

COMPARATIVE GROWTH OF 52 EUCALYPTUS SPECIES AT PESHAWAR

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Abstract. This paper gives comparative growth of 52 species of *Eucalyptus* at Peshawar at the age of 10 years. Significant differences of survival, and height and diameter growth of different species are reported. In addition to commonly planted species of *Eucalyptus*, other species have also shown promising growth in this study.

Introduction. *Eucalyptus* trees were introduced in Pakistan in 1860. However, significant efforts were first made by Forest Department, Punjab, in 1903, when a small nursery of *E. globulus* was raised at Changa Manga. Subsequently, a number of *Eucalyptus* species trials were started at various places to determine suitability of different species of this genus. The work was generally non-systematic and sporadic. As a result, a large number of *Eucalyptus* species were grown in different parts of the country in the nurseries as well as in the form of arboretum plots, avenue plantation or as single trees. But data about their performance was lacking. Most of the species were rejected after brief trials mostly under unfavourable conditions. Evaluation of performance of different species under Pakistan conditions has been reported by Parker (1925), Khan (1955), Brockway and Khan (1956), Nawaz (1963), Ahmad and Iqbal (1964), Boden (1967), Pryor (1967) and Qadri (1968).

This paper presents results of a 10-years old *Eucalyptus* species trial at Peshawar.

Material and Methods. Seed of a number of species of *Eucalyptus* was procured by Central Silviculturist, Pakistan Forest Institute, Peshawar, in 1965-66. Planting of one-year old plants of 58 species was done in experimental area of the Institute in April 1967 at about 3×3 m (10'×10') spacing. A randomised complete block design was used in the planting with six replications. 4 plants of each species were planted in each replication. *Eucalyptus alba*, *E. citriodora* and *E. fruticetorum* were planted in the surround.

The test site lies at 34°01' latitude and 71°34' longitude at an elevation of about 400 metres. The mean minimum and maximum temperatures at Peshawar are 10.9°C in the month of January and 32.9 C in June/July respectively. Average annual precipitation is about 350 mm, most of it received in January to April. The soil of the test site is calcareous clayey loam with fair drainage. Its pH varies from 8.5 to 9.1. The test plantation was artificially irrigated every fortnight during first two years of its establishment. Annual depth of irrigation water to the plantation is estimated to be 420 mm during this period. Thereafter, the supply of irrigation water to the plantation was irregular. Only one to two irrigations were given annually to the plantation depending upon availability of water. This is equivalent to 30 to 50 mm depth of irrigation.

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The survival of individual *Eucalyptus* species was recorded after one year of planting in March 1968. Later, in 1977-78, the number of plants of each species which survived during the intervening period was determined. A number of plants disappeared as a result of wind break or through insect damage. Height and diameter measurements were made at frequent intervals. However, this paper presents measurements of growth of 52 species made in December 1977 and January, 1978. Diameter was measured by a diameter tape at breast height and height of the trees by climbing them. Analyses of variance was carried out to determine significant differences in survival, height and diameter growth.

Specific gravity of wood samples from increment cores taken at breast height of 4 trees of 11 fast growing species was determined by maximum moisture content method of Smith (1954) to find out the effect of growth rate on wood specific gravity.

Results and Discussion. Survival and average diameter and height growth of 52 species of *Eucalyptus* in Peshawar study is given in Table 1. A large variation is observed for these parameters in all species. These differences were found to be highly significant for height and diameter and non-significant for survival %. F values in analyses of variance were 4.017 for diameter and 6.01 for height growth measurements made in 1977-78. Duncan's Multiple Range Test also indicated that on comparison, the differences of growth rate between a number of species are also significant. Among 52 species of *Eucalyptus* of this study, *E. macarthurii* is the fastest growing species as far as diameter growth is concerned. It is followed in descending order of diameter growth by *E. botryoides*, *E. kitsoniana*, *E. crebra*, *E. erythronema*, *E. largiflorens*, *E. Mysore Hybrid*, *E. polycarpa*, *E. rudis*, (*E. camaldulensis*), *E. alben*, *E. microtheca*, *E. polyanthemos*, *E. grandis*, *E. amplifolia*, *E. maculata*, *E. gomphocephala*, *E. microcorys*, *E. melanophloia*, *E. tereticornis* etc., *E. compaspe* is the slowest growing species and attained a diameter growth of only 3.7 cms at breast height during last 10 years. All species were classified in 2 cms diameter classes and listed in Table 2. Most of the species have intermediate rate of diameter growth and only very few species show high rate of growth.

