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THE MAX JACOBS INFLUENCE – A PERSONAL ACKNOWLEDGEMENT

E.H. Bunn

When I retired from the Forest Research Institute, I had cause to acknowledge three men who had had a marked influence upon my forestry career. The first, and earliest, of these was Dr Maxwell Jacobs, dating back to my student days at the Australian School of Forestry. My acknowledgement to him at the function was brief; I merely credited him with having "engendered a spirit of enquiry" which was to stand me in good stead during my subsequent career, both as a forester and as a research administrator. Now I have been given the opportunity to pay him due tribute.

Firstly a little about Max Jacobs, the man. He had a varied career in Australian forestry, initially as a forester, then as a silvicultural researcher, followed by a long term as lecturer in silviculture and Principal of the Australian Forestry School, and finally as a top forestry consultant. Obviously, he was a man of many parts but it was his role as researcher and "professor" that I wish to concentrate on. He was a mild mannered man, kindly, friendly and unpretentious. Students could relate to him easily. His striking qualities were his enquiring mind, the simplicity of his presentations, and his infectious enthusiasm for his subject. In the natural world he took nothing for granted; there had to be a reason for the way leaves hang the way they do, how and in what circumstances eucalypts shed their branches, and why some flitches 'pinch' during sawing whereas others 'spring'. His pursuit of answers to questions like these culminated in his book "The Growth Habits of the Eucalypts" which is a masterpiece of its type. He did somewhat similar research on the branching habits of *Pinus radiata* but this work unfortunately is not so well known.

To me, he personifies the good silviculturist: "a person with the ability to observe, and to make intelligent deductions based on those observations" – his own definition. His approach was that an understanding of the mechanisms which control the regeneration and growth of trees is fundamental to determining appropriate and efficient means for managing them. This principle is exemplified in his book, the last chapter of which is entitled "the effect of growth habits on the treatment of Australian eucalypt forests". Australia at that time had limited experience with growing eucalypts in plantations, so unfortunately he didn't write a corresponding chapter on growing eucalypts artificially. This is the topic I intend to cover, applying his principles.

ENRICHMENT PLANTING WITH EUCALYPTS

When I returned to New Zealand, there appeared to be little scope for doing any work on eucalypts. The genus was not the flavour of the month in official circles, as past Forest Service experience with eucalypt plantations had been unfortunate, to say the least; wrong species on the wrong sites and managed in the wrong way. It transpired though that my first assignment was the rehabilitation of cut-over indigenous forest that had been selectively logged for podocarps, leaving a depleted matrix of mostly rainforest hardwoods. Previous efforts had

concentrated on enrichment planting with shade tolerant exotic conifers, planting *Thuja plicata* and *Cryptomeria japonica* in the smaller gaps and Douglas fir in the larger clearings. It was a great battle, however, to get such slow-growing species established in competition with the rampant second growth. Furthermore, the approach was wrong; if successful it meant partial replacement with exotic conifer rather than rehabilitation of native forest. The management need was to restore a high forest canopy which had previously been provided by the emergent podocarps, preferably using a light canopied nurse which would provide shelter for the shade-tolerant rain forest species and allow them to regenerate. The forests were remote, so a minimum cost, low input solution was required, one virtually confined to spot planting immediately after logging.

To succeed the species used was required to be:

- fast growing to outstrip the second growth;
- of good form when spot planted at wide espacement;
- have a light canopy so that rainforest species could survive and regenerate beneath it;
- be relatively long lived to provide continuing shelter for the second stray hardwoods;
- be unable to regenerate successfully in competition with the native species, to ensure it doesn't have weed potential;
- provide a useful timber at maturity should the opportunity arise to use it.

There was only one genus with these characteristics that I knew of. The parallels with Max Jacobs' enrichment of selectively logged eucalypt forest were obvious. After seeing the good form of isolated pole eucalypts growing in forest gaps and how rainforest replaced eucalypt forest in the transition zones when fire was excluded, eucalypts were a logical choice. Initial trials soon proved the point, *E. delegatensis* planted in logged podocarp – beech forest looking particularly at home.

Establishing that eucalypts could play a role for enrichment planting opened the way for a broader assessment of their potential for supplying some of our future sawn timber requirements.

GROWING EUCALYPTS FOR SAWLOGS

Worldwide, eucalypt plantations now cover more than four million hectares in over 90 countries. Several of the species planted widely overseas are known primarily as sawn timber in Australia, but that is rarely the case elsewhere. Growers seem so dazzled by their fast initial growth rate and high volume production on short rotations that the bulk of the planted resource is regarded as fuelwood, roundwood, chips or fibre, and is managed accordingly.

The situation in New Zealand is different. Our established pulp and paper industry is based on softwoods and appears to have little desire to change. Our roundwood and fuelwood requirements are also largely provided by softwoods, so there are practically no profitable market outlets for small diameter eucalypts. Clear sawn timber or veneer though is a different proposition. Various conferences and seminars that have examined New Zealand's future wood needs have established

that we shall be short of clear strong timbers, and appearance grade timbers, a niche which eucalypts could help to fill if they are grown and processed in the appropriate manner.

