In his last years IB's greatest achievement was the teamwork and spirit he built up in the staff he recruited and trained. He was a most astute leader and administrator and he loved to talk, but he found writing up his results very irksome; he reckoned he was paid to produce improved seed not to write papers. Refractory by nature, he enjoyed a good battle with the "administration". But beneath the sometimes gruff exterior lay a sensitive and generous man, highly dedicated to his work, a great believer in genetic improvement of trees, and a tremendous inspiration to we who had the benefit and pleasure of working with him.

M. D. WILCOX
5 April 1984

Hybrids between Eucalyptus citriodora Hook. and E. torelliana F. v. Muell. in India

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Summary

Spontaneous hybrids between *E. citriodora* and *E. torelliana* belonging to subgenus *Corymbia* have been reported for the first time from India. Marker characters such as presence or absence of lignotubers, shape of the leaves and aroma of crushed leaves were used as diagnostic features for detection of F_1 hybrids in the nursery. Hybrids were compared with the parent species for various characters. Segregation in F_2 generation was observed for various morphological traits. The potential use of the hybrids has been discussed.

Key words: Eucalyptus citriodora, Eucalyptus torelliana, Hybridization, Marker characters, Segregation.

Zusammenfassung

Über spontane Hybriden zwischen *Eucalyptus citriodora* und *Eucalyptus torelliana,* die zur Untergattung *Corymbia* gehören, wurde zum ersten Male aus Indien berichtet. Markante Erkennungsmerkmale, wie das Vorhanden- oder Nicht-Vorhandensein von Stammknollen, Blattform und das Aroma zerkleinerter Blätter wurden als diagnostische Merkmale zur Auffindung von F_1-Hybriden in der Baumschule benutzt. Die Hybriden wurden mit den Elternarten hinsichtlich verschiedener Merkmale verglichen. Die Aufspaltung in der F_2-Generation wurde für verschiedene morphologische Merkmale beobachtet. Die Möglichkeiten der Verwendung der Hybriden werden diskutiert.

Introduction

In Eucalypts the occurrence of inter-specific hybrids is common when the species are planted together as exotics (PRYOR, 1976, 1978; FAO, 1981). Some of the commoner spontaneous hybrids reported by different authors (SHEIBOURNE, 1963; BODEN, 1964; COOLING, 1966; VENKATESH and SHARMA, 1976, 1977, 1978 & 1979) mostly involve the species of subgenus *Symphyomyrtus*. But in subgenus CORYMBIA (PRYOR and JOHNSON, 1971) hybrids have only been reported between *E. gummifera* × *E. maculata* (PRYOR, 1976); nevertheless it is of significance and considerable interest that the species *E. citriodora* and *E. torelliana* belonging to the subgenus *Corymbia* have also been observed to cross and produce natural hybrids in India which are being reported here for the first time.

Background

Seeds were collected separately from few trees of *E. citriodora* in 1976 and their progenies were raised for treating them with colchicine under polyploidy studies. But incidently two hybrid plants were spotted in the open-pollinated progeny of a tree of *E. citriodora* out of many seedlings, based on the apparant difference in their leaf morphology which was observed at the age of 6 months. This observation created interest and prompted the authors to inspect the place of seed collection (New Forest Estate, Dehra Dun, altitude 610M, latitude 30° N, longitude 78° E, Annual R.F. 216cms). As visualised a group of twelve mature trees of *E. torelliana* at about 50 meters distance from a group of about ten trees of *E. citriodora* along the road side was located. The occurrence of two species in close vicinity and their synchronized flowering periods were the main features which perhaps caused natural cross pollination and production of hybrids in the population of some of the trees. Thus, to confirm this, seeds were collected for the second time from these trees.

Material and Methods

Seeds were collected for the second time in 1977 from two trees each of the above mentioned species growing in close vicinity including the tree which produced hybrids in 1976. In the same year in October seeds were sown in pots (150 seeds × 3 pots) to raise the progenies. Hybrids were picked up from this lot again based on marker characters. At 6th leaf stage the hybrids were transplanted in polypots (23 cms × 18 cms) and kept in a net house for further observations. The hybrids were out planted in the field in rows along with their parents serving as control at 2 M × 2 M spacing during monsoon rains in the month of July in 1978 for growth measurements. Observations were recorded on juvenile and mature leaves, flowers, fruits, seeds, height and diameter of the hybrids and the non-hybrid controls of both the parent species. Seed was collected from the F_1 hybrids *(E. cit. × E. tor.)* identified in 1976 which exhibited segregation in seed coat colour. F_2 population was raised which segregated for cotyledon colour, lignotubers, leaf shape and aroma of crushed leaves. The results on segregation pattern are not being reported here but will be published else where.