Table 1
Survival and growth of different species of *Eucalyptus* at Peshawar.

S.No.	Species	Survival % in 1968	Survival % in 1977-78	Av. BDH (cm)	Av. height (m)
1	2	3	4	5	6
1.	<i>Eucalyptus alba</i>	75	20.8	8.3	8.7
2.	<i>E. alben</i>	91.7	87.5	15.6	12.5
3.	<i>E. amplifolia</i>	100	70.8	14.6	12.0
4.	<i>E. argillacea</i>	95.8	95.8	9.8	9.2
5.	<i>E. astringens</i>	75	20.8	12.7	10.7
6.	<i>E. botryoides</i>	54.2	4.2	19.1	5.8
7.	<i>E. bicostata</i>	33.3	8.3	10.0	8.6
8.	<i>E. blakelyi</i>	70.8	45.8	12.9	8.8
9.	<i>E. campaspe</i>	95.8	33.3	3.7	4.6
10.	<i>E. citriodora</i>	95.8	54.2	10.5	11.1

1	2	3	4	5	6
11.	<i>E. cladocalyx</i>	75	54.2	10.9	7.4
12.	<i>E. crebra</i>	100	70.8	18.0	12.5
13.	<i>E. dealbata</i>	70.8	50	12.7	10.1
14.	<i>E. erythronema</i>	33.3	12.5	17.7	10.1
15.	<i>E. fruticetorum</i>	62.5	58.3	11.6	9.5
16.	<i>E. gomphocephala</i>	25	8.3	14.2	9.2
17.	<i>E. gracilis</i>	41.7	29.2	4.5	4.1
18.	<i>E. grandis</i>	87.5	20.8	14.8	12.2
19.	<i>E. hemiphloia</i>	91.7	83.3	12.1	9.5
20.	<i>E. kitsoniana</i>	87.5	75.0	18.5	13.5
21.	<i>E. kondininensis</i>	87.5	58.3	9.0	8.2
22.	<i>E. largiflorens</i>	91.7	58.3	16.8	13.0
23.	<i>E. leptophleba</i>	100	79.2	13.7	11.8
24.	<i>E. leucoxylon</i>	83.3	54.2	10.6	8.1
25.	<i>E. macarthurii</i>	29.2	8.3	22.5	12.6
26.	<i>E. maculata</i>	100	41.7	14.6	14.7
27.	<i>E. melanophloia</i>	79.2	66.7	13.9	11.4
28.	<i>E. microcarpa</i>	79.2	70.8	11.9	12.5
29.	<i>E. microcorys</i>	87.5	20.8	14.1	10.5
30.	<i>E. microtheca</i>	100	90.7	15.5	10.1
31.	<i>E. nova-angelica</i>	50	4.2	5.3	5.6
32.	<i>E. occidentalis</i>	54.2	41.7	10.3	8.1
33.	<i>E. ochrophloia</i>	100	87.5	13.1	11.5
34.	<i>E. oleosa</i>	66.7	45.8	7.7	5.0
35.	<i>E. pallidifolia</i>	100	100	16.0	10.4
36.	<i>E. paniculata</i>	91.7	54.2	10.9	9.3
37.	<i>E. polycarpa</i>	62.5	62.5	16.5	16.2
38.	<i>E. polyanthemus</i>	75	54.2	15.2	10.6
39.	<i>E. populnea</i>	91.7	90.7	13.2	10.9
40.	<i>E. redunca</i>	66.7	66.7	12.9	8.3
41.	<i>E. robusta</i>	37.5	8.3	12.7	11.3
42.	<i>E. rudis</i>	91.7	75.0	16.5	12.1
43.	<i>E. saligna</i>	66.7	20.8	13.2	12.3
44.	<i>E. salubris</i>	75	45.8	8.4	8.8
45.	<i>E. siderophloia</i>	75	45.8	11.5	9.2
46.	<i>E. sideroxylon</i>	91.7	79.2	15.4	11.4
47.	<i>E. stricklandi</i>	91.7	58.3	7.3	6.1
48.	<i>E. tereticornis</i>	70.8	37.5	13.8	7.4
49.	<i>E. torelliana</i>	95.8	83.3	10.6	7.2
50.	<i>E. trachyphloia</i>	95.8	62.5	8.1	6.8
51.	<i>E. woodwardi</i>	70.8	50.0	5.7	4.9
52.	<i>E. mysore hybrid</i>	100	79.2	16.6	14.2