Priority was given to establishing that timbers cut from New Zealand grown trees are comparable with their Australian counterparts, and that the sawing and seasoning methods used by Australian processors are applicable here. There has been a strongly entrenched opinion that New Zealand grown eucalypts were markedly inferior, the assumption being "that they grow too fast". Only one small group among the farm foresters had a good word for them.

When I followed up reports of good sawing and good usage I found there was one common denominator – the timber had been cut from a large tree, usually fairly open grown with a short trunk and large crown. This clearly indicated that tree size was of greater importance than rate of growth in determining how the log would behave during sawing. Any adverse effects of fast diameter growth could be accommodated, provided the final crop trees were grown to a sufficiently large diameter. This was confirmed by subsequent sawing trials on trees of varying diameter selected from the same stand, where all the trees were of the same age, same seed origin, probably planted the same day by the same man. The larger the tree, the fewer the problems that were encountered in sawing, the higher the conversion factor, and the higher the proportion of quarter sawn boards and dressing grade timber. It was concluded that growth stress problems during felling and sawing are much more associated with log diameter than with growth rate or age, a small old tree reacting much worse than a big young tree.

BASIC GUIDELINES FOR SAWLOG REGIMES

Normal plantation practice for eucalypts has not varied markedly from that adopted for conifers. Relatively close initial spacings have been accepted, so thinnings must be envisaged if sawlogs are to be the end product. Unfortunately due to lack of market outlets, these thinnings have usually not been done. Fifty years later the end result is tall pole-like trees which may look good but are not much joy for the sawmiller.

It is certainly not a regime one could recommend to a small private grower, the sector most interested in growing something a little different from *Pinus radiata*. It's a case for going back to basic principles, in this instance the growth habits of the eucalypts that were so clearly demonstrated by Max Jacobs. Applying his findings, we get the following scenario.

1. Growth stress problems in sawing decrease in significance as log diameter increases. As the corewood of a large eucalypt will have compression failures, allow for a 20cm defect core to accommodate the brittle heart zone and knotty core.
2. Quarter sawing is favoured for veneer because of its more attractive grain. It also reduces shrinkage and face check problems during seasoning. Because of the need to box out the defect core, logs need to be of large diameter to quarter saw them effectively.
3. Emphasis should be placed on maintaining diameter growth. A broad relationship exists between the diameter of the stem and the diameter of the crown known as the stem: crown ratio. For good stem diameter increment to be maintained, the stem: crown ratio should not drop below 1:15.
4. Eucalypts are space demanders as they are crown shy – their crowns do not interlock. When crowns touch they abrade and can become uneven, causing trees to lean and to produce tension wood. Crop trees, therefore, should be evenly spaced to ensure they can develop balanced crowns.
5. If planting at wide spacing, select species that have good apical dominance to ensure straight stems.
6. The self-pruning mechanism in eucalypts works most effi-



Harry Bunn giving the Max Jacobs oration at the 1991 ANZIF Conference at Christchurch.

ciently for branches under 2.5 cm diameter. In self-pruned branches, the relationship between the diameter of the branch and the radius of the knotty core is 1:3. Thus if the defect core is to be restricted to 20 cm, branch size should not exceed 3 cm.

7. Gum veins detract from the value of sawn timber, so avoid circumstances and operations that can lead to their production (fire, bark, bruising, bark borers, defoliation, exposure).

An appropriate silvicultural regime is one that attains its end objective as efficiently as possible. From the scenario above, it is possible to visualise the target final crop tree and stand. The end objective in this instance is to grow the crop trees as rapidly as possible to around 75 cm diameter at a stocking of around 80 stems per hectare. Although Max Jacobs didn't directly apply his findings to growing plantations, I recall him saying that we should grow eucalypts like kauris, with columnar boles and broad crowns, rather than like spar trees. He was referring to the difficulty in natural forests of getting eucalypts that have good apical dominance to break crown. The same difficulty occurs when eucalypts are planted too densely in plantations.

In the direct sawlog regime, the situation is reversed. The main question is to decide the length of clear bole to aim for, and the best means to attain it. The self-pruning mechanism operates in part for open grown saplings and poles but steep angled branches tend to persist. If not assisted, open grown trees will have very short boles and large knotty cores, the opposite extreme to the spar tree. If we are to exploit the rapid diameter growth potential of eucalypts we require means for controlling branches over the length of the veneer or sawlog component of the crop trees.

1. A simple method is a modification of the cut-over forest enrichment technique. Where a suitable scrub nurse exists, like *Leptospermum*, it's a simple matter to create small canopy gaps at approximately final crop espacement (11

m), creating "light wells" for planting. The usual practice has been to plant two or three seedlings in each light well, reducing to the best in each gap at the sapling stage. Optimum scrub height is 8-10 m. Young eucalypts have proved to be much more shade tolerant than we had anticipated, particularly those which display their leaves horizontally. The self-pruning mechanism works perfectly until the leader emerges from the scrub. From that point they are virtually free growing, forming a balanced crown above a clear bole. The same technique is equally applicable to more shade tolerant species such as *Acacia melanoxylon*.

