THE GENUS EUCALYPTUS—ITS PAST AND ITS FUTURE IN PACIFIC FORESTS.

By N. W. JOLLY.

The genus *Eucalyptus*, though represented by a few species in the Phillipines, Java, Timor, New Guinea, New Britain and New Ireland, may almost be said to be peculiar to Australia, and from a forestry standpoint is the main characteristic of the woodlands and forests of the Commonwealth of Australia. Although a limited number of species has been proved to be of value for the production of oil from the foliage and of tannin from the bark and wood the importance of the genus lies in the quality of the timber and firewood produced, and, in the case of a few species, of the large volume yielded per acre in a comparatively short period. The outstanding characteristics which made the genus famous were the great strength and durability of the timbers yielded by certain species, but nevertheless the range in quality and character of the various timbers is very wide. Some of the best known species, such as *regnans* and *gigantea* yield non-durable and comparatively light woods, specially suitable for cabinet work and all indoor purposes, as well as for packing cases and, more recently, for the manufacture of wood pulp and paper on a large scale.

Because of divergence of opinion amongst botanists and also of the necessity for still further investigation in the less known parts of Australia, the number of species cannot be stated with accuracy, but it is approximately 500 and between them they are adapted to an extremely wide range of climatic and soil conditions. From the sub-alpine regions of the south-eastern highlands of the continent and of Tasmania, to the northern tropical latitudes and to the deserts of the interior, and on soils varying from fertile volcanic to arid limestones and sands, eucalypts of one species or another are to be found. They may form forests of gigantic trees, sometimes up to or over 300 feet in height, as in the *E. regnans* forests of Victoria and Tasmania and the karri forests of the south-west of Western Australia. On the other hand they may reach heights of only a few feet, as in the low mallee scrubs of the extensive dry belts of the continent. A natural corollary to the extremely wide range in forest conditions and climate associated with the numerous species is the correspondingly wide variation in their rates of height and diameter growth and in their annual volume increment. Their rates of growth may range from almost negligible figures to the hundreds of cubic feet per acre per year yielded by such fast growing species as *E. pilularis* and *E. grandis* of New South Wales and Queensland, *E. regnans* of Victoria and Tasmania, and *E. diversicolor* of Western Australia. What has not been generally appreciated, however, even in Australia itself, is that the exceptionally high rates of volume production, recorded for a few
species in the most favourable localities, should not be taken as typical of the eucalypt forests of Australia, even when the dry mallee scrubs are excluded. Instead of being measured in hundreds, the average volume increment of the natural forest areas should rather be recorded in tens of cubic feet per acre per year.

It may be accepted as a rough generalisation that an annual rainfall of 40 inches or more is necessary for the continued luxuriant growth of eucalypt forests in their native habitat. Where the rainfall falls below 30 inches, as is generally the case in districts inland from the coastal ranges, one frequently sees a sclerophyllous savannah type of forest, which, though frequently yielding durable timber of special value, shows a comparatively low volume increment. Moreover, even in the coastal regions of higher rainfall, changes in soil conditions from the lower slopes and gullies to the rocky sterile ridges are associated with a marked deterioration of forest growth. Millions of acres of coastal forest on unsuitable soils must therefore be classified with the inland forests as being of relatively low yield capacity. A further limitation is set to the extent of forests of the highest quality in the coastal zones by the adverse influence of very high rainfall, or of moderate rainfalls associated with the most fertile soils. An annual rainfall exceeding 60 inches, or an average of only 50 inches on rich soils, encourages the growth of temperate rain forests in Tasmania and Victoria and of semi-tropical and tropical jungle in the northern latitudes of the eastern coast, particularly if the favourable conditions are associated with freedom from fire hazard. It is not unusual in New South Wales and Queensland at the present time for eucalypt forests to be invaded by evergreen jungle species, and examples may be seen, where, after the lapse of centuries, the original eucalypts are represented only by the gaunt trunks of the old dead trees. It may not be stated with certainty however, that the few million acres of tropical jungle and temperate rain forest, which existed before the arrival of the white man, had replaced the original eucalypts, for, over comparatively large areas of jungle, no remnants of eucalypts are now to be seen. Nevertheless the evidence quoted above indicates that the intrusion occurring in places at the present time may possibly reflect the happenings of the past.

General Silvicultural Characteristics.