Eucalyptus camaldulensis was not included in the study at Peshawar. However, among all the *Eucalyptus* species tried elsewhere in Pakistan so far, it has proved to be physiologically more adaptable and consequently planted more than other species. Currently, it is the principal species of all *Eucalyptus* planting programme in the country. In a separate *E. camaldulensis* provenance study at Peshawar, which was raised under identical conditions, a diameter growth of 10.4 of 16.3 cms was observed for 13 seed sources of this species over a 10-years period (Siddiqui, 1979). When the growth of fastest growing seed source e.g., 16.3 cms, is compared with 52 species of the present study, *E. camaldulensis* would fall at position 10 in the descending order of diameter growth, from the fastest growing *E. macarthurii* to the slowest growing species *E. compaspe*. Other *Eucalyptus* species are also planted in Pakistan on a limited scale e.g. *E. microtheca* in arid region and *E. tereticornis* in sub-tropical region. These species were tested at Peshawar and occupy position 11 and 20 respectively in the above mentioned order of growth.

The performance of different *Eucalyptus* species was also evaluated for their stem form. A number of species have grown fairly straight as shown in Table 3. Further, almost all the fast growing species exhibit good stem form.

It may be mentioned here that some of the species of the present study were recommended for trial under Pakistan conditions by the workers who evaluated performance of *Eucalyptus* species in the country (Brockway and Khan, 1956; Nawaz, 1964; Boden, 1967), though this was never done systematically in the past. On the other hand, Pryor (1967) had suggested planting of only five species for afforestation purpose e.g., *E. camaldulensis*, *E. microtheca*, *E. citriodora*, *E. melanophloia* and *E. tereticornis*, till suitability of other species is known. There is no doubt that these species have proven their adaptability under local conditions over the years, still the results of the Peshawar study show that it would be useful to test other species of *Eucalyptus* as well in the field trials. The species which have shown promising growth at Peshawar, were never tried on a large scale in Pakistan. Further, seed origin of most of the species in the present study is unknown. This aspect should be taken into consideration in future studies. It would be appropriate to establish provenance trials of the fast growing species in different ecological regions.

Table 2
Classification of *Eucalyptus* species according to diameter growth

S.No.	Diameter classes (cm)	Sl. No. of the species*
1.	3.6— 6.5	9, 17, 31, 51
2.	6.6— 8.5	1, 34, 44, 47, 50
3.	8.6—10.5	4, 7, 10, 21, 32
4.	10.6—12.5	11, 15, 19, 24, 28, 36, 45, 49
5.	12.6—14.5	5, 8, 13, 16, 23, 27, 29, 33, 39, 40, 41, 43, 48
6.	14.6—16.5	2, 3, 18, 26, 30, 35, 38, 37, 42, 46
7.	16.6—18.5	12, 14, 20, 22, 52
8.	18.6—20.5	6
9.	20.6—22.5	25

*as given in Table 1.

Table 3

Classification of Eucalyptus species according to stem form

S.No.	Tree Form	Sl. No. of species*
1.	Fairly straight	1, 4, 6, 7, 10, 11, 12, 13, 14, 15, 16, 18, 23, 25, 26, 27, 28, 29, 35, 36, 37, 39, 41, 43, 45, 49, 52
2.	Forked and branchly	2, 3, 5, 8, 19, 20, 21, 22, 24, 30, 31, 32, 33, 38, 40, 42, 46, 47, 48, 50
3.	Prostrate	9, 17, 34, 44, 51

*as given in Table 1.

Comparison of wood specific gravity and diameter at breast height is given in Table 2. An increase in wood specific gravity is observed with increased diameter growth. The correlation between these parameters is +0.344 but is non-significant. This is quite uncommon. Generally a decrease in wood specific gravity has been observed with increase in diameter growth (Siddiqui, 1979). On the basis of results of present study, it can reasonably be stated that appreciable loss of wood specific gravity would not be encountered in fast growing species of *Eucalyptus*.

