



Flora Technical Note No. 12:

Management of gene flow from plantation eucalypts



The Flora Technical Note Series provides information for Forest Practices Officers on flora management in production forests. These technical notes are advisory guidelines and should be read in conjunction with the requirements of the Forest Practices Code.

Technical notes can be accessed on the Forest Practices Authority's website: www.fpa.tas.gov.au.

1. Introduction

Eucalypt species are often capable of cross-pollination within related groups. Such crossing, termed hybridisation, can result in viable hybrid offspring. Such hybrids are sometimes observed in nature or in seed collected from native trees where compatible species naturally co-occur. Hybridisation is a natural process and has played a role in the evolutionary history of eucalypts. Nevertheless, hybridisation can be problematic when the natural distribution of a species is greatly extended by human activities.

Pollen dispersal from exotic eucalypt plantations in Tasmania creates the potential for hybridisation and exotic gene flow into native eucalypt populations. This issue has been the subject of research conducted by the University of Tasmania and the Co-operative Research Centre for Forestry. Such exotic gene flow could impact on the genetic diversity and integrity of native eucalypt populations, particularly in the case of rare species (e.g. *Eucalyptus perriniana*) or fragmented populations (e.g. *E. ovata*). When dominant organisms such as trees are involved, hybridisation may not only affect the tree population but could have broader consequences for biodiversity, due to the diverse plant and animal communities that trees support.

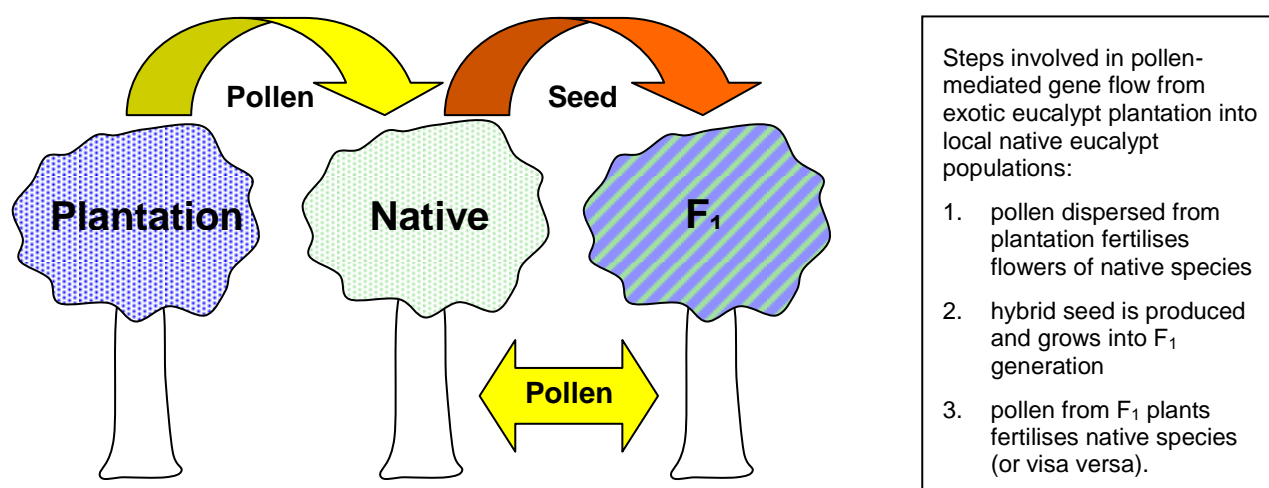
The expansion of the Tasmanian hardwood plantation estate to over 200 000 ha using *E. nitens* or genetic races of *E. globulus* some of which are not native to Tasmania (Strzelecki Ranges, Otway Ranges and Furneaux races), exposes many native Tasmanian eucalypt populations to the potential impacts of hybridisation and gene flow from non-native species or populations. While it may take many decades or even centuries for the full impact of such hybridisation to be seen due to the long-generation cycle of eucalypts, research in this area is on-going and seeks to establish the extent to which hybridisation is occurring, how vigorous new hybrid combinations may be in the wild, as well as identifying priority areas, populations and species for monitoring.

This technical note provides the following information for forest industry planners and others – bold text indicates topics of particular relevance to Forest Practices Officers (FPOs):

- the process of hybridisation and possible risks of exotic gene flow (*Section 2*)
- **which Tasmanian eucalypts are most susceptible to hybridisation with non-local plantation species based on current research findings** (*Section 3*)
- **how to identify exotic eucalypt hybrids** (*Section 4*)
- current and future lines of research and how forest planners and others can let researchers know of relevant observations and locations for potential monitoring sites (*Section 5* – plus appended record sheet)
- **assessment and management of the risks of gene flow from eucalypt plantations** (*Section 6*).

2. The process of hybridisation and exotic genetic flow

Plant species introduced for agricultural, forestry and ornamental purposes, as well as weeds, can all act as potential sources of foreign genes which can invade native populations. Such invasion may occur through seed or pollen dispersal. While seed-mediated gene flow is generally a process involving dispersal and regeneration, pollen mediated gene flow requires successful hybridisation. If the first generation hybrid offspring (referred to as F_1 hybrids) grow and flower, they may be able to back-cross with the native species again, leading to an on-going mixing of non-local and local genes. Hybridisation between local and non-local species (or populations) and subsequent back-crossing is sometimes referred to as 'genetic pollution' or 'genetic contamination'. At one extreme, particularly with small native populations, this process could result in the loss of reproductive capacity where hybrids are unfit or, if not, the complete genetic replacement of the 'pure' native species through reproductive swamping by the more abundant introduced species or population. At the other extreme, it has been argued that such hybridisation may provide the genetic diversity that small, genetically depauperate native populations need to better adapt to their environment.



