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TRITERPENOIDS FROM *WALSURA PISCIDIA**

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Key Word Index—*Walsura piscidia*; Meliaceae; triterpenoids; piscidinols A–E; tetranortriterpenoids; piscidofuran.

Abstract—A series of tirucallane (piscidinol A and B) and apotirucallane (piscidinol C–E) derivatives has been isolated from the leaves of *Walsura piscidia*. The fruit yielded a new tetranortriterpenoid, piscidofuran. The structures were assigned on the basis of ^{1}H NMR and ^{13}C NMR evidence.

INTRODUCTION

Walsura piscidia Roxb., which is used in traditional medicine in India [1], is synonomous with *Heynea trifoliata* A. Juss, *Trichilia coriacea* Wall and *T. trifoliata* Wall [2, 3]. We now report the results of an examination of the leaves, fruit and bark of this tree.

Two tirucallanes, piscidinols A (**1**) and B (**6**) and three apotirucallanes, piscidinol C (**8**), D (**9**) and E (**10**), were isolated from the leaf extract. The fruit yielded a new tetranortriterpenoid, piscidofuran (**18**), while the known tetranortriterpenoid 7-deacetoxy-7-hydroxyazadirone (**19**) and its 1,2-dihydro derivative (**21**) were obtained from the bark.

RESULTS AND DISCUSSION

Piscidinol A (**1**), $C_{30}H_{50}O_4$, mp 195°, $[\alpha]_D$ −90° ($CHCl_3$; *c* 1.0), IR $\nu_{max}^{CCl_4}$ cm^{-1}: 3610, 3575, 1712, has one secondary and seven tertiary methyls (see Experimental), a cyclohexanone (δ_C 217.2), a trisubstituted double bond [δ_H 5.3 (*m*, H-7); δ_C 145.8 (C-8), 117.9 (C-7)] and one tertiary and two secondary hydroxyl groups [δ_H 3.2 (*br s*, H-24), 4.15 (*m*, H-23); δ_C 75.1, 69.7 (both *d*), 74.3 (*s*)] and is a tetracyclic triterpenoid. Oxidation of **1** with mercuric acetate gave the heteroannular diene (**2**) whose UV spectrum (λ_{max} nm: 232, 240, 247) is characteristic of a 7,9(11)-tirucalladiene (or euphadiene) rather than a 7,9(11)-lanostadiene [4]. Piscidinol A (**1**) formed a diacetate (**3**) and an acetonide (**4**) both of which showed hydroxyl absorption in their IR spectra due to the presence of a tertiary hydroxyl group. Oxidation of **1** with sodium metaperiodate yielded the tetranor-ketoaldehyde, **5** [δ_H 9.75 (*t*)]. These results suggest that piscidinol A is 3-oxo-7-tirucallene-23ξ,24ξ,25-triol (**1**). The configuration at C-20 is assumed to be *S* on biogenetic grounds since tirucallane derivatives occur widely in the Meliaceae while euphanes (20*R*) are restricted to *Melia* species [5]. The relative stereochemistry of the vicinal diol was not established.

Piscidinol B (**6**), $C_{30}H_{52}O_4$, mp 240°, differs from **1** only in the absence of a ketonic carbonyl group and the presence of a new secondary hydroxyl group [δ_H 3.6 (*m*, H-3α)]. It formed a triacetate, **7**. The product of sodium borohydride reduction of piscidinol A (**1**) was identical in all respects with piscidinol B which is, therefore, 7-tirucallene-3β,23ξ,24ξ,25-tetrol (**6**).

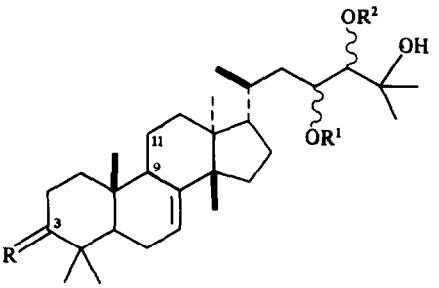
It is apparent from the ^{1}H NMR and ^{13}C NMR shifts (see Experimental and Table 1) of piscidinols C (**8**), D (**9**) and E (**10**) and their derivatives that they are apotirucallanes which have in common seven tertiary methyls, a ring A enone, an oxygen substituent at C-7, an 11α-hydroxyl group, a 14,15-double bond and a side chain which includes a cyclic hemiacetal acetate, a ketone and a secondary alcohol. The nature of this side chain was established by decoupling experiments on the acetylation products of piscidinol D (see below).

In addition to the above functional groups, piscidinol D (**9**), $C_{32}H_{46}O_9$, contains a secondary hydroxyl group attached to C-16. Acetylation afforded the tetra-acetate (**11**) which still retains a free secondary hydroxyl group (IR ν_{max} cm^{-1}: 3590, 3540) and the penta-acetate (**12**) which has no hydroxyl absorption. Thus, there is no tertiary hydroxyl function in piscidinol D and the singlet oxygen-bearing carbon [δ_C 72.2 (C-25)] must be part of the cyclic hemiacetal.