Table 4

Comparison of wood specific gravity and growth rate of selected species of Eucalyptus

S.No.	Species	Specific gravity	Average DBH (cms)	Average height
1.	<i>Eucalyptus maculata</i>	.563	14.6	14.7
2.	<i>E. largiflorens</i>	.71	16.8	13.0
3.	<i>E. microtheca</i>	.69	15.5	10.1
4.	<i>E. mysore hybrid</i>	.636	16.6	14.2
5.	<i>E. rudis</i>	.558	16.5	12.1
6.	<i>E. polycarpa</i>	.619	16.5	16.2
7.	<i>E. melanophloia</i>	.687	13.9	11.4
8.	<i>E. kitsoniana</i>	.609	18.5	13.5
9.	<i>E. tereticornis</i>	.475	13.8	7.4
10.	<i>E. grandis</i>	.502	14.8	12.2
11.	<i>E. crebra</i>	.638	18.0	12.5

Conclusion. This study has provided useful data regarding growth performance of a large number of *Eucalyptus* species at Peshawar over a period of more than ten years. A number of species have shown better growth rate than those which are currently commonly planted in afforestation programme in the country. Therefore, large-scale field studies, preferably provenance studies, of the promising species should be immediately started under different ecological conditions which should include local seed sources of those *Eucalyptus* species which are commonly planted. These studies would enable selection of the fastest growing species of *Eucalyptus* for afforestation purpose.

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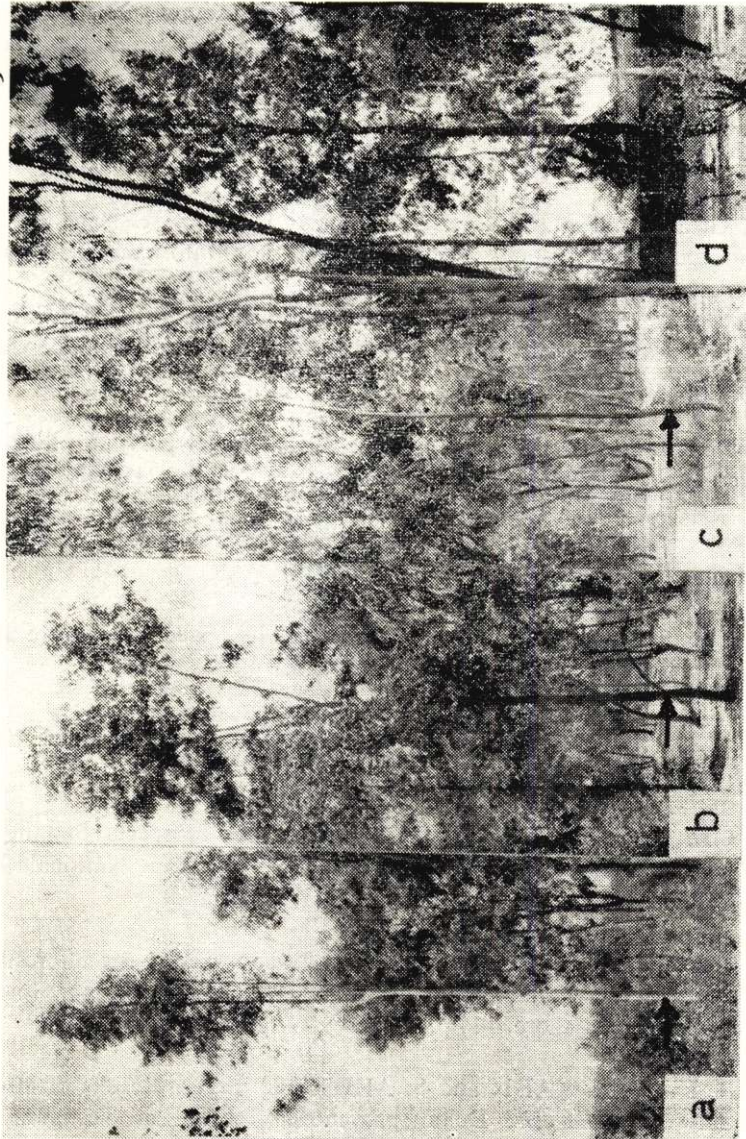


Fig. 1 (a) *Eucalyptus woodwardi* (b) *Euc. fruticetorum*
(c) *Euc. siderophloia* (d) *Euc. kondinensis*