Leaving out of account the low mallee scrubs of the dry belts and dealing only with those species which form timber yielding forests or woodland, one finds that certain characteristics are common to most species of the genus, viz:

1. Their foliage is of the sclerophyllous type, able to withstand wilting during periods of drought of greater or less duration, but transpiring large quantities of water when it is available.

2. Juvenile leaves differ from those of the adult stage, in that the former are less sclerophyllous and form a dense forest canopy,
giving excellent soil cover. With increasing age the canopy opens, the adult leaves being frequently borne only towards the ends of the branches, so that the entry of wind, light and heat is facilitated, while the development of inflammable xerophytic undergrowth may be permitted.

3. Leaves frequently contain essential oils, which unfortunately increase their inflammability and, with the circumstances mentioned in (2), may result in forests which are amongst the most inflammable in the world.

4. According to the old European classification of trees into shade-bearers and light demanders, eucalypts must be classed generally as strong light demanders. From the standpoint of reproduction, however, seeing that lack of moisture in the surface soil is of greater importance than the light shade cast by old trees and is frequently the principal factor governing regeneration in Australia, the term “intolerant” is probably more applicable to the genus.

5. Most species naturally form a main central stem without the necessity for dense stocking. Close stocking may in fact be disadvantageous in that it promotes the development of long whippy stems, the crowns of which trash one another unduly. Ample crown space is necessary for the most healthy and vigorous growth, and closer stocking in old age may in fact be attained if a lighter stocking in youth has permitted the development of strong stable trunks less subject to wind away.

6. That the reproductive power of the genus is strong is evident from the fact that, notwithstanding the frequency and severity of the forest fires which have ravaged Australian forests for generations, the eucalypts still persist except where they have been destroyed in the interests of settlement.

7. The main factor assisting in resistance of seedling growth to fire is the development in most species of ligno-tubers just below the surface of the soil. These tubers are very tenacious of life and enable the young plant to send forth new shoots after the killing of the main stem by fire or other causes. (An extreme form of ligno-tuber is the “mallee” root which, from lands being cleared for wheat, provides Australia’s best household firewood). Such species as do not develope ligno-tubers have, as compensation, very high powers of reproduction from seed, e.g. *E. pilularis* and *E. gigantea*.

8. Although very old stumps may not send forth vigorous stool shoots, reproduction by coppice from the sapling to pole stages is generally strong, notable exceptions, however, being *E. gigantea* and *E. regnans* which must be classed as non-coppicing species.
9. Reproduction from seed varies greatly, not necessarily on account of inherent qualities, of the different species, but rather because of the climatic conditions under which they grow. The seed is light and readily distributed from the crowns of large trees on which the seed vessels open during hot periods of dry weather. Germinative capacity is high and given a good seed bed, such as is provided by ground fires, and suitable moisture conditions, the seedlings readily establish themselves and make vigorous growth.

10. Seed years may be expected at intervals of from one to four years, according to species, while there is a similar variability amongst the species in the abundance of the seed crop.

11. Absence of seedling growth may be due, apart from deficiencies in seed supply, to lack of soil moisture, because of unfavourable climatic conditions or the drying effect of existent vegetation, or, in the inland areas particularly, to grazing by rabbits, sheep and other grazing animals.

Forest Types.

The light demanding characteristic of the genus and the open nature of the forest canopy naturally give rise to enquiries by foresters concerning underwood and associated genera, but in these respects again there is a wide variation. Owing to the excessive demands made by the genus on soil moisture when it is available, it may be accepted that, the drier the soil the more scanty is the underwood, regardless of the nature of the canopy, and that, except on the most favourable sites, the undergrowth is of a xerophytic nature.

Inland Types.—In the inland forests of the eastern states eucalypts are quite frequently found mixed, either singly or in groups, with species of Casuarina and Callitris and an undergrowth of low shrubs or grass. The demands made by settlement on Casuarina for domestic firewood has greatly reduced the stand of this genus in many localities, while Callitris, the white ant resistant house building timber of the inland has been heavily exploited in the larger sizes. The associations still persist, however, as a guide to the future, though the silvicultural value of the associations is not yet understood.

