfolk NR17 1BP
Tel: 01953 488163 Fax: 01953 483187
e-mail: info@wtgn.co.uk
- Ardcarne Garden Centre, Ardcarne, Boyle, Co. Roscommon, Ireland.
Tel: 07196 67091 Fax: 07196 67341
e-mail: ardcarne@indigo.com
- Buckingham Nurseries, 14 Tingewick Road, Buckingham MK18
4AE
Tel: 01280 822133 Fax: 01280 815491
e-mail: enquiries@buckingham-nurseries.co.uk
- Goscote Nurseries Ltd, Syston Road, Cossington, Leicestershire LE7
4UZ
Tel: 01509 812121 Fax: 01509 814231
sales@goscote.co.uk
- Brian Lewington – See ‘Commelin’
- ‘Groeneveld’** Brian Lewington – See ‘Commelin’
- ‘Homestead’** Not offered
- ‘Jacan’** Not offered
-

‘Lobel’	Dulford Nurseries, Cullompton, Devon EX15 2DG Te: 01884 266361 Fax: 01884 266663 e-mail: dulford.nurseries@virgin.net
	Goscote Nurseries Ltd, see ‘Dodoens’
	Brian Lewington – See ‘Commelin’
‘Mitsui Centennial’	Not offered
‘New Harmony’	Not offered
‘Pioneer’	Not offered
‘Plantijn’	Brian Lewington – See ‘Commelin’
‘Regal’	Not offered
Spporo Autumn Gold’	Dingle Nurseries, Welshpool, Powys, Wales SY21 9JD Tel: 01938 555145 Fax: 01938 555778 e-mail: kerry@dinglenurseries.co.uk
‘Thompson’	Not offered
‘Urban Elm’	Not offered
‘Valley Elm’	not offered

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