2. If no suitable nurse crop exists, the light well approach can still be adopted using a companion species, preferably one which has a dense crown and established market outlets for small diameter logs. A dense crown casts more side shade, containing the branches of a eucalypt more effectively than another eucalypt would. The object is to bring the eucalypt from behind, exploiting its fast initial growth rate and ready response to fertilisers. It should be co-equal with the companion species as a small pole and emergent by the time the canopy level is 15-18 m. From this point, the companion species can be removed, either entirely or in part, having done its job of stem cleaning the eucalypt.

The companion species obviously needs to be of slower initial growth and established in advance – how far in advance depends on relative growth rates. In New Zealand, *P. radiata* has been a logical companion species to use because of its dense crown and ready marketability. Various spatial arrangements have been tested. The most successful was pine groups of four trees planted at final crop centres, with a eucalypt planted in the centre two years later. There is evidence that the eucalypt benefits from the association with pine, perhaps partly from the suppression of weed growth and partly through obtaining higher levels of nutrients from the pine litter. Alternatively, slower growing more shade tolerant species like *Cupressus macrocarpa*, *C. lusitanica* or Leyland cypress could be used, aiming in this instance to carry some of the cypress right through the rotation as a second tier beneath spaced eucalypt standards. Hypothetically, the benefits to improving form should be mutual, the cypress helping to draw the eucalypt up initially, and the spaced eucalypt standards subsequently performing a similar function for the cypresses. There are indications that it will work but the concept has been inadequately tested.

3. If disposing of thinnings is a problem, the obvious approach is to avoid the need for them altogether, obtaining an intermediate yield if possible from other sources. For a pastoral farmer, the obvious other source is grazing. Eucalypts established at a final crop stocking of 80 s/ha are not going to fully occupy the site for at least half the rotation, so if they are established in pasture, there is opportunity for continued grazing. The open crown structure and vertically hanging leaves of most species are added advantages in maintaining grass growth.

If two or three seedlings are planted in a tight group at final crop centres, with subsequent reduction to the best sapling per group, a reasonable allowance has been made for misadventure or management slop. There must be a commitment on the grower's part to annual individual tree care until the desired bole length is attained. Pruning is not as labour demanding as it is for pines but should still be done annually to control branch size and ensure a small knotty core. Steep angled branches in particular should be removed because they are the ones which develop and persist. Pruning is best done in dry weather during the winter to reduce the risk of fungal infection of the stubs.

These approaches to growing eucalypt sawlogs are a far cry from the traditional plantation management of eucalypts elsewhere, yet I think you will agree they are quite logical, at least for the small grower, knowing the growth habits of the genus.

Many of the techniques and concepts developed for eucalypts were subsequently applied effectively to *P. radiata* silvicultural practice. The concept of defining the mean final crop tree and its grade outturn led to the direct sawlog regime which forgoes any production thinnings, which in turn led to agroforestry with pines using spaced cuttings. The pruning of pines and vegetative propagation from cuttings were two topics on which Max Jacobs did pioneer research over 50 years ago.

Speaking personally, I was taught to observe, to question and to deduct by the example of Max Jacobs, and this was the legacy which he passed on to me. Prior to going to Canberra, I thought I knew a lot about trees, having majored in Botany and spent several years in the Forest Service. When I returned I realised how much I hadn't seen or comprehended. A second legacy was that, through his work on growth habits, he influenced me to define specifically in terms of shape, size, properties and grade outturn the target tree we planned to grow. With that image in mind, it is much easier to evaluate silvicultural options and rationalise practice.

The fact that fortuitously I was in a position to direct silvicultural research in New Zealand for many years meant that "The Max Jacobs Influence" flowed through into the FRI research programme. He could claim also to have contributed significantly to an earlier form of C.E.R. – not closer economic relations but closer educational relations – which I believe has been very beneficial to forestry in both New Zealand and Australia. Surely this joint meeting of two Forestry Institutes is a reflection of it.

Max Jacobs, I'm sure, is with us in spirit.

Chilean presentation for Wink Sutton

In November, Dr Wink Sutton was invited to Chile to give an address at Expocorma, an exposition of forestry and wood processing equipment held about 20km south of Concepcion.

The exposition was organised by Corma, which is the Chilean equivalent of the New Zealand Forest Industries Council and represents both growers and processors of wood.

Wink's address covered a range of topics dealing with *radiata* and the environment and as he spoke, it was simultaneously translated into Spanish.

During the exposition, Corma presented to Wink, in appreciation of his contribution over the past decade to Chilean forestry, a very attractive wooden carving.

The tree featured on the Corma logo is that which New Zealanders know as The Monkey Puzzle. In Chile, it is called Araucarian Pine (*Araucania araucana* – a close relative of our own Kauri). The Monkey Puzzle was once a common tree in Chile, but its desirable wood properties and the demand for farmland has resulted in nearly all the natural stands being felled. It is now a protected species.