Hybridisation is influenced by a range of factors (see Potts *et al.* 2003). Where there are strong reproductive barriers, reproductive isolation between two species may be complete. At the other extreme, two normally geographically separated species may be completely reproductively compatible and when they come in contact a high proportion of hybrid progeny may be produced at the expense of pure species offspring. Hybridisation has been observed to occur between many eucalypt species, thus creating the potential for genetic contamination to occur when exotic eucalypt plantations are established. Fertilisation of flowers in native eucalypt populations by pollen from non-local eucalypts is of particular concern because pollen can travel much greater distances than seed.

The extent to which gene flow will occur into native Tasmanian eucalypt populations as a result of pollen movement from exotic eucalypt plantations will depend upon the species and locations involved. The factors that appear most significant are:

- the relative quantity of exotic vs. native species pollen (i.e. plantation vs. native population size)
- the distance over which exotic pollen is dispersed by animal pollinators
- levels of flowering synchrony between the exotic and native species
- cross-compatibility of the two species
- the establishment and growth of first and later generation hybrids.

The following section of this technical note attempts to summarise what we currently know about the above factors for various Tasmanian eucalypt species.

3. Tasmanian eucalypts susceptible to hybridisation with plantation species

Both natural and artificial hybridisation has been documented within subgenera of eucalypts. However, hybridisation has not been recorded between the subgenera in Tasmania (i.e. *Symphyomyrtus* and *Eucalyptus* [ex. *Monocalyptus*]); this provides the first example of reproductive isolation that will act as a complete barrier to gene flow from plantations. The two hardwood plantation species used in Tasmania, *E. nitens* and *E. globulus*, are both from subgenus *Symphyomyrtus*; the 12 native species belonging to subgenus *Eucalyptus* are therefore not at risk. The potential for gene flow from plantations exists for the 17 Tasmanian native *Symphyomyrtus* species unless there are other barriers leading to reproductive isolation.

Flowering time and other reproductive barriers that make some *Symphyomyrtus* more susceptible to hybridisation with plantation species than others are summarised in Table 1 for *Eucalyptus nitens*. The susceptibility of native *Symphyomyrtus* species to hybridisation with *E. globulus* is yet to be closely examined in Tasmania, but one naturally regenerating site has been identified with 80 exotic *E. globulus* x *E. ovata* hybrid seedlings in Victoria (Barbour et al. 2008). Hybridisation between *E. globulus* and *E. ovata* at some sites where their ranges naturally overlap has been observed in Tasmania. Although *E. globulus* is a Tasmanian species, its range has been expanded in lowland areas of the state through its use in plantations and amenity plantings. Because these plantings may have used non-native provenances (i.e. from Victoria and Flinders Island) the potential not only exists for exotic hybrid combinations to arise outside the natural range of *E. globulus*, but also within its range there is potential for exotic intra-specific gene flow.

Exotic hybrids between *E. nitens* and *E. ovata* have already been observed establishing in areas adjacent to hardwood plantations in the wild – research findings about this hybrid combination are summarised in the text box on page 5 of this technical note. Seedlings suspected to be hybrids of *E. nitens* crossed with native *E. viminalis* have also been observed in the wild, but their hybrid status is yet to be confirmed through genetic analysis.

Naturally pollinated seed collected from native trees of *E. rodwayi*, *E. archeri* and *E. perriniana* in proximity to *E. nitens* plantations has also been shown to contain a low frequency of *E. nitens* hybrids. These seeds have the potential to establish in the wild if a suitable recruitment event occurs.

The next stage of research to help assess the risk and consequences of exotic hybridisation aims to determine how exotic hybrids can establish in the wild and survive to reproductive maturity.

Please inform the FPA Biodiversity Program if you find a suspected exotic hybrid seedling.

Some species may be apparently susceptible to hybridisation (based on flowering time overlap and successful fertilisation through artificial pollination) but in fact are at low risk of hybridisation in the wild due to their distribution not overlapping with the current (or likely future) distribution of plantations (e.g. high altitude species such as *E. vernicosa* and localised dry habitat species such as *E. morrisbyi*).

Due to the diversity and number of steps involved in the establishment of viable hybrid offspring, reliably *predicting* the extent and scale of exotic hybrid establishment takes considerable research and time. The *identification* of exotic F₁ hybrid seedlings in the wild, on the other hand, can be done relatively easily as research has provided a good understanding of the morphological characteristics of the hybrids. In addition, molecular genetic markers are being developed to provide further verification of any that are identified.

Exotic eucalypt hybrids from some Tasmanian native eucalypt species have been confirmed to occur:

- as a result of artificial pollinations
- among open-pollinated seed lots collected from native trees
- as seedlings in the wild (Table 1).