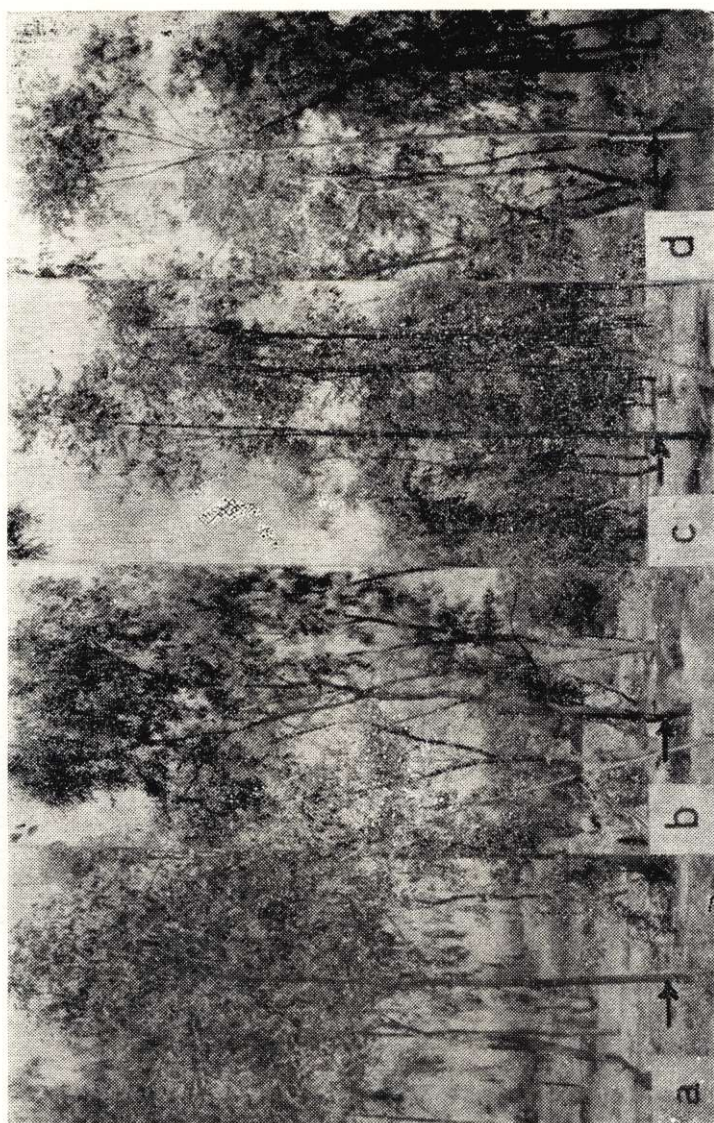
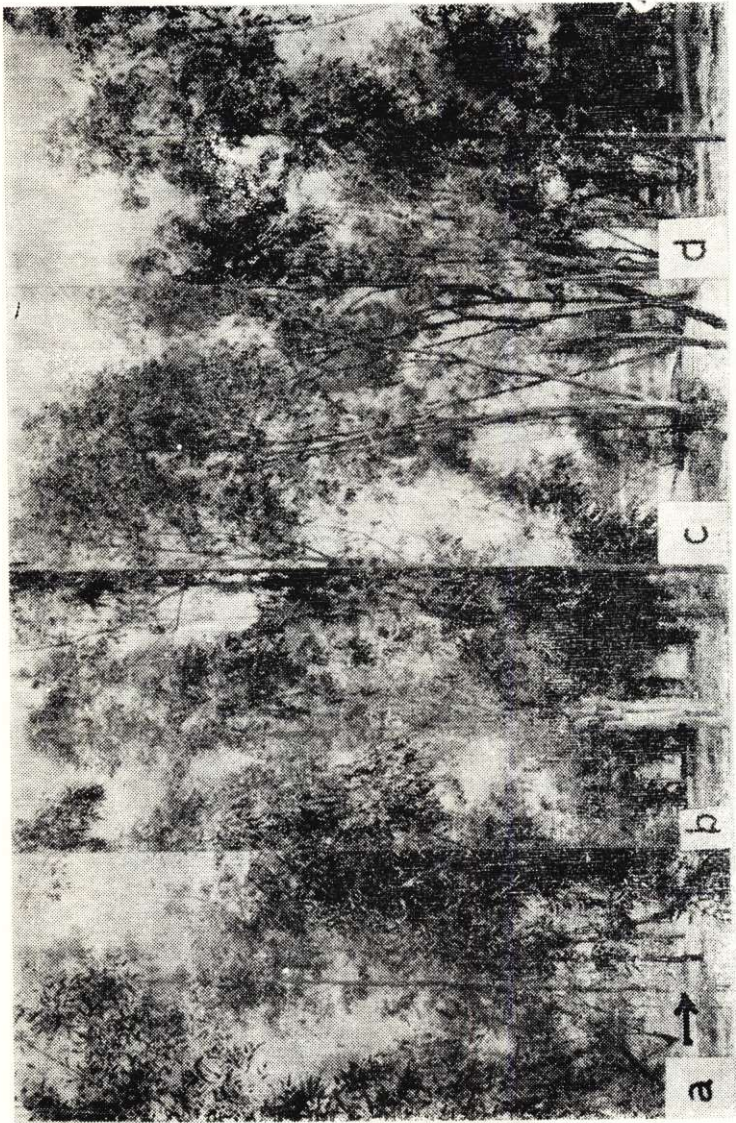


