FLAVOUR AND FRAGRANCE JOURNAL, VOL. 12, 269–275 (1997)

Volatile Leaf Oils of some South-Western and Southern Australian Species of the Genus *Eucalyptus* (Series I). Part XVII: Subgenus Symphyomyrtus (i) Section Bisectaria, Series Calycogonae and (ii) Section Dumaria, Series Dumosae, Series Rigentes and Series Ovulares

C. M. Bignell[1], P. J. Dunlop[1]* and J. J. Brophy[2]

[1]*Department of Chemistry, University of Adelaide, South Australia, 5005, Australia*
[2]*Department of Organic Chemistry, University of New South Wales, Sydney, NSW 2052, Australia*

The volatile leaf oils of *Eucalyptus yilgarnensis* (Maiden) Brooker, *E. gracilis* F. Muell., *E. quadrans* Brooker & Hopper, *E. calygocona* Turcz. var. *calygocona*, *E. celastroides* Turcz subsp. *celastroides*, *E. celastroides* Turcz. subsp. *virella* Brooker. *E. myriadena* Brooker, *E. aequioperta* Brooker & Hopper, *E. cylindrocarpa* Blakely, *E. ovularis* Maiden & Blakely, *E. cyclostoma* Brooker, *E. rigens* Brooker & Hopper, *E. famelica* Brooker & Hopper, *E. striaticalyx* W. Fitzg. subsp. *striaticalyx*, *E. striaticalyx* W. Fitzg. subsp. *gypsophila* D. Nicolle, *E. striaticalyx* W. Fitzg. subsp. *beadellii* D. Nicolle, *E. striaticalyx* W. Fitzg. subsp. *canescens* D. Nicolle, *E.* 'species U', *E.* 'aff. *pileata*' (Eyre Peninsular form), isolated by vacuum distillation, were analysed by GC and by GC–MS. Many species contained α-pinene (0.08–33.1%), limonene (0–3.6%), 1,8-cineole (2.6–86.1%), *p*-cymene (0.3–14.2%), pinocarvone (0–9.0%), aromadendrene (0–29.9%), *allo*-aromadendrene (0–2.5%), *trans*-pinocarveol (0–22.0%), globulol (0.07–6.6%), spathulenol (0.07–8.0%) and torquatone (0.06–3.0%) as principal leaf oil components. © 1997 by John Wiley & Sons, Ltd.

Flavour Fragr. J., **12**, 269–275 (1997) (No. of Figures: 0 No. of Tables: 2 No. of Refs: 10)

KEY WORDS: *Eucalyptus yilgarnensis* (Maiden) Brooker; *Eucalyptus gracilis* F. Muell.; *Eucalyptus quadrans* Brooker & Hopper; *Eucalyptus calygocona* Turcz. var. *calygocona*; *Eucalyptus celastroides* Turcz. subsp. *celastroides*; *Eucalyptus celastroides* Turcz. subsp. *virella* Brooker; *Eucalyptus myriadena* Brooker; *Eucalyptus aequioperta* Brooker & Hopper; *Eucalyptus cylindrocarpa* Blakely; *Eucalyptus ovularis* Maiden & Blakely; *Eucalyptus cyclostoma* Brooker; *Eucalyptus rigens* Brooker & Hopper; *Eucalyptus famelica* Brooker & Hopper; *Eucalyptus striaticalyx* W. Fitzg. subsp. *striaticalyx*; *Eucalyptus striaticalyx* W. Fitzg. subsp. *gypsophila* D. Nicolle; *Eucalyptus striaticalyx* W. Fitzg. subsp. *beadellii* D. Nicolle; *Eucalyptus striaticalyx* W. Fitzg. subsp. *canescens* D. Nicolle; *Eucalyptus* 'species U'; *Eucalyptus* 'aff. *pileata*' (Eyre Peninsular form); Myrtaceae; leaf essential oil composition; torquatone; mono- and sesquiterpenoids; GC–MS

INTRODUCTION

Continuing our investigation of indigenous Australian eucalypts[1] we have examined the leaf oils of six species of Series Calycogonae, six of Series Dumosae, two of Series Rigentes and five of Series Ovulares. In this study we have followed the system of M. I. H. Brooker and D. A. Kleinig.[2] Locations of all species, which are native to south-western and southern Australia, are listed in Table 1. A more detailed description of the occurrence of these eucalypts has been given elsewhere.[2]

To our knowledge only analyses of the leaf oils of *E. gracilis*,[3] *E. calycogona*,[4] and *E. celastroides*[4] have been published previously.