The most widely distributed species of the inland forests is the red gum, *E. camaldulensis* (rostrata), which is found bordering rivers and creeks almost universally and in the river flats adjoining the Murray and its larger tributaries forms extensive forests. These forests, though frequently carrying trees of poor form, are of high value on account of the very durable timber yielded. *E. racemosa* (crebra), the principal inland ironbark of the eastern states, extends from the latitude of Dubbo in New South Wales northerly to North Queensland, yielding a very durable timber specially suitable for poles,
piles, girders and railway sleepers. Associated with it in the southern part of its range are two other ironbarks, *E. nubilis* (*siderophloia var. glauca*) and *E. sideroxylon*. These three species may also intrude into the drier regions occurring at intervals in the moister coastal zone. Southward from Dubbo *E. sideroxylon* extends into Victoria and is associated with two boxes, *E. microcarpa* and *E. melchiori*, which besides yielding durable timbers are esteemed by apiarists on account of the superior quality of the honey obtained from the flowers.

No reference to inland eucalypts, however cursory it may be, should omit the occurrence near the Kalgoorlie gold mines of West Australia of species such as *E. salmonophloia*, *E. salubris* and *E. longicornis*. They have been the main source of timber and firewood for the mines for over 50 years, and are unique in Australia, and perhaps in the world, in that they reach heights up to 100 feet, though very high summer temperatures are common and the average annual rainfall is only about 10 inches, and extremely erratic and uncertain at that. Soil conditions are however particularly favourable. Other species of the inland zone in Western Australia, occurring in a rainfall of about 20 inches, include *E. wandoor*, valuable for its very durable timber, and *E. astringens* the bark of which is rich in tannin.

**Coastal Type.**—With increasing rainfall in the coastal zones, the upper storey of eucalypts may be associated in the northern half of the continent with their allied genera *Tristania* and *Syncarpia* towering over a second storey of species of *Casuarina*, or lower underwood of xerophytes amongst which *Acacia* may be well represented. Alternatively, coarse grasses and bracken may cover the forest floor to the exclusion of other growth, though it is not unlikely that this last condition is not natural but rather a result of periodical burning undertaken originally in the interests of rough grazing for cattle.

Ordinarily, over the great part of Australia, forest humus in eucalypt forests is conspicuous by its absence, the harsh dry leaf litter merging abruptly into the mineral soil. In the moist coastal zone, however, the more fertile gullies and richer plateau soils, which are less subject to fierce fires, encourage the development of an understorey, not of xerophytic species but rather of soft leaved trees, and in Victoria and Tasmania of a luxuriant growth of tree ferns, etc. This understorey gives rise to the production of humus and better forest conditions than obtain elsewhere, seeming to indicate that, under long continued fire prevention, the silvicultural status of much of the eucalypt forest might be radically altered. Incidentally, it is of interest to note that in this highest type in Queensland and New South Wales the allied genera *Tristania* and *Syncarpia* with the very valuable *Eucalyptus microcorys* attain their best development. As mentioned earlier this type may represent nature's transitional stage from eucalypts to the climax evergreen jungle. The number
of species in this moist coastal zone, which includes the south-west of West Australia and then extends from Tasmania to North Queensland, is naturally large, and only a few of the most important can be mentioned. For the most part they grow in mixed forest, giving relatively low yields of each individual species; but, where *E. diversicolor* in West Australia and *E. regnans* in Tasmania and Victoria occur in almost pure forest, the acreage yields from virgin forest may be very high and far in excess of those obtained elsewhere in Australia. Volumes of individual trees of these species have not infrequently been measured in thousands of cubic feet, and they share the honour of being Australia's proudest specimens of the genus.

In West Australia however, the most important and widespread species is *E. marginata*, which may occur in pure forest or mixed with *E. calophylla*, *E. diversicolor* and other species. Silviculturally *E. marginata* is probably the most difficult of all the important eucalypts, due in some measure to the lateritic soils upon which it occurs and its tendency to poor form and crown deterioration.

In Tasmania and Victoria *E. obliqua* ranks next to *regnans* and is the most important species of the lower altitudes, while *E. bicostata* attains fine development in the Otway forests of the south of Victoria. They all have strong powers of reproduction from seed and are amongst the fastest growing species of the genus. The timbers of these three species are widely used for house building, but that of *regnans* is in special demand for flooring, panelling and cabinet work, while in recent years it has become the chief source of supply for paper manufacture, comprising writings and printings, wrappings and newsprint, in three separate factories.