Table 1. Tasmanian native eucalypt species with the subgenus *Symphymyrtus* and their susceptibility to hybridisation with pollen from *Eucalyptus nitens* plantations **Bold indicates species with a medium or high hybridisation susceptibility (to assist with plantation risk assessment – see Section 6)**

Species (conservation status; r = rare, e = endangered)	Common name	Distribution overlap based on current and likely future plantation estate ¹	Rates of hybridisation following artificial pollination	Degree of flowering time synchrony ²	Susceptibility Assessment ³	Hybrid seedlings:	
						grown from wild seeds	observed in wild
<i>E. archeri</i>	Alpine cider gum	Low	Medium	High	High	Yes	-
<i>E. barberi</i> (r)	Barbers gum	Low	High	Low	Medium	-	-
<i>E. brookeriana</i>	Brookers gum	High	Medium	Medium	Medium	-	-
<i>E. cordata</i>	Tasmanian silver gum	Medium	Low	Low	<i>Low</i>	-	-
<i>E. dalrympleana</i>	Mountain white gum	Medium	Medium	Medium	Medium	-	-
<i>E. globulus</i>	Tasmanian blue gum	Medium ⁴	None	High	<i>Low</i>	-	-
<i>E. gunnii</i> ssp. <i>gunnii</i>	Cider gum	Medium	High	High	High	-	-
<i>E. gunnii</i> ssp. <i>divaricata</i> (e)	Miena cider gum	Low	High	High	High	-	-
<i>E. johnstonii</i>	Yellow gum	Medium	Medium	Medium	Medium	-	-
<i>E. morrisbyi</i> (e)	Morrisbys gum	Low	High	Low	Medium	-	-
<i>E. ovata</i>	Black gum	High	High	High	High	Yes	Yes
<i>E. perriniana</i> (r)	Spinning gum	High	High	High	High	Yes	-
<i>E. rodwayi</i>	Swamp peppermint (or black swamp gum)	Medium	Medium	Medium	Medium	Yes	-
<i>E. rubida</i>	Candlebark	Medium	High	Medium	High	-	-
<i>E. subcrenulata</i>	Alpine yellow gum	Low ⁴	Medium	Medium	Medium	-	-
<i>E. urnigera</i>	Urn gum	Medium	None	Low	<i>Low</i>	-	-
<i>E. vernicosa</i>	Varnished gum	Low	Medium	Medium	Medium	-	-
<i>E. viminalis</i>	White gum	Medium ⁴	Medium	Medium	Medium	Yes	<i>Unconfirmed</i>

¹ For more information on distribution overlap between native species and *E. nitens* plantations see Barbour et al (2007) and Williams and Potts (1996).

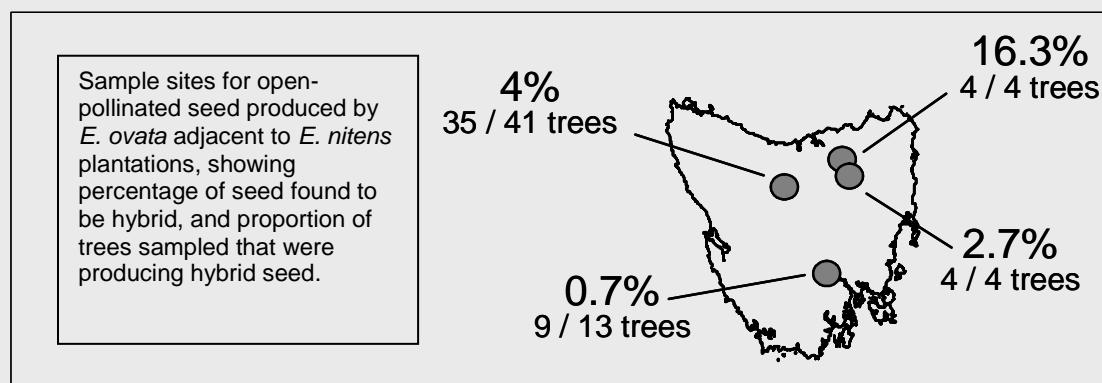
² Based on Barbour et al (2006).

³ This susceptibility risk assessment is derived mainly from artificial hybridisation rate and degree of flowering time synchrony. It may be amended in light of future research.

⁴ For these species note that distribution overlap may be high in some localised parts of Tasmania.

Case Study: *Eucalyptus ovata* X *E. nitens* hybrids in the wild

Hybrids between *Eucalyptus ovata* and *E. nitens* have been observed as seedlings in the wild at multiple sites in Tasmania and their hybrid status has been confirmed through genetic analysis (Barbour *et al.* 2003). Seeds collected from *E. ovata* adjacent to plantations have been germinated under glasshouse conditions and also have been confirmed to include a percentage (ranging from less than 1% to more than 15%) of *E. ovata* x *E. nitens* hybrid seed.



The sites where hybrid seedlings have been found to occur are close to *E. nitens* plantations and mature stands of *E. ovata*. The nearby *E. nitens* were 10–14 years old when the first hybrids were observed. The hybrids have developed from seed produced by *E. ovata* (i.e. *E. nitens* was the pollen source). The hybrids are generally detectable as seedlings of intermediate morphology between the two parents, and they have been found growing among seedlings of pure *E. ovata*. Although *E. ovata* is not a threatened species, forest types in which it is dominant or co-dominant have very high conservation value.

Eucalyptus nitens is pollinated by small insects, which can disperse pollen up to 1.6 km from its source. However, research shows that hybrids are far more likely to occur within a short distance (less than 200 m) of an *E. nitens* plantation. In a study of hybrid versus pure seed produced by *E. ovata* at various distances from *E. nitens* plantations, an average of 7.2% of seed was hybrid within 100 m of *E. nitens*, and this diminished to 0.7% by 200 m. The proportion of hybrid seed produced was found to vary greatly between individual trees, with as much as 56% of seed produced by an individual tree on the boundary of a plantation being hybrid seed (Barbour *et al.* 2005a).



Recent research indicates that first generation hybrids between *E. nitens* and *E. ovata* show poorer germination and early-age performance than pure *E. ovata* when the two are grown together in the wild (Barbour *et al.* 2006).



Above: An *E. ovata* X *E. nitens* hybrid growing on a road verge near Lilydale.