EXPERIMENTAL

Samples of clean, mature leaves were picked from single trees and, after freezing with liquid nitrogen,

* Correspondence to: P. J. Dunlop, Department of Chemistry, University of Adelaide, South Australia, 5005, Australia.

CCC 0882–5734/97/040269–07$17.50

Received 20 June 1996
Accepted 16 September 1996

were reduced to a fine powder using a stainless steel Waring Blender (Model no. SS110). This procedure was necessary to rupture the oil glands. The dry powder was then vacuum-distilled so that the leaf oil condensed on to a gold-plated copper rod maintained at approximately −75°C. Complete details of this procedure have been published previously.[5,6] All oils obtained were colourless to pale yellow and lighter than water. Table 1 lists the oil yields (wt%, dry weight) for the 19 species studied.

The GC analyses were performed with a HP5890 Series II unit operated in conjunction with a HP3396 Series II integrator. The 'on-column' injection technique was used with a SGE BP20 capillary column (25 m × 0.33 mm i.d., film thickness 0.5 μm). The carrier gas was hydrogen with an inlet pressure of 25 kPa: the flow rate was 2.0 cm^3/min. The oven was programmed to rise from 80°C to 220°C at 5°/min, and the inlet temperature set to 83°C and increased at the same rate as the column. Using these conditions and a 1.0 μl sample of 0.4% solution of oil in purified dry diethyl ether, essentially all the components were recorded by the integrator in 31 minutes. GC–MS was performed on a VG Quattro mass spectrometer operating at 70 eV ionization energy. The GC column in this case was a DB-Wax (60 m × 0.32 mm). Compounds were identified by their GC retention indices to known compounds and by comparison of their mass spectra with either known compounds or published spectra.[7–9]

Only three of the species (*E. striaticalyx*, *E. yilgarnensis* and *E. myriadena*) were analysed with GC–MS. The oil components of the rest were identified using normalized retention times. For this purpose the column was calibrated by assuming times for three markers, 1,8-cineole, octadecane (OD added to the ether) and torquatone. The raw retention times were first normalized to 525 s for OD, and times before and after OD adjusted by *assuming* linearity and using *99s* for cineole and *997s* for torquatone. Torquatone was found to be present in all oil samples. The normalized retention times of the column were identified with oil components analysed previously by GC–MS for over 100 *Eucalyptus* species: some of these results have been published.[1] In addition, Kováts Indices were obtained (see Table 2) by running a mixture of C_{10}–C_{25} alkanes on the SGE-BP20/GC column.

All GC analyses were performed in duplicate and the retention times and percentage compositions of each component averaged. Duplicate times were

Table 1. Oil yields from the *Eucalyptus* species, Series Calycogonae, Series Dumosae, Series Rigentes and Series Ovulares[a]

Species and locality	Oil yield (wt%, dry weight)
Series Calycogonae	
E. yilgarnensis (Maiden) Brooker[b] (S31°03′21″/E120°48′15″)	0.79
E. gracilis F. Muell. Waite Arboretum, South Australia	0.56
E. quadrans Brooker & Hopper[b] (S33°21′43″/E121°41′51″)	0.76
E. calycogona Turcz. var. *calycogona* Waite Arboretum, South Australia	1.37
E. celastroides Turcz. subsp. *celastroides* Waite Arboretum, South Australia	2.39
E. celastroides Turcz. subsp. *virella* Brooker Badgingarra, Western Australia	0.59
Series Dumosae	
E. striaticalyx W. Fitzg. subsp. *striaticalyx*[b] (S27°17′10″/E117°55′44″)	1.73
E. striaticalyx W. Fitzg. subsp. *gypsophila* D. Nicolle[b] (S28°05′35″/E115°39′29″)	0.77
E. striaticalyx W. Fitzg. subsp. *beadellii* D. Nicholle[b] (S29°20′07″/E130°13′15″)	0.71
E. striaticalyx W. Fitzg. subsp. *canescens* D. Nicholl[b] (S29°48′40″/E131°10′00″)	3.70
E. 'species U' Currency Creek Arboretum, South Australia	0.85
E. 'aff. *pileata*' (Eyre Peninsular form) Currency Creek Arboretum, South Australia	2.06
Series Rigentes	
E. rigens Brooker & Hopper[b] (S33°20′55″/E121°46′00″)	1.98
E. famelica Brooker & Hopper[b] (S33°47′48″/E120°26′01″)	0.53
Series Ovulares	
E. myriadena Brooker[b] (S32°38′33″/E118°11′50″)	1.46
E. aequioperta Brooker & Hopper Currency Creek Arboretum, South Australia	1.09
E. cylindrocarpa Blakely Waite Arboretum, South Australia	1.87
E. ovularis Maiden & Blakely[b] (S33°08′49″/E112°06′29″)	0.96
E. cyclostoma Brooker, Currency Creek Arboretum, South Australia	2.03