Northerly from the Victorian border through New South Wales into Queensland, under subtropical influences and with the heaviest rainfalls occurring in late summer and autumn, the number of species of interest to forestry in the Pacific increases. For rapid growth *E. grandis*, *pilularis* and *resinifera* are in the first rank, but for strength and durability of its timber *E. paniculata* is unrivalled, though the rate of growth and reproductive capacity of the last-named are inferior to many of its associates.

Other northern species of special value for durability and suited to warm humid climates are *E. propinqua*, *E. triantha* (*acmenioides*), *E. carnea* and *E. gummiifera* (*corymbosa*) all of which, though they prefer the best forest soils, are adapted to growth on the drier harder ridges. An additional species, *E. siderophloia* is an ironbark which is of special interest because of its suitability for shallow clay soils on which other species are unhappy.

*E. maculata* is a tree of more than ordinary interest in that it has a wide range in the coastal zone from Victoria to Rockhampton in central Queensland, and at the same time extends over the Dividing Range in southern Queensland to the drier inland districts. It is a hardy species and regenerates well on dry soils, though its rate of growth is relatively slow. It yields an excellent all-round timber for
house building and is specially in demand for tool handles and carriage construction, but is not durable in the ground. The chief fault of the timber is the susceptibility of the sapwood to attack by the powder post borer.

The most attractive species, silviculturally, of all eucalypts of the east coast is *E. microcorys*, which carries the best crown and provides the densest forest cover of all its associates. Climatically it has a wide range, ascending to altitudes where light snowfall may be experienced in winter. It produces well from seed and grows moderately rapidly, yielding a good all-round hardwood, though inferior to *E. paniculata* in strength. It is very durable as poles, piles and sleepers and the sawn timber is favoured above all others for flooring.

*E. deglupta* (*naudiniana*), though not an Australian species, deserves special mention for the benefit of those interested in the growth of timber in tropical islands of the Pacific. It was brought under notice and interestingly described by Lane-Poole in his report on *The Forest Resources of the Territories of Papua and New Guinea*, to which those interested are referred. That it attains a height of over 230 feet and a girth of over 20 feet clearly indicates its possible future value in tropical latitudes.

**Mountain Type.**—In the State of New South Wales between the moist east coast and the drier inland zone lies a stretch of higher country ranging from about 2,000 to 7,000 feet in altitude and subject to varying amounts of snowfall. At the highest elevations tree growth is absent, but from about 5,000 feet downwards the forest growth of eucalypts has a special interest. Until comparatively recent years these forests were drawn upon for limited timber supplies only, and were considered of more value for cattle grazing and for relief country for sheep from drought-sticken inland districts. The rainfall varies from about 30 to 50 inches and produces a heavy growth of coarse grass with scattered underwood under eucalypts which may reach very large dimensions, and whose importance has increased rapidly of recent years. These mountain species yield timbers of no mean value, though generally of the lighter and less durable kinds, such as *E. obliqua, andrewsi, campanulata, fastigata, dalrympleana, paniculiflora, robertsoni* and *gigantea*. The last-named, *Eucalyptus gigantea*, is of more than ordinary interest in that it forms pure forest of the best mountain type and yields almost the softest eucalypt timber of all, specially suited for all indoor purposes. In New South Wales its greatest development is attained above an altitude of 3,000 feet, and it extends also into the highlands of Victoria and Tasmania, where it occupies larger areas. *E. robertsoni* of the high mountain regions of New South Wales and Victoria may be compared silviculturally with *E. microcorys* of the northern coast, in that it carries an even closer and denser crown than the latter. It is sometimes associated with
*E. gigantea*, these two species forming an attractive mixed forest, with the thin crowned and faster growing *gigantea* dominant.

**Management of Eucalypt Forests.**

Although forest and timber reserves have been in existence in Australia for generations it is only during the last 30 to 40 years that serious attempts have been made to bring them under management. Such control over timber cutting as was practised in earlier years was restricted to regulating the girth of trees below which felling was not authorised. Frequently however a more effective restriction on the cutting of sawmill logs was the size below which cutting was not considered by sawmillers or cutters to be payable. On the other hand if the demand was for the strongest and most durable timbers in the shape of poles, piles and hewn girders the girth limits were lowered accordingly.