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Table 1. — Comparison of some morphological traits of hybrids and parents.

Character	E. citriodora	Hybrids: E. citriodora × E. torelliana	Hybrids: E. torelliana × E. citriodora	E. torelliana
Lignotuber	Present	Present	Present	Absent
Stem Form	Good	Excellent	Good	Poor
Crown	Sparse	Very dense	Very dense	Dense
Leaves:				
Intermediate				
Shape	Lanceolate	Broadly Lanceolate	Broadly Lanceolate	Ovate
Petiole	Peltate	Peltate	Peltate	Peltate
Surface	Hairy	Hairy	Hairy	Hairy
Mature				
Disposition	Isobilateral	Intermediate	Intermediate	Dorsiventral
Shape	Narrowly Lanceolate	Broadly Lanceolate	Broadly Lanceolate	Ovate
Petiole	Non-peltate	Peltate	Peltate	Peltate
Surface	Smooth	Hairy	Hairy	Hairy
Colour	Concolorous	Intermediate	Intermediate	Discolorous
Aroma (Crushed leaves)	Citronellal (Strong)	Intermediate (More towards citriodora)	Intermediate (More towards torelliana)	Displeasing (Citronellal absent)
Stomata				
Distribution	More or less equally distributed on both the surfaces	Some on upper surface, more on under surface.	Some on upper surface, more on under surface.	Confined to under surface only.
Size	Large	Intermediate	Intermediate	Small
Frequency	Low	Intermediate	Intermediate	High
Flower			*	
No. of flowers/ inflorescence	3	3		3
Range	2-3	2-5		2-5
Operculum shape	Hemispherical	Peaked hemispherical with mucronate tip		Hemispherical
Stamen filaments in bud	Inflexed	Inflexed		Inflexed
Style Length	Long	Long		Short
Fruit			*	
Shape	Urceolate to ovoid	Urceolate-ovoid		Globular
Pedicellate or sessile	Pedicellate	Pedicellate		Sessile
Size	Large	Intermediate		Small
Opening of capsule	Wide	Intermediate		Narrow
Seed			*	
Colour	Black	Both type of seeds-black and chocolate		Chocolate
Size	Large	Intermediate		Small
Chaff size	Large	Intermediate		Small

*: Not flowered.

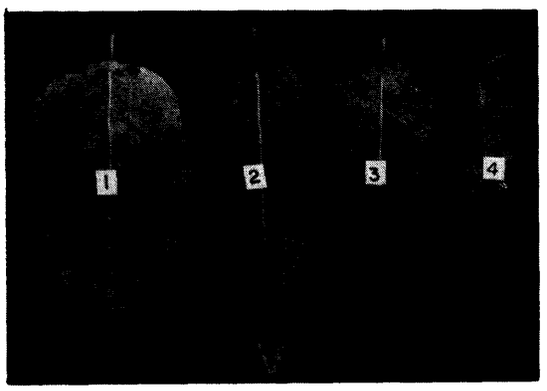

Fig. 1. — Intermediate leaves of: 1) *E. torelliana;* 2) F_1 *E. torelliana* × *E. citriodora;* 3) F_1 *E. citriodora* × *E. torelliana* and 4) *E. citriodora* from 2 year old saplings.

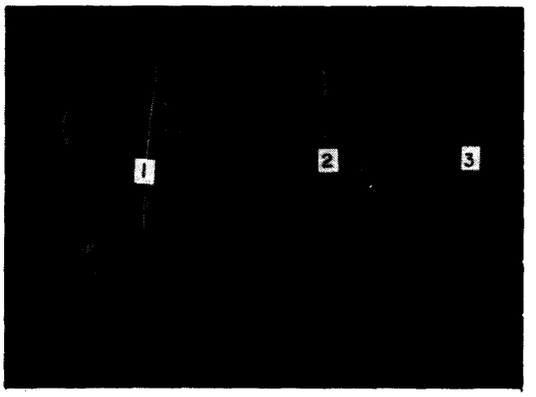

Fig. 2. — Typical mature leaves of: 1) *E. torelliana;* 2) F_1 *E. citriodora* × *E. torelliana* and 3) *E. citriodora.*