[a] The specimens for these species were authenticated by Mr M. I. H. Brooker, Australian National Herbarium, or Dean Nicolle, Currency Creek Arboretum.
[b] Botanical voucher specimens have been deposited at the South Australian Herbarium by Dean Nicolle, who collected the leaves for these species.

Table 2. Compounds identified and their percentage occurence (0.05%) in the leaf oil of *Eucalyptus* species[a]

	Kováts indices	*E. yilgarnensis* (Maiden) Brooker	*E. gracilis* F. Muell.	*E. quadrans* Brooker & Hopper	*E. celastroides* Turcz. subsp. *celastroides*	*E. calcogona* Turcz. var. *calcogona*	*E. celastroides* Turcz. subsp. *virella* Brooker	*E. striaticalyx* W. Fitg. subsp. *striaticalyx*	*E. striaticalyx* W. Fitzg. subsp. *gypsophila* D. Nicolle	*E.striaticalyx* W. Fitzg. subsp. *beadellii* D. Nicolle	*E. striaticalyx* W. Fitzg. subsp. *canescens* D. Nicolle	*E.* 'species U'	*E.* 'aff. *pileata*' (Eyre Peninsular form)	*E. rigens* Brooker & Hopper	*E. famelica* Brooker & Hopper	*E. myriadena* Brooker	*E. aequioperta* Brooker & Hopper	*E. cylindrocarpa* Blakely	*E. ovularis* Maiden & Blakely	*E. cyclostoma* Brooker
Series		Calycogonae							Dumosae					Rigentes		Ovulares				
1 α-Pinene	1038	3.9	3.0	6.0	27.2	26.8	2.3	0.08	1.4	14.7	12.9	33.1	25.8	4.0	0.1	3.2	10.1	22.0	11.3	30.8
2 α-Fenchene	1084	–	–	–	–	–	–	–	0.07	0.08	–	–	–	–	–	–	–	–	–	–
3 Camphene	1085	–	–	–	–	0.09	–	–	0.2	0.3	–	–	–	–	–	0.07	–	–	–	–
4 *β*-Pinene	1128	5.1	8.5	0.1	0.4	0.3	4.6	–	–	0.2	0.8	0.4	0.5	0.2	–	–	3.2	8.6	0.9	1.0
5 Sabinene	1149	1.1	0.5	–	–	0.07	0.1	–	–	0.1	–	0.08	0.08	–	–	–	0.9	0.3	0.07	–
6 Myrcene	1175	0.8	0.09	–	0.7	0.2	–	–	–	–	0.07	–	0.3	–	–	–	0.9	0.2	0.08	0.2
7 α-Phellandrene	1186	2.4	–	–	3.6	0.1	0.2	–	–	–	–	–	–	–	–	–	6.8	0.3	0.3	0.4
8 Isobutyl isovalerate	1199	–	–	0.07	0.1	–	–	–	–	–	–	–	–	–	–	–	–	0.07	–	–
9 Limonene	1219	0.5	0.5	0.1	3.6	1.6	0.3	–	–	0.4	1.3	1.6	1.6	–	–	–	1.3	1.4	0.9	1.8
10 1,8-Cineole	1231	12.5	2.6	43.4	44.7	37.0	28.5	77.5	56.2	16.0	13.2	30.9	28.5	68.7	86.1	70.9	35.7	16.9	45.7	33.9
11 *β*-*cis*-Ocimene	1248	–	–	–	–	–	–	0.07	–	–	–	–	0.06	–	–	–	–	0.3	–	–
12 *γ*-Terpinene	1266	0.1	–	0.06	0.5	0.2	–	–	–	–	–	–	0.1	–	–	–	0.3	0.2	–	–
13 *β*-*trans*-Ocimene	1271	–	–	–	–	0.08	–	–	–	0.06	–	–	–	–	–	–	–	–	–	–
14 *p*-Cymene	1292	13.9	10.7	3.4	1.3	0.3	14.2	4.8	1.0	1.0	1.3	0.7	0.5	0.6	1.4	2.3	3.3	9.7	7.0	1.2
15 Terpinolene	1300	0.07	–	–	0.09	–	–	0.3	–	–	–	–	–	–	–	0.8	0.2	–	–	–
16 Isoamyl isovalerate	1304	–	–	0.9	0.6	0.07	–	–	0.09	0.3	–	0.07	–	–	–	–	–	0.7	–	0.4
17 α-*p*-Dimethylstyrene	1457	0.06	–	–	–	–	–	–	–	0.06	–	–	–	–	–	–	–	–	–	–
18 α-Cubebene	1480	0.07	–	–	0.09	0.1	–	–	–	–	0.2	–	0.2	–	–	–	0.5	–	–	0.08
19 α-Copaene	1505	–	–	0.07	–	0.09	–	–	–	0.09	0.07	0.3	0.2	–	–	–	0.1	0.08	–	0.4
20 α-Campholenic aldehyde	1511	0.1	0.6	0.08	–	0.1	0.2	–	–	0.2	–	0.3	0.09	0.06	–	–	–	0.5	–	0.4
21 α-Gurjunene	1545	1.0	1.0	–	0.5	0.9	–	–	–	–	–	–	0.8	–	–	–	1.7	0.4	–	0.3
22 *β*-Cubebene	1553	–	–	–	–	–	0.06	–	–	–	–	–	–	–	–	–	–	–	–	–
23 Linalol	1564	0.5	0.5	–	–	–	–	–	–	–	–	–	–	–	–	–	0.5	0.2	0.07	–
24 *trans*-*p*-Menth-2-en-1-ol	1578	0.1	–	–	–	–	0.1	–	–	–	–	–	–	–	–	–	0.1	0.07	–	–