The result was that the stocking of the most durable species whose intermediate sizes were taken for poles and piles, was most seriously affected, whereas, in the case of less durable species used only for sawmilling, many larger trees remained standing and provided a reserve for future cutting. In addition considerable quantities of timber of species not then in demand, together with overmature trees of the more favoured species, were left. As happens generally in all new countries, exploitation was followed by fires and more fires, causing malformation of younger stems and stimulating the growth of epicormic branches on the trunks of the older trees. Fortunately, however, most eucalypts are hardy, and only with sensitive species like *regnans* and *gigantea* were forests killed out over considerable areas.

The nett result, when foresters had to face the question of forest management, was that they had to deal with forests of mixed species, sizes and qualities, greatly deteriorated, it is true, but still forests capable of being restored. There was no question of introducing any special silvicultural system known or thought to be suitable to any or all eucalypts, but rather the first steps of rehabilitation and protection. The forests generally were understocked with seedling and sapling growth and overstocked with overmature trees, the intermediate sizes being represented in greater or less proportions, with many malformed stems amongst the smaller poles. In addition a proportion of the stand would consist of mature trees of species which, though not then marketable, had an undoubted future value. As the drying effect on the soil of old overmature trees frequently prevents the establishment of seedlings, these had to be utilised if possible or destroyed by ringbarking, while young malformed stems were cut back to ground level to encourage vigorous coppice growth. All healthy trees of intermediate sizes, together with unwanted species of good form, were strictly preserved, except where thinnings in dense groups was necessary, the complete work thus combining regeneration fellings and thinning operations. At the same time the boundaries of
each compartment defined by natural features and roads were treated as firebreaks, all debris being stacked and burned. The continuation of these simple measures through every compartment in turn of each state forest naturally led to the adoption of the system of selection by groups, which, given effective fire protection, has been shown to be suitable to the type of mixed forest common in the moist coastal regions of Australia. It undoubtedly resulted in the preservation of much middle sized and older growth to provide a useful yield in the next cutting cycles, whereas clear fellings with a view to establishing even aged crops would have entailed heavy sacrifice. This selection system has a special value also in that its flexibility is necessary for the satisfactory management of forests of mixed species of greatly varying development. The rapid change in quality from the lower slopes to the stony ridges of any one compartment means the production of large mill timber on the one hand and of comparatively small poles on the other, and it is thought that no other system is so well adapted to effective management under such changing conditions of quality and species. Moreover it enables the forester, by varying the density of the openings and by retention of suitable seed trees, to favour the reproduction of the more valuable species, which might otherwise be ousted by those which are more aggressive.

As opposed to the uneven aged system introduced into the mixed hardwood forests of New South Wales and later into the more or less pure forests of *marginata* in West Australia, consideration must be given to the value of an even aged system for forests composed mainly of one species. Such species include, amongst others, *regnans* in Victoria and Tasmania, *E. pilularis*, *racemosa* and *maculata* in parts of New South Wales and Queensland, *obliqua* in New South Wales, Victoria, Tasmania and South Australia, *camaldulensis* of the inland river flats, particularly of the Murray and its tributaries, and *E. diversicolor* and the very valuable *E. marginata* of the south-west of West Australia. This system requiring as it does an almost complete clear felling—except for the retention of a small number of seed trees per acre—may entail a heavy sacrifice of younger trees in some cases. In virgin forest, however, especially where reproduction of eucalypts has been prevented by a dense understorey, no great sacrifice may be involved, and the system having the definite advantage of simplicity makes a strong appeal, provided always that complete fire protection is assured.

Unfortunately the density of sapling growth following such treatment is generally very great, involving early and heavy thinning at considerable expense. Where a large market for small sizes exists, as for instance pit props, a useful financial return may be obtained, but, otherwise, this "wheat field" type of regeneration may result in greatly increased costs of tending. As mentioned earlier adequate crown space is essential to the best growth of eucalypts, and thinnings should be early and frequent, entailing, in the case of the less durable species, a large output of small sizes, for which in the past the mining
industry has provided the only large market. Possibly the continued expansion of the hardwood pulp and paper industry will finally provide the financial solution to the problem of high costs of thinning the dense stands of even aged regeneration. With such fire-sensitive and non-coppicing species as *regnans* and *gigantea* the fire protection of large areas of young even aged crops assumes the first importance. Fierce fires during early youth may destroy the young crops completely and necessitate the re-stocking of the land by sowing or planting, whereas with forests of mixed species and ages something may be saved from the wreck. Unfortunately the fire-sensitive eucalypts during an Australian summer of intense heat and raging dry winds provide the most difficult problem with which Australian foresters are faced.