Left: A wild *E. ovata* x *E. nitens* hybrid seedling (left) growing next to a pure *E. ovata* seedling (right) in the Meander Valley

Photos: Robert Barbour

4. Recognising exotic hybrids

Hybrids generally have characteristics intermediate between those of the two parent species. Figures given in **Appendix 1** provide the morphological features of 'pure' and hybrid seedlings for the Tasmanian eucalypt species that have been found to produce hybrids after artificial pollination with *Eucalyptus nitens* pollen.

Note that although there are no images provided here for recognising hybrid seedlings between *E. globulus* and Tasmanian native species, their appearance is expected to be very similar to the *E. nitens* hybrids.

5. Further research and monitoring

The impact of exotic plantation eucalypts on the genetics and conservation of Tasmanian eucalypt species is the subject of ongoing research at the University of Tasmania (within the Co-operative Research Centre for Forestry and the School of Plant Science). The importance of this research has been heightened by the large-scale expansion of the eucalypt plantation estate in Tasmania. Research findings will allow us to predict the risk of genetic pollution for individual species and populations and, therefore, inform appropriate management of the issue. Risk assessment will be particularly relevant to the conservation of threatened eucalypt species or communities.

The impacts of gene flow from *Eucalyptus* plantations may include:

- reduced regenerative capacity of 'pure' native eucalypts due to pollen swamping and the production of large numbers of hybrids
- 'pure' native eucalypts being out-competed by their exotic hybrid off-spring
- flow-on effects to the community of dependant organisms due to replacement of the native parent species with exotic hybrids.

These potential impacts are of particular concern where the native species in question is rare or endangered (e.g. *E. barberi* and *E. perriniana*) or is an important element in a high conservation priority community (e.g. *E. ovata* in many situations). An important area of current research is establishing whether there are effective natural barriers to gene flow after the initial hybridisation event. For example, exotic hybrids may not reach reproductive maturity, or may have a different flowering season, making them unable to backcross with native populations (Barbour et al. 2003).

FPOs and others with field knowledge can greatly assist researchers by making them aware (via the FPA) of sites where there are Tasmanian *Symphyomyrtus* species growing close to plantation eucalypts. Of particular interest are sites **within 500m** of a eucalypt plantations where:

- there are rare or threatened native *Symphyomyrtus* species (e.g. *E. barberi*, *E. morrisbyi* or *E. gunnii* var. *divaricata*); and/or
- there are native *Symphyomyrtus* species in an area of high conservation value such as a National Park or reserve.

In addition to reporting sites where there is the potential for hybridisation, it would be helpful for FPOs to be alert to the possible presence of exotic hybrids. *E. ovata* is the most likely of the non-threatened species to hybridise: **FPOs should look out for *E. ovata* seedlings next to plantations in disturbed habitats.** The exotic hybrids will then be found amongst the pure *E. ovata* seedlings.

Eucalyptus gunnii, *E. subcrenulata* and *E. brookeriana* are other species to watch in areas where outlying populations occur in the vicinity of large areas of plantations (e.g. Surrey Hills, Woolnorth areas and the north east Highlands). The rare *E. perriniana*, which is also susceptible to hybridisation with *E. nitens*, is already being closely monitored by researchers.

FPOs are also encouraged to record where plantation eucalypts are self-establishing through seed dispersal (usually within 30 meters of the plantation but machinery can transport seed further).

A recording template is appended to this technical note. All records made should be forwarded to the FPA Biodiversity Program.



Left: Seedlings grown from open-pollinated seed collected from native *E. ovata* populations with red tags placed on the exotic hybrids.

Photo: Robert Barbour

6. Assessing and managing hybridisation risk

To reduce the risk of genetic pollution from hardwood plantations into native eucalypt populations in Tasmania, forest industry practitioners should first assess the risk category of the proposed or existing plantation and then introduce planning and/or active management measures where needed.

6.1 Hardwood plantation risk assessment

Research to-date has demonstrated that hybridisation between plantation eucalypts and many local species is possible, but how readily this occurs in the wild and the relative vigour of the hybrid offspring is still under investigation. Based on current knowledge, there are certain variables that can be used to assess the level of risk posed by plantation at a particular site.

FPOs should use the risk assessment matrix in Table 2 to assess whether a proposal to establish or replant an *E. nitens* plantation requires measures to reduce the risk of genetic pollution. It may also be used to assess the hybridisation risk associated with existing plantations.

Please note that this risk matrix is a simplification of many complex factors and that risk categories may change in response to new research. **Ensure you are using the most up-to-date version of this technical note (check the FPA website).**

Please consult FPA Biodiversity Program staff if you need help in assessing the risk level associated with a plantation.

Once a plantation has been planted, any monitoring of hybrid establishment and of the breeding system (see Section 6.2) should be used to revise the pre-planting risk-assessment. For example, if hybrid seedlings are found establishing around a plantation previously assessed as 'low risk', the risk level should be raised to 'moderate' and when due for replanting the corresponding planning and monitoring measures outlined below should be followed.

Table 2. Hybridisation risk matrix for existing or proposed *Eucalyptus nitens* plantations

Use this matrix to assess the hybridisation risk associated with a plantation based on the conservation value of nearby native eucalypt populations and their susceptibility to hybridisation (e.g. a high conservation value population with low susceptibility will lead to a 'Low' hybridisation risk). The assessment should be conducted for native *Symphyomyrtus* eucalypt populations (i.e. species listed in Table 1) occurring within approximately 500 meters of the (proposed) plantation site. Where two or more native populations occur within this proximity of the plantation site, adopt the risk assessment for that of highest conservation significance.