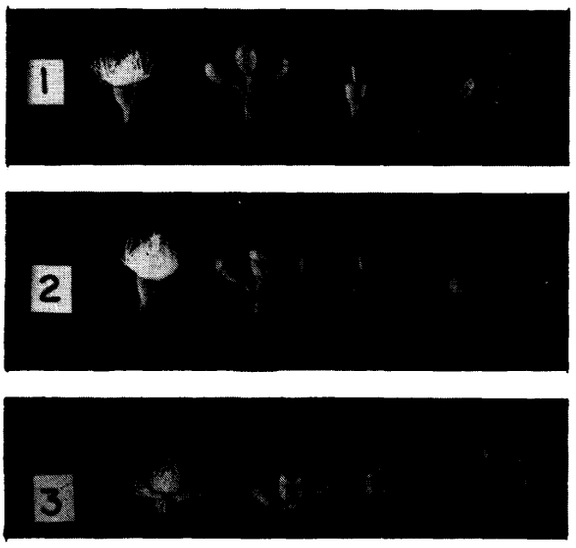

Fig. 3. — Bloomed flowers, flower buds, carpels and fruits of: 1) *E. citriodora;* 2) F_1 hybrid *E. citriodora* × *E. torelliana* and 3) *E. torelliana.*

Results and Discussion

A few hybrid seedlings were detected for the second time in the progenies of two *E. citriodora* and two *E. torelliana* trees based on marker characters including aroma of crushed leaves. The occurrence of ovate leaved seedlings in the progenies of *E. citriodora* and of broadly lanceolate leaved seedlings with lignotubers *(Fig. 5)* inherited by *E. citriodora* as dominant trait (PRYOR and BRYNE, 1969) in the progenies of *E. torelliana* which does not possess lignotubers served as marker character in the detection of hybrids in the nursery *(Table 1).*

The number of reciprocal hybrids detected from the open-pollinated progenies was limited to 4 out of 67 seedlings (5.9%) in *E. citriodora* and 8 out of 370 seedlings (2.5%) in *E. torelliana.*

Observations on various morphological traits of hybrids and parents are presented in *Table 1* and measurements on height and diameter in *Table 2* and *3.* It may be seen from the data that for most of the traits the hybrids were intermediate *(Fig. 1, 2, 3, 4, 6,* and *7* and *Table 1)* to the