Table continued on next page

	Kováts indices	*E. yilgarnensis* (Maiden) Brooker	*E. gracilis* F. Muell.	*E. quadrans* Brooker & Hopper	*E. celastroides* Turcz. subsp. *celastroides*	*E. calcogona* Turcz. var. *calcogona*	*E. celastroides* Turcz. subsp. *virella* Brooker	*E. striaticalyx* W. Fitg. subsp. *striaticalyx*	*E. striaticalyx* W. Fitzg. subsp. *gypsophila* D. Nicolle	*E.striaticalyx* W. Fitzg. subsp. *beadellii* D. Nicolle	*E. striaticalyx* W. Fitzg. subsp. *canescens* D. Nicolle	*E.* 'species U'	*E.* 'aff. *pileata*' (Eyre Peninsular form)	*E. rigens* Brooker & Hopper	*E. famelica* Brooker & Hopper	*E. myriadena* Brooker	*E. aequioperta* Brooker & Hopper	*E. cylindrocarpa* Blakely	*E. ovularis* Maiden & Blakely	*E. cyclostoma* Brooker
25 Camphor	1580	–	0.2	–	–	–	–	–	–	–	–	–	0.07	–	–	–	–	–	–	–
26 Pinocarvone	1590	0.9	3.5	5.2	0.2	2.3	1.5	–	4.0	9.0	–	2.7	0.6	5.3	0.2	2.1	0.4	1.3	2.7	1.9
27 Fenchol	1598	1.1	–	–	0.08	0.2	1.3	–	–	–	–	–	–	0.2	0.06	–	–	0.9	0.1	–
28 *β*-Elemene	1602	–	1.6	–	–	–	–	–	–	–	0.2	–	–	–	–	–	–	–	–	–
29 *β*-Gurjunene	1606	–	–	0.06	0.07	0.6	–	–	–	0.3	–	0.5	0.6	–	–	–	0.07	–	0.06	0.2
30 *β*-Caryophyllene	1611	0.2	0.1	0.2	–	0.09	–	–	–	0.06	–	0.1	0.9	–	–	0.1	–	–	0.5	1.2
31 Terpinen-4-ol	1617	0.5	1.0	–	0.7	–	0.4	–	–	–	–	–	–	–	0.3	0.2	0.7	–	–	–
32 Aromadendrene	1620	0.08	0.2	1.8	1.9	10.9	0.3	2.4	–	16.9	29.9	6.9	11.3	0.2	–	–	0.6	1.8	4.3	5.1
33 α-Bulnesene	1629			0.06	–	0.4	–	–	–	0.5	0.5	0.2	0.3	–	–	–	–	–	0.1	0.2
34 *cis*-*p*-Menth-2-en-1-ol	1645	0.3	0.3	–	0.06	–	0.2	–	–	–	0.06	0.06	–	–	–	–	0.4	0.1	–	0.1
35 Myrtenal	1647	1.5	3.8	0.1	–	–	2.7	–	0.08	0.2	0.06	–	–	0.3	0.06	–	0.2	1.9	0.4	–
36 *allo*-Aromadendrene	1659	0.3	0.4	0.4	0.4	1.2	0.4	0.4	–	1.6	2.5	1.0	1.8	–	–	0.2	0.6	0.4	0.6	0.8
37 *trans*-Pinocarveol	1671	2.9	6.1	20.5	0.8	8.0	–	1.1	17.6	22.0	2.0	7.1	1.9	11.0	0.2	8.8	0.9	4.6	8.6	3.1
38 Humulene	1684	–	–	0.3	–	–	0.1	0.1	–	–	–	0.08	0.1	–	0.3	0.3	–	–	0.3	–
39 *δ*-Terpineol	1687	–	–	–	0.1	–	–	–	0.1	0.1	–	–	–	0.2	–	0.2	0.08	–	0.4	–
40 Cryptone	1690	10.4	10.4	–		–	8.6	–	–	–	0.1	–	0.06	–	0.2	–	2.8	1.6	–	–
41 *cis*-Piperitol	1692	–	–	0.06	–	–	–	–	–	–	0.1	–	–	0.3	–	–	–	1.4	0.1	0.08
42 Neral	1702	–	–	–	0.1	0.1	–	–	–	–	0.2	0.07	0.3	–	–	–	–	0.1	0.1	0.1
43 Viridiflorene	1704	–	–	–	0.5	0.6	–	0.2	–	–	–	–	0.4	–	–	0.3	0.1	–	0.07	0.1
44 α-Terpineol	1711	0.4	0.6	0.2	1.7	0.4	0.3	–	0.06	0.1	0.1	0.3	0.3	–	–	–	0.5	0.6	0.4	0.3
45 Borneol	1717	0.3	0.2	0.3	0.1	0.2	0.1	–	0.6	0.4	–	0.1	0.1	0.08	–	–	–	0.1	0.1	–
46 Verbenone	1725	1.4	1.5	0.06	–	–	1.7	–	–	0.07	–	–	–	0.3	0.9	–	0.1	1.3	0.2	–
47 *β*-Selinene	1731	0.1	–	0.2	0.07	0.2	–	–	–	–	0.3	0.3	0.3	0.07	–	–	–	–	0.2	0.3
48 α-Selinene	1735	–	–	–	–	0.08	–	–	–	–	–	0.07	0.2	–	–	0.4	–	–	0.2	0.2
49 A Muurolene	1742	–	–	0.3	0.3	0.2	–	0.4	0.4	0.2	0.09	0.08	–	0.2	0.3	–	–	–	–	–
50 Piperitone	1744	0.09	0.6	0.1	–	0.5	0.7	0.2	–	–	0.3	0.4	–	–	–	1.0	–	0.4	0.5	–