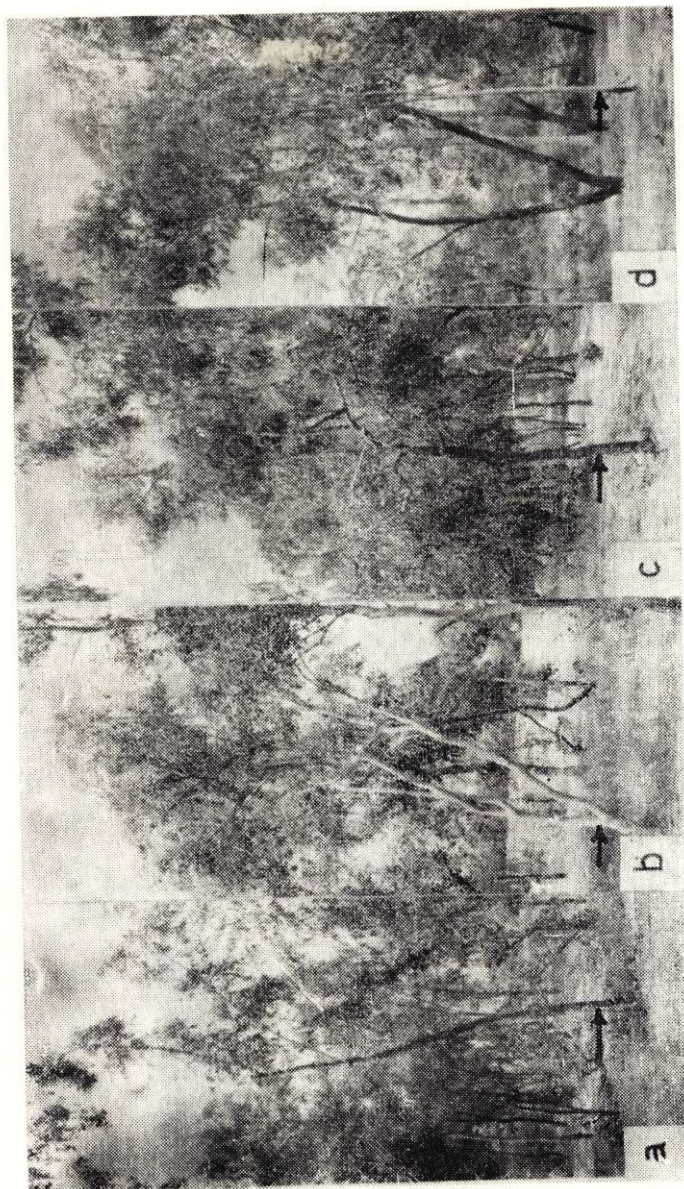
Fig. 2 (a) *Euc. occidentalis* (b) *Euc. leucoxylon*
(c) *Euc. redunca* (d) *Euc. gomphocephala*