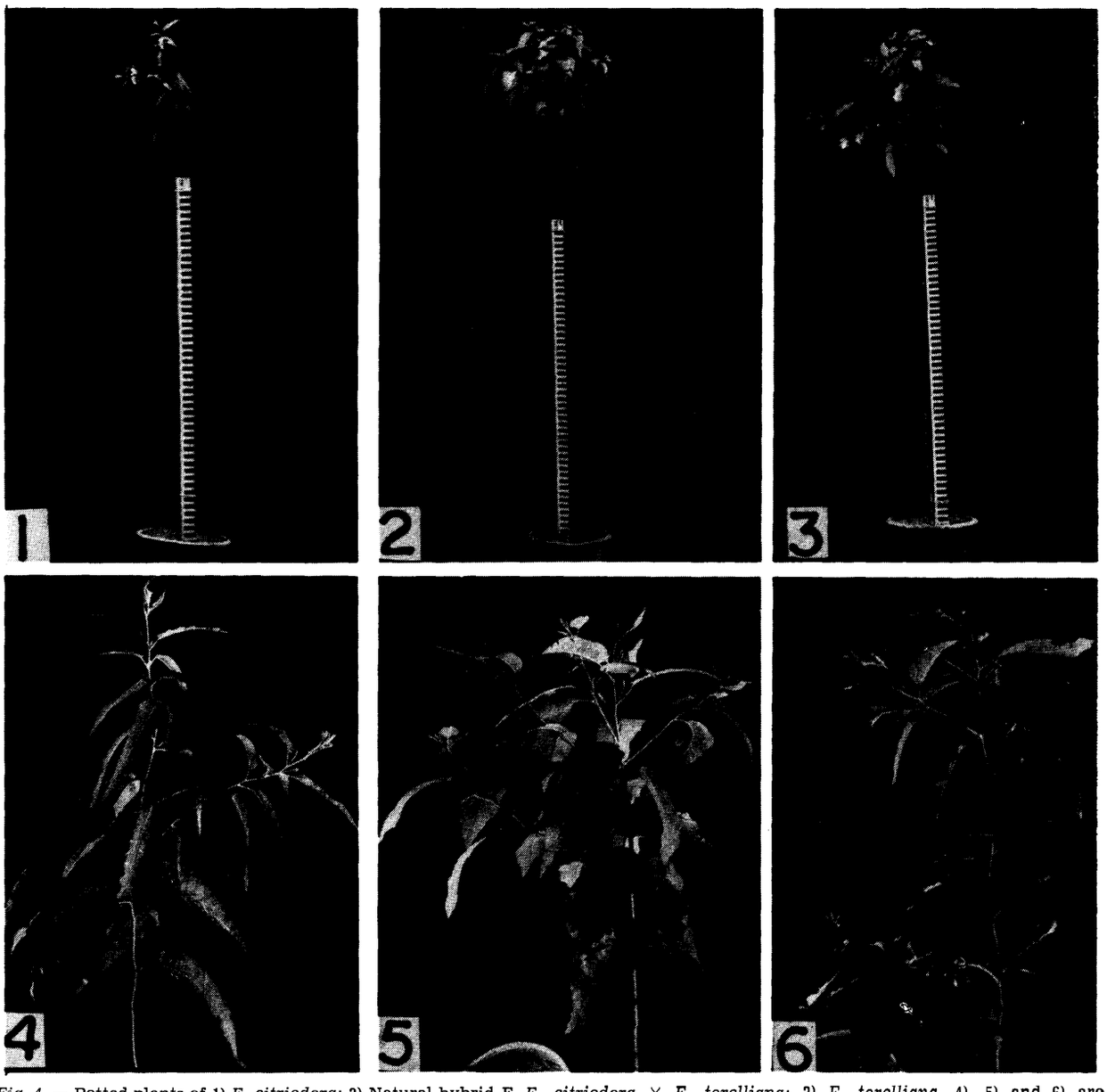

Fig. 4. — Potted plants of 1) *E. citriodora;* 2) Natural hybrid F_1 *E. citriodora* × *E. torelliana;* 3) *E. torelliana.* 4), 5) and 6) are close-ups of leading shoots of the same respectively.

Table 2. — Height and Diameter at age of 5 years of Hybrids and parents raised from the seeds collected in 1976.

Sl. No.	Treatment	Mean height (M)	Mean DBH (cm)	Mean collar diameter (cm)	Sample size
1.	*E. citriodora* × *E. torelliana* F_1	8.38	9.03	14.79	2
2.	*E. torelliana*	5.81	5.76	9.30	10
3.	*E. citriodora*	4.35	4.05	7.40	10

Table 3. — Height and Diameter at the age of 18 months of Hybrids and parents raised from the seeds collected in 1977.

Sl. No.	Treatment	Mean height (cm)	Mean diameter at ½ height of plant (cm)	Mean collar diameter (cm)	Sample size
1.	*E. citriodora* × *E torelliana* F_1	200.00	0.93	1.64	4
2.	*E. torelliana* × *E. citriodora* F_1	215.00	1.02	1.80	8
3.	*E. torelliana*	167.00	0.79	1.56	12
4.	*E. citriodora*	146.40	0.51	0.97	12

parent species. However, the hybrids grew faster in comparison to their parent species serving as controls *(Table 2* and *3)* giving an indication of heterosis, which would be of interest to confirm by attempting controlled crosses and growing sufficient number of hybrids. The availability of marker characters for detection of hybrids in the nursery is a needed situation. It would be of interest to compare the reciprocal hybrids for their performance in the field and to find the cytoplasmic effect of seed parent on different parameters and their economics, as *E. citriodora* may contribute useful properties like citronellal qualitatively and quantitatively for use in the perfumery industry

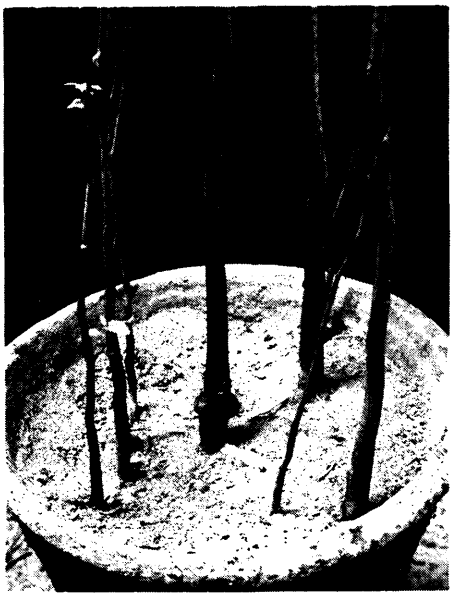

Fig. 5. — Single tree progeny of *E. torelliana* in pot with a natural hybrid F_1 *E. torelliana* × *E. citriodora,* note the development of lignotuber in hybrid which has been inherited as dominant trait.