Speaking generally, it may be said that the complex question of effective management of eucalypt forests in the future is vitally connected with the development and growth of industries and population, with which must surely come an appreciation of the importance of forests and forestry. Problems of management which caused many heartburnings thirty or forty years ago, are gradually becoming less difficult as the demand for smaller sizes and for species formerly un-saleable increases, and, within another generation the whole position will probably have been transformed. It is already evident, however, from the sketchy survey above that forestry thought concerning silvicultural practice in Australia must be directed to the century old forestry problem of older countries, namely, the choice between even and uneven aged systems. In New South Wales and Western Australia some of us were forced by the circumstances of our time to adopt an uneven aged system, but in other places and different conditions even aged forest has made a greater appeal. As yet, however, forestry practice is still in its infancy in Australia, and the most that has been done has been to lay the foundation for future development.

**Eucalypts in Plantations.**

Seeing that Australian forestry relies mainly on the natural regeneration of eucalypts, it is not surprising that acreage figures of growth in plantation have been derived chiefly from countries other than Australia. Such figures, being not infrequently the results from plantations in comparatively small areas on selected sites, may well give a false impression of what is to be expected from large areas of country with variable soil conditions. Sowing and planting have of course been practised in natural forest areas in Australia for the purpose of filling up blanks and favouring selected species, and remarkable rates of growth in early years, comparable with figures from abroad, have been recorded. For example, Victorian reports mention the growth of *regnans* from planting to a height of 50 feet in 5 years. Broadcast sowing of *E. pilularis* on Fraser Island,
P. radiata, Whakarewarewa Forest. Natural regeneration 8 months after thinning and pruning. Trees in foreground attacked by Sirex and killed.

Photo: State Forest Service
Queensland, produced in three years a crop with a maximum height of 40 feet and a maximum d.b.h. of 7 inches. Small plantings of *E. grandis* in New South Wales yielded trees with a height of 70 feet in 4 ½ years, in all cases the climatic and soil conditions being most favourable.

On the other hand the experience gained in South Australia, which is the least timbered state in Australia and where efforts were made over 70 years ago to establish eucalypt plantations, should serve as a warning against undue optimism concerning the results to be obtained from planting in unfavourable climates. In areas north of Adelaide with a rainfall, mostly in winter, of slightly over 20 inches, plantations were established on stiff fertile soils following thorough cultivation, which encouraged vigorous growth in the early years. Various species were used, and *E. globulus* from a humid climate and *E. cladocalyx*, a dry country species, gave the best results. Sample plots measured at near 30 years of age showed average annual increments for *globulus* of 200 cubic feet on a moist bottom down to 23 cubic feet on a dry site, while *cladocalyx* ranged from 100 cubic feet downwards, on the drier areas. The highest figures were of course eminently satisfactory, as far as figures go, but the condition of the plantations was decidedly the reverse, the majority of the trees being stagheaded and fast deteriorating, indicating beyond doubt that long sustained growth of eucalypt forest under such conditions could not be obtained. The best of those plantations were utilised and are now only a memory, but, as showing the difference between growth of single trees and growth in forest, one isolated *globulus* 70 years old is still to be seen with a girth at breast height of 17 feet—though with a barrel of less than 10 feet in length.

It is perhaps necessary to emphasize that for the production of timber of high quality, the very rapid growth recorded under artificial conditions is not desired in Australia. Brittle heart is frequently an objectionable fault in eucalypts, so much so that it has become standard practice in some states, when mill logs of certain species are measured, for a deduction of 4 x 4 inches to be allowed for brittle heart, even when the logs are apparently sound. Not infrequently the central core has decayed and left a pipe which may be hollow and infested with white ants. The faster the growth in early youth the greater may be the diameter of this brittle heart, which is of course useless in itself for structural purposes though it may at times be enclosed in sections of large dimensions. Reports from other countries emphasize also the unsatisfactory behaviour of logs cut from plantation-grown eucalypts on account of their tendency to serious checking and quartering after felling and crosscutting. This feature is well known in Australia, particularly in the case of small fast grown trees, but is much less serious with trees of large dimensions grown under natural conditions. Associated with it are the curvature troubles with which benchmen in sawmills are faced, and also those which skilled timber hewers have to overcome when engaged in the
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hewing of rectangular girders. It would appear that the favourable conditions under which eucalypts have been grown overseas have intensified the faults common to the species in their own home, and those desirous of studying the question are specially referred to the intensive studies made by M. R. Jacobs and detailed in Bulletins 23, 25 and 28 issued by the Commonwealth Forestry and Timber Bureau, Canberra.