(Note that it should be possible to adapt this assessment process for *E. globulus* or other eucalypt plantation species once more information becomes available on their tendency to hybridise with native eucalypts.)

Susceptibility level of nearby native eucalypt populations (refer to Table 1)	Native eucalypts of high conservation value *	Other native eucalypts
Low susceptibility	Low hybridisation risk	Minimal hybridisation risk
Medium susceptibility	High hybridisation risk	Moderate hybridisation risk
High susceptibility	High hybridisation risk	Moderate hybridisation risk

* Native eucalypts of high conservation value are those that:

- have a threatened status (refer to Table 1), OR
- dominate a threatened community, OR
- occur within a formal conservation reserve (e.g. National Park, Private Flora Reserve etc). OR
- belong to a population which has particular biological conservation value for other reasons (e.g. geographical isolation).

6.2 Management recommendations

Management prescriptions for the establishment and replanting of plantations have been developed by the FPA in consultation with industry and research scientists (Table 3). Note that although these prescriptions are advisory only at this stage, specialists from the FPA Biodiversity Program may request they are partially or fully implemented under an FPP where necessary to protect adjacent values.

Table 3. Forest planning and management prescriptions for reducing the risk of gene flow from exotic eucalypt plantations.

Use Table 1 and 2 in this technical note to establish the risk category of the plantation in question.

<i>Hybridisation risk</i>	<i>Planning measures</i>	<i>Monitoring and control measures</i>
Minimal risk	No special planning requirements	No formal monitoring requirements
Low risk	No special planning requirements	Regular monitoring for established hybrid seedlings ¹ and hand-weeding programs instigated if hybrids found.
Moderate risk	No special planning requirements (however note possible measures discussed in the text below)	Regular monitoring for hybrid seedlings plus breeding system monitoring (explained in dot point 7 in the text below). Hand-weeding programs instigated if hybrids found.
High risk	Do not establish or re-establish eucalypt plantations without consultation with FPA. (Substantial planning and monitoring obligations may be required).	

Current prescriptions are primarily focussed on monitoring for hybrids. The following points should be noted concerning monitoring:

1. Hybrid seedlings are usually readily identifiable by leaf and stem morphology (see Section 4 of this technical note). Therefore monitoring will involve visual inspection of the perimeter of the plantation plus areas suitable for eucalypt regeneration (e.g. areas disturbed by machinery or fire) within approximately 100–200 m from the plantation. Searches should target the most likely sites, which will generally be 1–2 canopy heights away from potential seed trees. If hybrids are detected more extensive surveys should be done.
2. Regular monitoring (i.e. every one to three years) should commence three years after plantation flowering is detected (typically flowering will commence when trees are around five years of age and is best observed along edge rows). This allows one year for seed development and 1–2 years for any hybrid seedlings to grow to a detectable age. Sites where wildfire burns forests adjacent to reproductively mature *E. nitens* plantations may be particularly susceptible to hybrid establishment. Such an event should be recorded (using GIS where applicable) and monitoring for hybrids should be instigated 2–3 years later.
3. Plantation managers should keep a written record of monitoring dates and results.
4. Where suspected hybrids are found, their genetic identity should be confirmed by sending material to the FPA Biodiversity Program prior to initiating a removal program.

5. If hybrids are found on adjacent land (e.g. reserves) that are not managed by the plantation manager, the appropriate land manager should be contacted before initiating a removal program.
6. Staff conducting monitoring should also be alert to plantation wildlings, and follow the same control measures for these as for hybrids.
7. *Breeding system monitoring* (for moderate or higher risk plantations) should include collection of data on:
 - plantation flower abundance
 - plantation and native flowering synchrony
 - levels of hybridisation in native seed (i.e. seed collected from adjacent native population should be grown in nursery conditions to detect the presence of hybrid progeny that may not yet have had the chance to establish in the wild due to lack of appropriate disturbance event).

The results from monitoring should be used to re-assess the risk level of the plantation on a three-yearly basis.

The prescriptions given in Table 3 are likely to be adapted in response to future research findings. Possible planning-stage measures that could be introduced to reduce the risk of gene flow from plantations include planting of non-flowering edge-rows (or edge rows of a different species that doesn't pose a hybridisation risk)¹ or leaving a non-plantation buffer between the plantation perimeter and any high conservation value native forest. Such measures are aimed at reducing dispersal of exotic pollen into nearby native eucalypt populations but cannot eliminate all such dispersal. They therefore do not replace the need for monitoring.

References

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- Barbour RC, Potts BM, Vaillancourt RE 2005b 'Gene flow between introduced and native *Eucalyptus* species: crossability of native Tasmanian species with exotic *E. nitens*', *Australian Journal of Botany*, **53**, 465–477.
- Barbour RC, Potts BM, Vaillancourt RE, Tibbits, WN 2006, 'Gene flow between introduced and native *Eucalyptus* species: flowering asynchrony as a barrier to F1 hybridisation between exotic *E. nitens* and native Tasmanian *Symphyomyrtus* species', *Forest Ecology and Management* **226**, 9–21.
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- Potts BM, Barbour RC, Hingston AB, and Vaillancourt RE 2003, 'Turner Review No. 6. Genetic pollution of native eucalypt gene pools – identifying the risks', *Australian Journal of Botany* **51**, 1–25.
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Publication details

¹ Plantation trees in edge rows have been found to be more likely to produce pollen and seed than trees on inside rows (Barbour et al 2008). It follows that the risk of genetic pollution is likely to be reduced by planting lower-risk species or non-flowering genotypes in the edge rows of a plantation. Non-flowering genotypes of *E. nitens* are not available at the time of writing, however these may be developed with further breeding efforts. Currently the use of a species such as *E. olivacea* or *E. regnans* in the edge rows would be a feasible way of achieving the desired reduction in pollen output from the *E. nitens* plantation.