51 Bicyclogermacrene	1747	1.4	–	–	0.2	–	–	–	–	–	–	–	6.2	–	–	–	11.8	–	–	3.1
52 Carvone	1750	0.3	0.4	0.2	–	–	0.4	0.2	0.1	0.1	–	–	–	–	0.3	0.1	–	0.4	0.1	–
53 *trans*-Piperitol	1761	0.09	0.1	–	0.06	–	0.09	–	–	–	0.08	0.1	0.09	–	–	–	0.06	0.1	0.08	0.07
54 δ-Cadinene	1774	0.1	0.3	–	0.2	0.2	–	–	–	–	0.4	0.2	0.3	0.1	–	–	0.1	0.2	–	0.3
55 γ-Cadinene	1779	–	0.1	–	–	–	–	–	–	–	–	–	0.07	–	–	–	0.1	–	–	–
56 Myrtenol	1807	1.1	2.9	0.4	–	–	2.3	–	0.4	0.4	0.2	0.2	–	–	0.08	0.2	0.3	2.0	0.5	0.1
57 Cadina-1,4-diene	1810	–	–	–	–	0.1	–	–	–	–	–	–	0.4	–	–	–	–	–	–	–
58 *trans*-*p*-Mentha -1(7),8-dien-2-ol	1811	0.4	0.6	0.9	0.2	0.2	0.6	0.6	0.8	0.4	0.2	0.3	–	0.4	0.1	0.8	0.2	0.4	0.5	0.2
59 Calamenene	1847	–	0.3	–	–	–	–	–	–	–	0.08	–	–	–	0.06	–	–	0.3	0.06	0.1
60 *trans*-*p*-Mentha-1,8 -dien-6-ol	1850	0.4	0.8	–	–	0.1	–	0.07	0.1	0.2	–	0.2	0.08	0.4	0.1	0.2	0.1	0.5	0.3	0.1
61 Geraniol	1859	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0.6	–	–	–
62 *p*-Cymen-8-ol	1865	1.6	0.9	0.2	–	–	1.4	0.1	0.1	0.1	0.2	0.07	0.1	–	0.4	0.1	0.1	0.5	0.2	0.08
63 *cis*-*p*-Mentha-1,8 -dien-6-ol	1881	–	0.07	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
64 *cis*-*p*-Mentha-1(7),8 -dien-2-ol	1903	0.06	–	1.0	0.09	0.2	–	–	0.9	–	–	–	–	0.6	–	0.8	–	0.09	0.4	–
65 Calacorene	1932	0.06	0.1	–	–	–	0.06	–	0.06	–	–	–	–	–	–	0.2	–	0.1	–	–
66 Palustrol	1938	0.3	0.1	–	0.2	–	0.09	0.2	–	–	–	–	0.1	–	0.1	–	0.1	0.2	0.5	0.09
67 Caryophyllene oxide	1994	0.4	0.7	0.1	–	–	0.2	–	–	–	–	–	–	0.08	0.09	0.07	–	–	0.2	0.1
68 β-Phenylethyl propionate	2001	0.07	0.09	0.06	–	–	–	–	–	–	–	–	–	–	–	–	–	0.1	–	–
69 $C_{15}H_{26}O$	2008	0.3	0.7	–	–	0.06	0.2	0.06	–	0.09	0.3	0.08	0.1	–	–	–	0.3	0.2	0.07	0.06
70 $C_{15}H_{26}O$	2023	0.1	0.1	0.2	0.2	0.4	–	0.4	–	0.7	1.6	0.5	0.8	–	0.1	–	0.06	–	0.3	0.6
71 $C_{15}H_{26}O$	2040	0.2	0.1	0.09	0.06	0.06	0.08	0.06	0.08	0.1	0.3	0.09	0.2	–	0.1	–	0.2	0.1	0.08	0.08