The unsatisfactory results obtained in South Australia from planting eucalypts in a hot dry climate should not discourage foresters in other countries if their climatic conditions are satisfactory. Given annual rainfalls of 40 inches and more, the genus provides an excellent choice of species for the production of large volumes of timber for miscellaneous uses in comparatively short rotations. Only time can tell whether or not they will maintain good forest growth over several rotations in their new homes, but for over 100 years in Australia they have certainly stood up to as harsh treatment from both nature and man as one could expect any species of trees to bear. If specially fast and long sustained growth is desired, then reasonably fertile and well drained soils are required, but moderate results can be obtained on poorer and harder country if the right species are chosen. Cultivation before planting is very effective in ensuring that the young plants make a good start; also the use of plants in tubes assists in obtaining a good “take,” the moisture retained in the tubes being a reserve against dry weather following plantings. In the days when planting was practised in South Australia, small plots of the common reed, *Arundo donax*, were always maintained near the nurseries for the supply of tubes.

A special word of warning is given concerning the correct specific names and the variability of the species of the genus. Strangely enough some of the extraordinary rates of growth recorded from overseas plantations have been obtained from a species which has almost the most restricted range of any eucalypt, viz. *E. globulus*. This species, which occurs under maritime influences in the moister regions near Hobart, Tasmania, is thought not to be natural to the mainland of Australia. Another species, found in Victoria and the southern highlands of New South Wales and once thought to be *globulus*, is now known as *E. bicostata*, and it is not impossible that the seed of the latter may once have been unwittingly supplied for the former. Also much divergence of opinion amongst botanists has been caused by apparent variations in species throughout their wide distribution. For instance, *E. grandis* is found from the Hawkesbury river, near Sydney, to as far north as the divide between the Atherton and Evelyn Tablelands in North Queensland—a range of 1,000 miles. *E. obliqua* which occurs from the border of New South Wales and Queensland to Tasmania, has a similarly wide range, and it would not be surprising therefore if the local variations were responsible for much uncertainty and conflict of opinion in these as well as in other species.
The botanical names of species mentioned in this paper are taken from the most comprehensive publication available, viz.: Blakely’s *Key to the Eucalypts*, published in 1934. In some cases they are different from those formerly in common use, and, where that is so, the older specific names have been shown in parenthesis. Blakely draws particular attention to the protean nature of the genus, and foresters requiring seed would be well advised to obtain supplies from sources, the climatic conditions of which are reasonably close to those prevailing in their own countries.

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**ECOLOGICAL INVESTIGATIONS IN THE NOTHOFOGUS FORESTS IN NEW ZEALAND**

By J. T. HOLLOWAY.

Within recent years there has been a growing awareness of the fundamental importance in the national economy of the *Notohofagus* forests of New Zealand, not only in connection with problems of timber production but perhaps to an even greater extent in connection with the conservation of our soil and water resources. It has been necessary, therefore, to re-examine these forests in order that, so far as possible, management and conservation policy may be based upon a sound understanding of their ecology. The problem is no simple one and will not be capable of easy resolution. The *Notohofagus* forests—and I use the plural not to stress the fact that many separate areas of forests are being dealt with but to emphasise the point that many distinct types of forest, many distinct forest associations must, be recognised—are developed in regions with an annual rainfall as high as two hundred and fifty inches, or as low as twenty-five inches. They are found as coastal forests or at the limits of tree growth in the mountains. They occur as swamp forests or on dry mountain slopes surrounded by tussock grasslands. Five species of the genus *Notohofagus* are present and the forest in any locality may contain these species in any combination or in any proportion from mixed forest in which all five are represented to areas where a single species forms a simple consociation. And again there may or may not be an admixture with podocarp species or with hardwood trees more characteristic of the podocarp forests. I might emphasise the complexity of the structure of these forests by stating that over a restricted area in the Western District of Southland upwards of fifty

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