Recording sheet for suspected exotic hybrid seedling observations and/or wildling observations associated with eucalypt plantations

Site details	
Location:	
Map and grid reference:	
Other details (e.g. habitat characteristics, disturbance):	
Recorder (include contact number):	Date:
<div style="display: flex; justify-content: space-around; align-items: center;"> (circle one) <div style="text-align: center;"> Suspected hybrid OR Plantation wildling </div> </div>	
Species/suspected hybrid combination:	
Number of hybrid/wildling seedlings found:	
Height of seedlings:	
Health of seedlings:	
(For hybrids) – Number of non-hybrid seedlings from native parent on site:	
Distance from plantation edge:	
Age of plantation:	
Is plantation flowering (at least at the edge)?	
Any other relevant details:	
Attach (if possible): <ul style="list-style-type: none"> - photo of the area - photo of the plant and suspected 'pure' native seed parent (in the case an exotic hybrid record). 	

Appendix 1

Using the figures in this appendix to recognise hybrid seedlings:

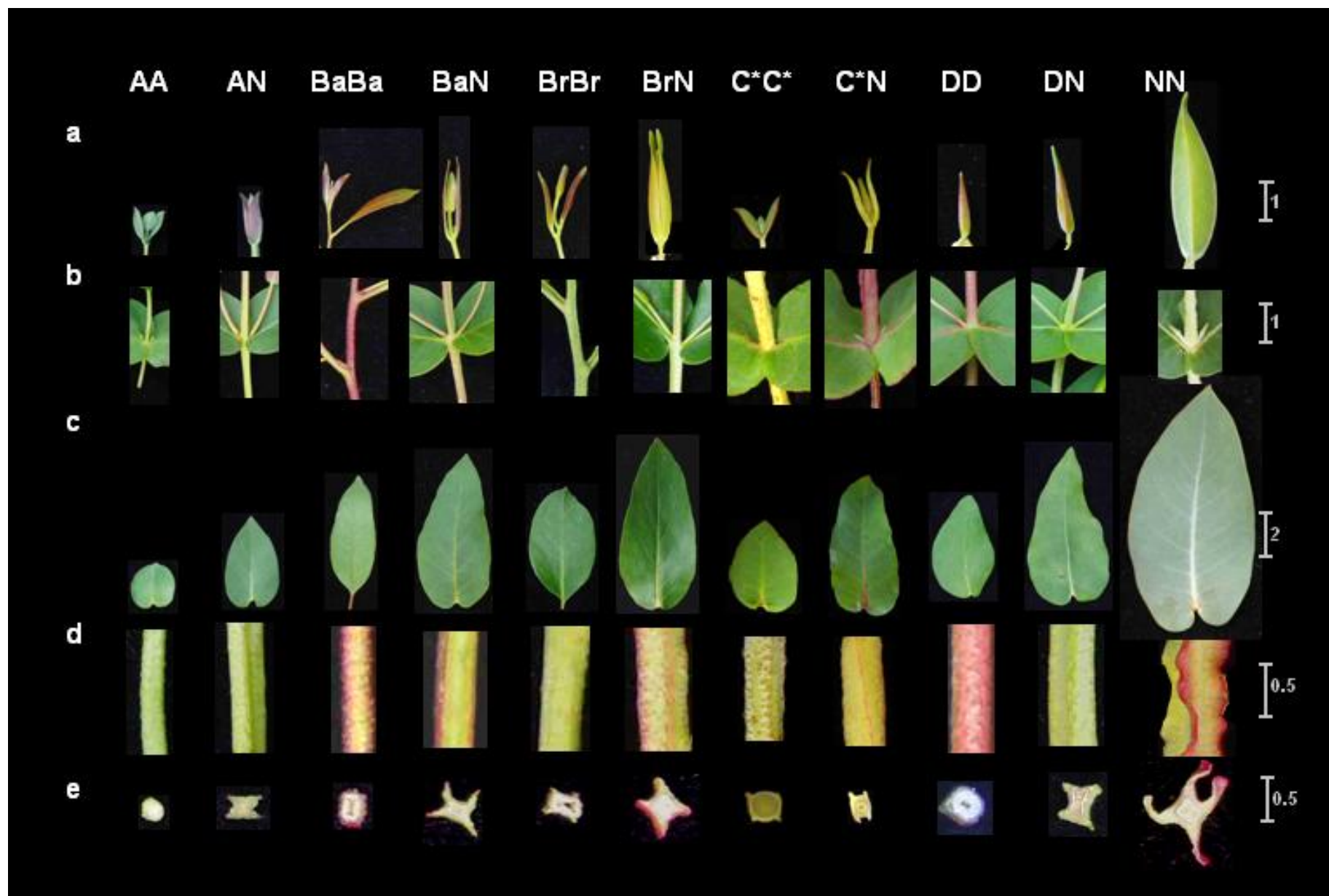
Each Tasmanian *Symphyomyrtus* species and its hybrid progeny (F_1 generation) with *E. nitens* is identified by the letters above the column of photographs. Letter codes for species are as follows:

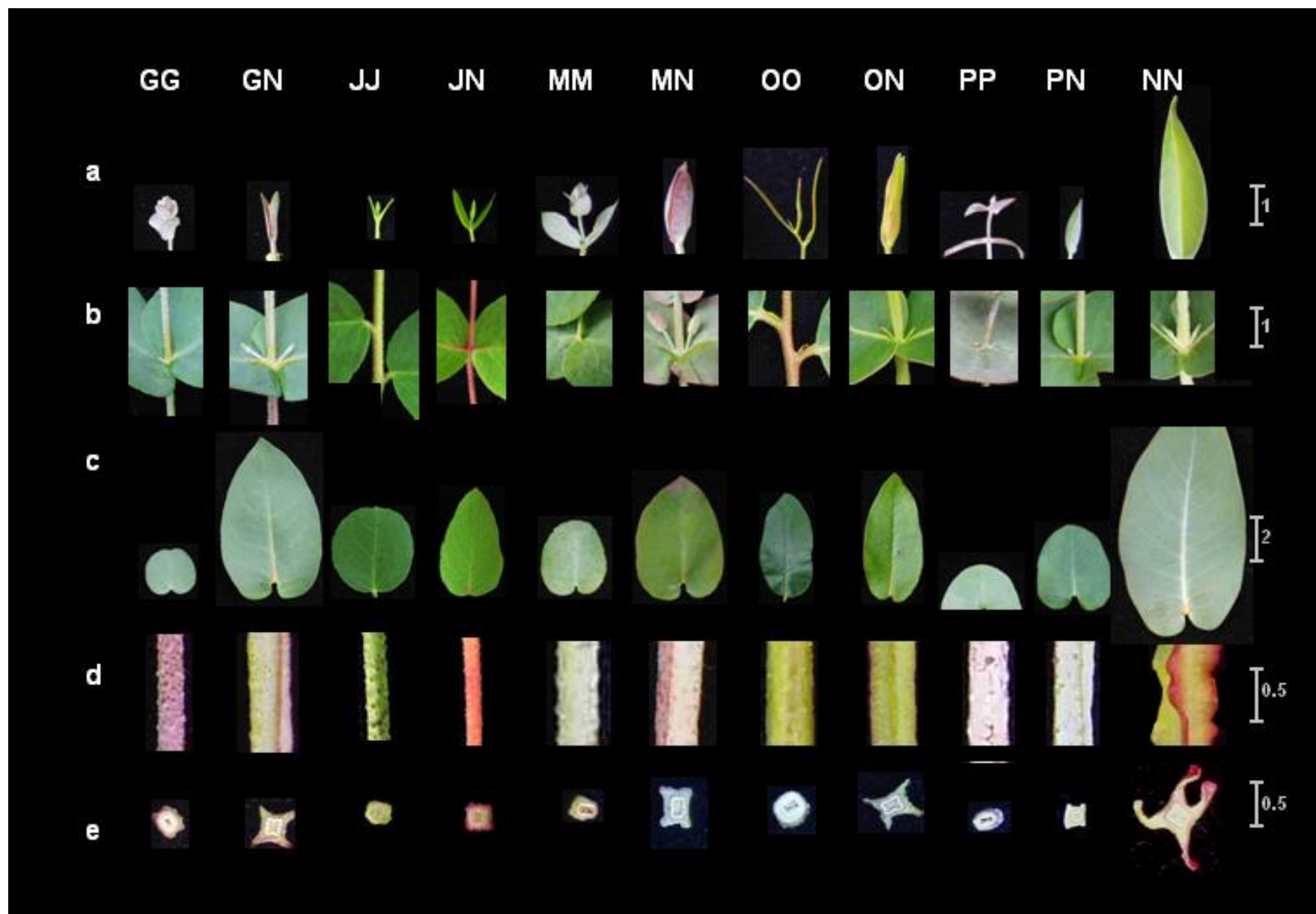
Eucalyptus archeri (AA), *E. barberi* (BaBa), *E. brookeriana* (BrBr), *E. cordata* ssp. *quadrangulosa* (C*C*), *E. dalrympleana* (DD), *E. gunnii* (GG), *E. johnstonii* (JJ), *E. morrisbyi* (MM), *E. nitens* (NN), *E. ovata* (OO), *E. perriniana* (PP), *E. rodwayi* (RoRo), *E. rubida* (RuRu), *E. subcrenulata* (SS), *E. urnigera* (UU), *E. vernicosa* (VeVe) and *E. viminalis* (ViVi).