72 $C_{15}H_{26}O$	2050	0.08	0.1	–	–	–	0.1	–	–	0.06	–	0.07	–	0.06	–	–	–	–	–	
73 $C_{15}H_{26}O$	2070	0.8	–	–	0.08	0.08	0.06	0.2	–	0.1	0.3	0.08	0.2	–	–	0.09	–	–	–	0.07
74 $C_{15}H_{26}O$	2076	0.06	–	–	0.08	–	0.06	0.07	–	–	0.6	–	0.06	–	–	–	0.07	–	0.1	–
75 Globulol	2085	0.4	0.4	0.8	0.9	1.3	0.2	1.9	0.07	2.1	6.6	1.8	3.5	0.1	0.8	0.1	0.3	0.5	1.2	1.1
76 Viridiflorol	2093	0.3	0.2	0.3	0.3	0.3	0.1	0.3	–	0.3	1.9	0.4	0.9	0.1	0.3	0.07	0.1	0.2	0.3	0.3
77 Guaiol	2104	0.1	–	–	–	–	0.1	–	–	–	0.8	–	0.2	0.06	–	0.07	–	0.07	0.06	0.1
78 $C_{15}H_{26}O$	2110	2.0	2.0	0.2	0.1	0.1	1.5	0.3	–	0.3	0.6	0.2	0.4	–	0.2	–	0.5	0.4	0.3	0.2
79 $C_{15}H_{26}O$	2120	–	0.06	0.2	0.3	0.2	–	0.1	0.06	0.2	0.5	0.2	0.5	0.09	–	–	–	–	0.2	0.2
80 Spathulenol	2136	2.5	4.5	0.1	0.07	0.2	3.2	0.3	0.08	0.09	8.0	0.2	1.6	0.3	0.3	0.5	3.2	3.4	0.6	0.4
81 $C_{15}H_{24}O$	2153	–	–	–	–	–	0.2	–	–	–	0.9	–	–	–	–	–	–	–	–	–
82 γ-Eudesmol	2177	–	0.1	–	–	–	0.6	0.06	0.06	–	0.1	–	0.2	–	–	–	0.1	0.1	–	0.2
83 δ-Cadinol	2187	0.6	–	–	–	–	–	–	–	–	–	0.6	0.3	–	–	–	–	–	–	0.5
84 $C_{15}H_{26}O$	2197	0.2	–	–	–	–	–	–	–	–	–	–	0.2	–	–	–	–	–	–	0.2
85 $C_{15}H_{26}O$	2216	2.0	1.2	–	–	–	–	–	–	–	–	0.2	–	–	–	–	–	0.3	–	–
86 $C_{15}H_{26}O$	2223	0.3	0.4	–	–	–	0.2	0.3	–	–	–	–	–	–	0.07	0.1	0.1	0.2	0.06	–
87 α-Eudesmol	2234	0.8	0.5	0.7	0.1	0.07	0.6	–	0.1	–	0.1	0.6	0.7	–	–	0.2	0.4	0.6	0.8	1.2
88 β-Eudesmol	2244	2.6	1.2	3.7	0.1	0.2	–	–	7.6	–	0.2	3.2	1.4	1.8	–	0.8	0.6	1.1	1.4	3.2
89 $C_{15}H_{26}O$	2263	–	–	–	–	–	–	–	0.2	–	–	–	–	–	–	–	–	0.1	–	–
90 $C_{15}H_{26}O$	2269	1.7	–	0.1	–	–	–	0.08	–	–	0.3	–	0.1	–	–	–	–	0.5	–	–
91 Farnesyl acetate	2271	–	2.8	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
92 Jacksonone	2280	–	–	–	–	–	–	–	–	–	–	–	–	–	0.1	–	–	–	0.4	–
93 Component A	2293	–	–	–	0.2	–	–	–	–	0.1	–	–	–	–	–	–	–	–	–	–