(b) *Euc. tereticornis*
(d) *Euc. microcorys*

(a) *Euc. macarthurii*
(c) *Euc. campaspe*

Fig. 3



(b) *Euc. dealbata*
(d) *Euc. alba*

(a) *Euc. salubris*
(c) *Euc. mysores hybrid*

Fig. 4

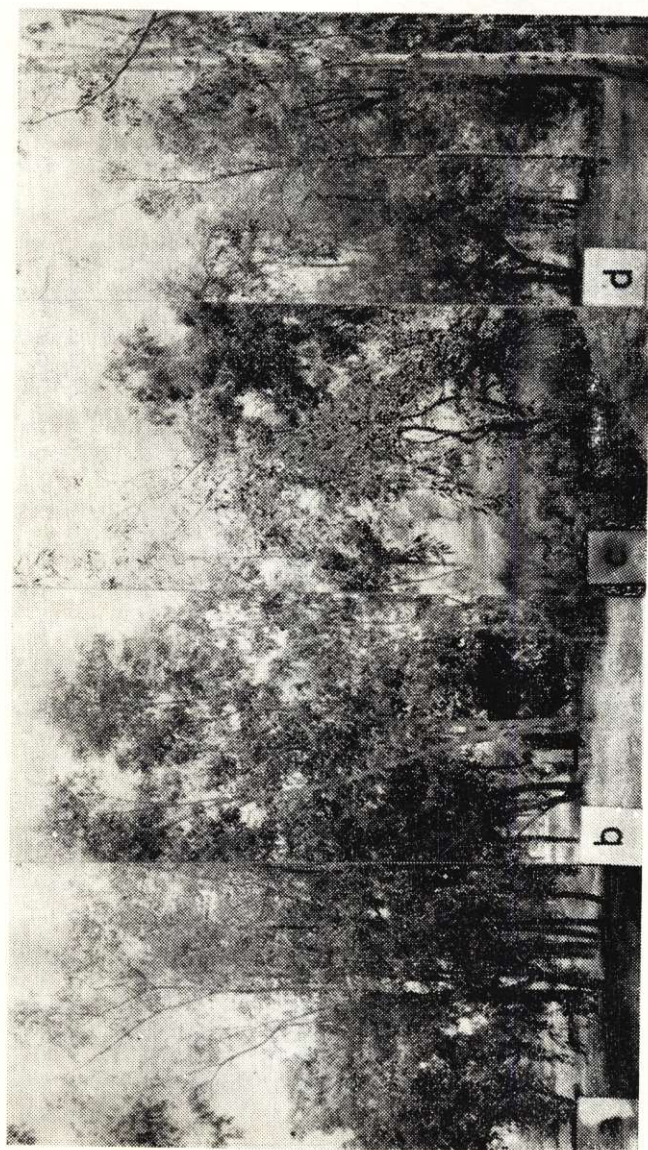
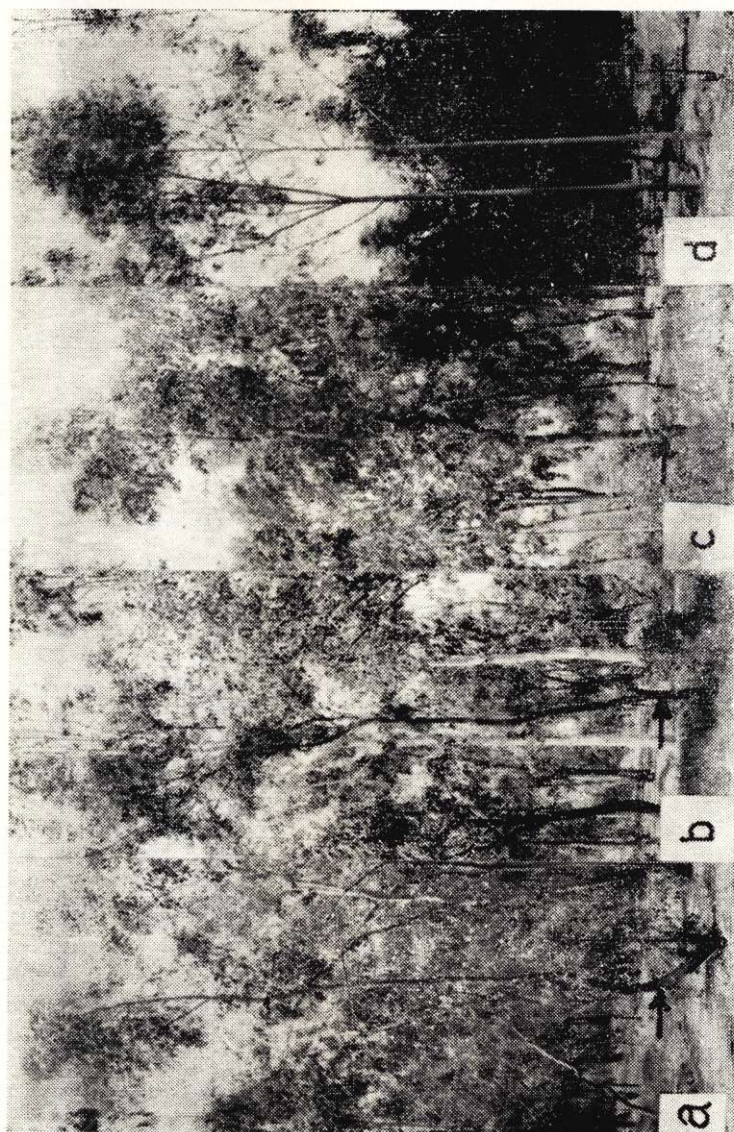