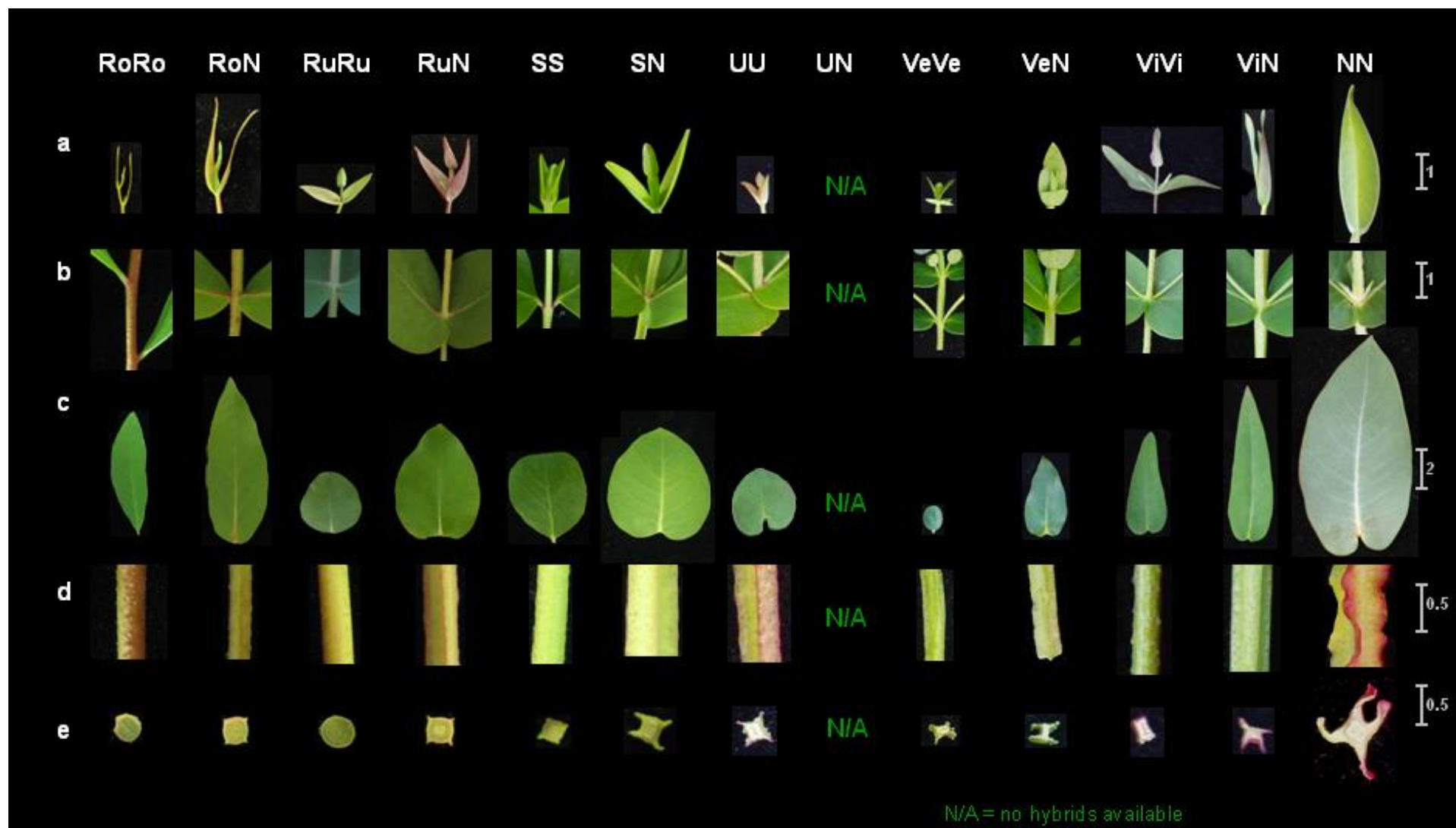
Hybrid combinations combine the letter code of the native parent with 'N' for *E. nitens* (e.g. ViN = *E. viminalis* x *nitens*).

Seedling morphology is depicted at node 10. For each species and hybrid combination the features shown are: variation in bud (a), node (leaves truncated) (b), leaf (c), longitudinal stem (d) and cross-sectional stem (e). The scale is given in centimetres along the right hand side of the illustrations.

These figures are provided by the School of Plant Science, University of Tasmania

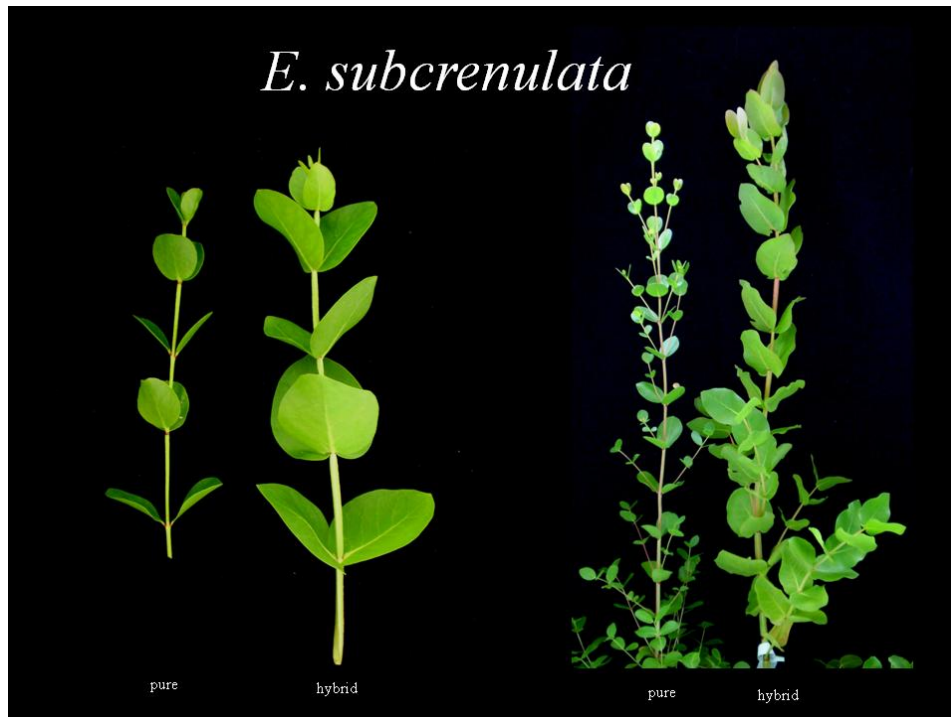






Examples of some types of *Eucalyptus nitens* hybrid seedling





This technical note has been prepared by Nina Roberts (FPA), Robert Barbour (School of Plant Science, University of Tasmania) and Fred Duncan (FPA). It should be cited as:

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