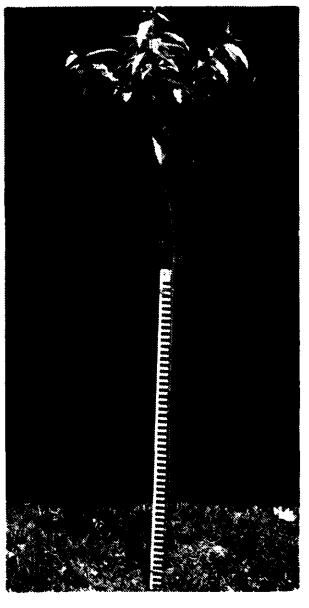

Fig. 6. — 2 Year old plant of natural hybrid F_1 *E. citriodora* × *torelliana* growing in the field.

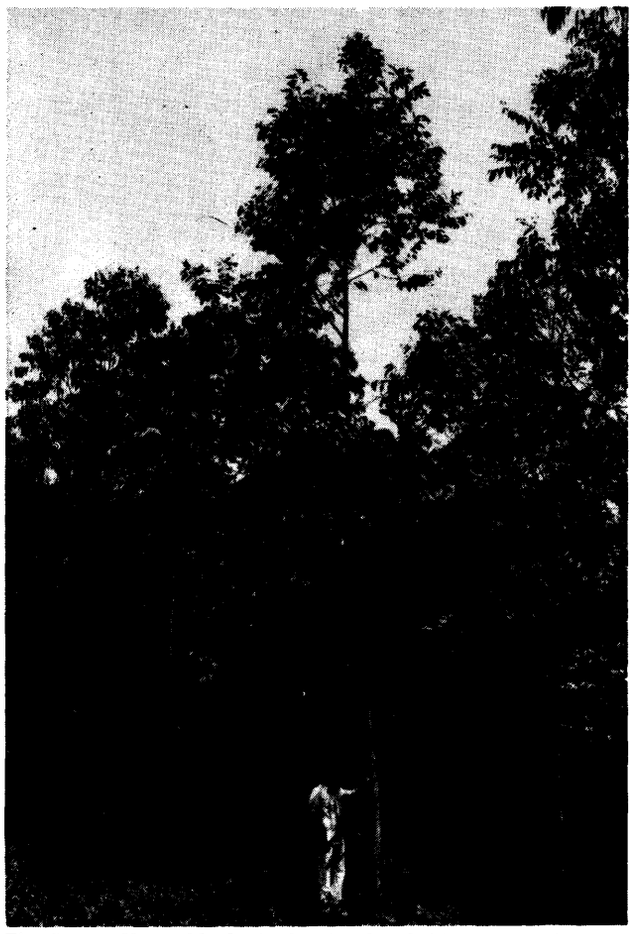

Fig. 7. — 5 Year old plant of natural hybrid F_1 *E. citriodora* × *E. torelliana* growing in the field.

and *E. torelliana* may serve as donor species for dense crown for better site control and resistance to pink disease (FAO, 1981) because such hybrids have been observed under the present studies in the two species. New plant types having quite different properties of wood and oil may also be picked up from the subsequent segregating populations. A tree type having a dense crown like *E. torelliana* and sweet smell like *E. citriodora* would be a desired recombinant having a potential use for the perfumery industry and as a shade tree for the tea gardens.

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Graphic Solution in Relating Seed Sources and Planting Sites for White Ash Plantations

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Abstract

A contour plot with latitudes of seed sources and of planting sites as independent variables is useful to deter mine the range of suitable seed sources and suitable planting sites for the best growth and survival of white ash seedlings. The relative importance of seed source selection, planting site selection and seed source × plantation location interaction can be evaluated from the plot.

Key words: Provenance test, seed collection zone, site selection, white ash.

Zusammenfassung

Konturdiagramme mit der geographischen Breite der Samen-Herkunft und des Pflanzortes als unabhängige Variablen erweisen sich zur Bestimmung der geeigneten Herkunfts- und Pflanzortbereiche für das optimale Wachstum und Überleben einer Art als nützlich. Die relative Bedeutung des Herkunftsortes, des Pflanzortes und der Wechselwirkung zwischen der Kombination von Herkunft und Pflanzort kann mit Hilfe der Konturdiagramme interpretiert werden.

Introduction

Forest trees must be planted on sites where they will survive and grow well in order to maximize yields. However, matching a species to site is difficult and uncertain when it has not previously been used as a plantation tree. Widely distributed species pose the greatest problem due to the genetic variation among populations that can be expected in response to climatic, edaphic, and other environmental differences throughout the natural range. Because each population is adapted to a particular combination of environmental conditions, it is important to know

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