Table continued on next page

	Kováts indices	*E. yilgarnensis* (Maiden) Brooker	*E. gracilis* F. Muell.	*E. quadrans* Brooker & Hopper	*E. celastroides* Turcz. subsp. *celastroides*	*E. calcogona* Turcz. var. *calcogona*	*E. celastroides* Turcz. subsp. *virella* Brooker	*E. striaticalyx* W. Fitg. subsp. *striaticalyx*	*E. striaticalyx* W. Fitzg. subsp. *gypsophila* D. Nicolle	*E.striaticalyx* W. Fitzg. subsp. *beadellii* D. Nicolle	*E. striaticalyx* W. Fitzg. subsp. *canescens* D. Nicolle	*E.* 'species U'	*E.* 'aff. *pileata*' (Eyre Peninsular form)	*E. rigens* Brooker & Hopper	*E. famelica* Brooker & Hopper	*E. myriadena* Brooker	*E. aequioperta* Brooker & Hopper	*E. cylindrocarpa* Blakely	*E. ovularis* Maiden & Blakely	*E. cyclostoma* Brooker
94 Tasmanone	2303	0.1	–	0.1	–	–	0.7	–	–	–	–	–	–	–	0.06	0.2	0.1	–	–	–
95 Isobicyclogermacral	2325	0.7	–	0.4	–	–	0.4	–	–	–	–	0.06	0.08	–	0.1	–	0.2	–	0.1	–
96 (*E*,*E*) Farnesol	2366	0.2	–	–	–	–	–	–	–	–	–	–	–	–	0.09	–	0.4	–	–	–
97 Agglomerone	2381	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0.06	–	–	–
98 Component B	2382	–	–	–	0.1	–	–	–	–	0.06	–	–	–	–	–	–	–	–	–	–
99 Torquatone	2424	0.4	0.5	0.3	3.0	0.2	0.09	0.6	0.4	2.2	0.6	0.09	0.09	0.1	0.3	0.2	0.2	0.1	0.08	0.06
Total percentages:		85.4	80.0	94.1	97.0	97.9	81.9	93.5	92.9	92.5	91.1	96.9	96.8	95.8	94.0	95.6	93.4	91.2	95.2	97.3