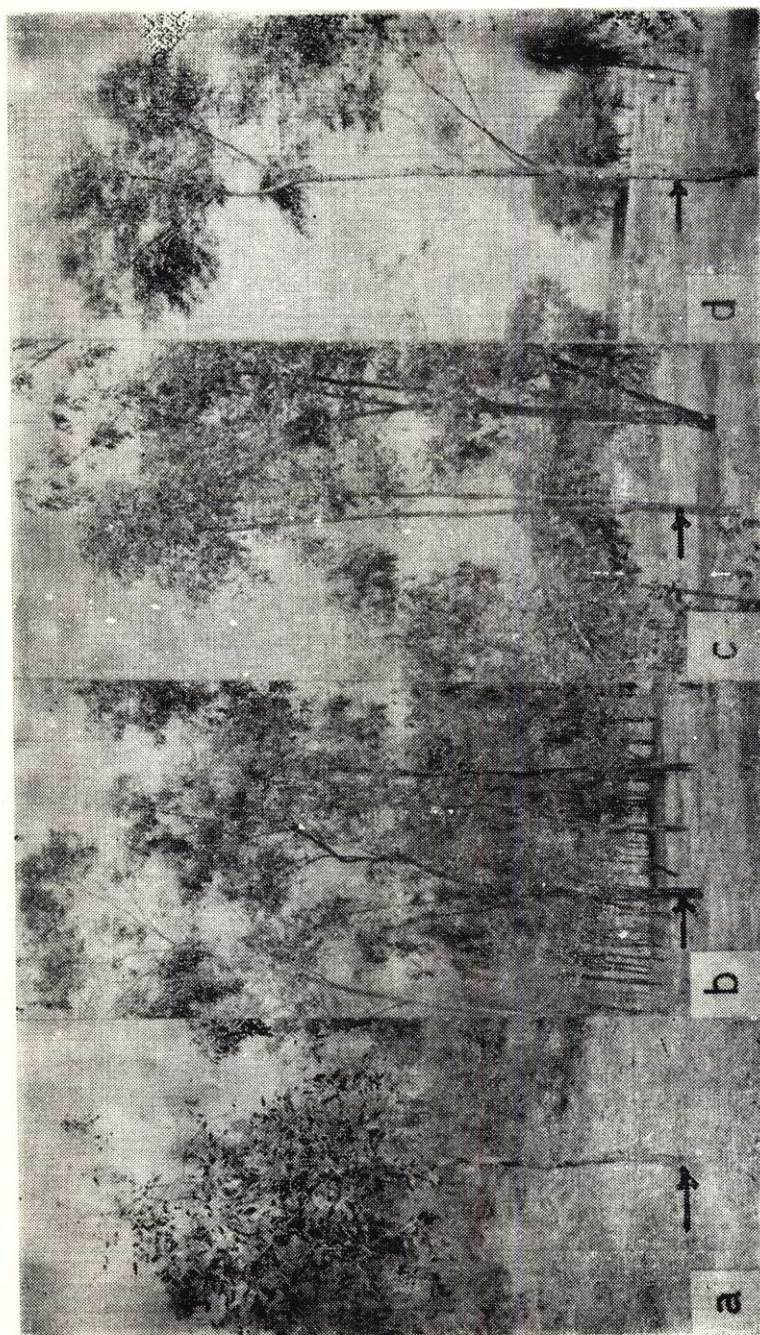
Fig. 5 (a) *Euc. grandis*,
(b) *Euc. melanophloia*,
(c) *Euc. pallidifolia*,
(d) *Euc. sideroxylon*



(b) *Euc. paniculata*
(d) *Euc. crebra*.

(a) *Euc. maculata*
(c) *Euc. microcarpa*

Fig. 6



(b) *Euc. hemiphloia*
(d) *Euc. oitriodora*

(a) *Euc. astringens*
(c) *Euc. polyanthemos*

Fig. 7