[a] Kováts indices on SGE-BP20.

discarded if they differed from each other by more than 1 s. Components which contributed less than 0.06% to the final analyses were not considered (an arbitrary but practical decision).

RESULTS AND DISCUSSION

Freshly isolated oils obtained by vacuum distillation of powdered leaves from *single* trees were analysed by GC and by GC–MS. The results for the nineteen species are listed in Table 2; only those components with concentrations greater than 0.05% are reported. The principal components in the oils were the monoterpenes α-pinene (0.08–33.1%), *β*-pinene (0–8.6%), 1,8-cineole (2.6–86.1%) and *p*-cymene (0.3–14.2%). Apart from 1,8-cineole, the *main* oxygenated monoterpenes detected were pinocarvone (0–9.0%), *trans*-pinocarveol (0–22.0%), and α-terpineol (0–1.7%).

The principal sesquiterpenes encountered in these species were aromadendrene (0–29.9%), *allo*-aromadendrene (0–2.5%) and the related alcohols, globulol (0.07–6.6%) and spathulenol (0.07–8.0%). The aromatic ketone torquatone was detected (0.06–3.0%) in all of the 19 species. The structure 2,4,6-trimethoxy-3,5-dimethylisobutrophenone has been tentatively assigned to component A: component B is an analogous structure with a C-5 side chain (see Series 1, Part IX[10]).

Our oil analyses agreed to some extent with those of previous workers[4] but not with others;[3] in *general* more components were identified.

Acknowledgements — The authors thank Mr Ian Brooker, Australian National Herbarium and Dean Nicolle, Currency Creek Arboretum, South Australia, for identifying the species and helpful discussions. We are grateful to Dr Jennifer Gardner, Curator of the Waite Arboretum, for her interest in this study. This work was supported in part by a grant from the Australian Council for International Agricultural Research (ACIAR) to J.J.B.

REFERENCES

1. (Series I) Part XVI. C. M. Bignell, P. J. Dunlop and J. J. Brophy, *Flavour Fragr. J.* **12**, 261 (1997), and earlier Parts cited therein.
2. M. I. H. Brooker and D. A. Kleinig, *A Field Guide to the Eucalypts*, Vol. 2, Inkata Press, Melbourne (1990).
3. R. T. Baker and H. G. Smith, *A Research on the Eucalypts, Especially in Regard to their Essential Oils*, 2nd edn, Government Printer, Sydney (1920).
4. J. J. Brophy and E. V. Lassak, *Flavour Fragr. J.*, **6**, 265 (1991).
5. R. B. Inman, P. J. Dunlop and J. F. Jackson, *Modern Methods of Plant Analysis, New Series*, Vol. 12, ed. H. F. Linskens and J. F. Jackson, Springer-Verlag, Berlin, p. 201 (1991).
6. C. P. Milner, R. D. Trengove, C. M. Bignell and P. J. Dunlop in *Modern Methods of Plant Analysis New Series*, Vol. 19, ed. H. F. Linksens and J. F. Jackson, Springer-Verlag, Berlin, in press (1996).
7. S. R. Heller and G. W. A. Milne, *EPA/NIH Mass Spectral Data Base*, US Government Printing Office, Washington DC (1978, 1980, 1983).
8. E. Stenhagen, S. Abrahamsson and F. W. McLafferty, *Registry of Mass Spectral Data*, Wiley, New York (1974).
9. A. A. Swigar and R. M. Silverstein, *Monoterpenes*, Aldrich, Milwaukee WI (1981).
10. (Series I) Part IX. C. M. Bignall, P. J. Dunlop and J. J. Brophy, *Flavour Frag. J.*, **11**, 95 (1996).