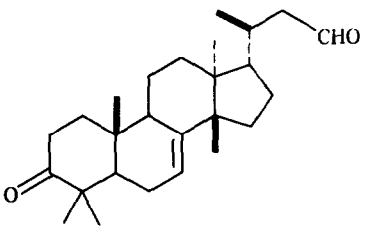
In the tetra-acetate (**11**), H-15 is a doublet (J = 3.2 Hz) which is coupled to a secondary acetate proton, H-16 [δ_H 5.26 (*dd*, J = 5.7, 3.2 Hz)]. Irradiation of H-16 affects H-17 (*ca* δ 1.7) which is in turn, coupled to H-20. Irradiation of H-20 causes the simultaneous collapse of H-17, the hemiacetal acetate proton H-21 and the methylene multiplet arising from 2H-22. The ketonic carbonyl group must be placed at C-23 since the geminal coupling constant of 2H-22 is 16 Hz. The remaining secondary hydroxyl group [δ_H 3.85 (*s*, H-24)], which acetylates more slowly than the OH-7 group is, therefore, attached to C-24. In the penta-acetate (**12**), H-24 shows the expected downfield shift to δ_H 5.16. The side chain is completed as in **11** and **12** by the formation of an ether link between C-25 and C-21 to give a seven-membered cyclic hemiacetal acetate.

The configurations at C-7 and C-11 of **11** and **12** are readily defined from the coupling data. Thus, H-7 is a

*This species is most widely described under the name *Walsura piscidia* Roxb. although a referee points out that the valid name is *Walsura trifoliata* (A. Juss) Harms.



1 R = O; $R^1 = R^2 = H$
2 $\Delta^{9(11)}$ (1)
3 R = O; $R^1 = R^2$ = Ac
4 R = O; $R^1 = R^2 = CMe_2$
6 R = H, βOH; $R^1 = R^2 = H$
7 R = H, βOAc; $R^1 = R^2$ = Ac



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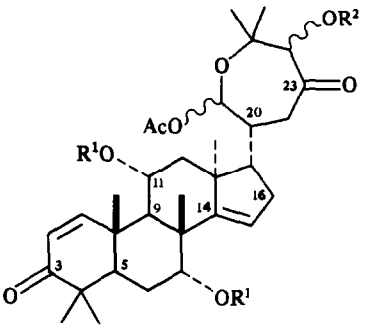
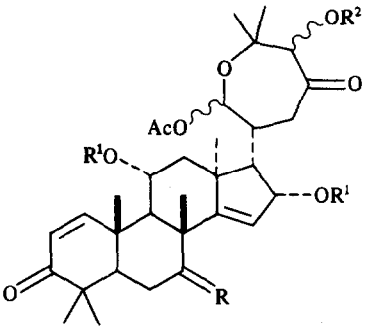


8 $R^1 = R^2 = H$
14 $R^1 = R^2$ = Ac
15 R^1 = Ac; $R^2 = H$



9 R = H, αOH; $R^1 = R^2 = H$
10 R = O; $R^1 = R^2 = H$
11 R = H, αOAc; R^1 = Ac; $R^2 = H$
12 R = H, αOAc; $R^1 = R^2$ = Ac
13 R = O; R^1 = Ac; $R^2 = H$

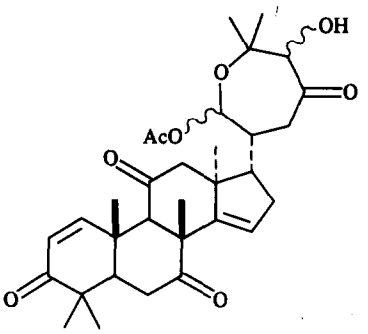
narrow triplet (J = 2.5 Hz) and is, therefore, β-orientated (equatorial) while H-11 appears as a double doublet of doublets (J = 10.0, 5.7, 2.5 Hz) coupled to H-9 [δ_H 2.66 (*d*, J = 10.0 Hz)] and the C-12 methylene group and is, therefore, β-orientated (axial) (cf 11α-acetoxyazadirone [6]). The normal tirucallane stereochemistry at C-17 and C-20 is assumed. The configuration of the O-16 substituent is assigned as α since one methyl ^{13}C resonance (C-18) is shifted downfield by Δδ4 in tetra-acetate **11** with respect to the corresponding derivative of piscidinol C, 16-deoxypiscidinol D (**15**) (see below). The introduction of an O-16 function also causes an upfield shift (Δδ3.3) of C-20 in **11** relative to **15**. The configurations at C-21 and C-24 remain unassigned.

Piscidinol E (**10**), $C_{32}H_{44}O_9$ is readily identified as the 7-ketone corresponding to piscidinol D. It forms the triacetate (**13**) which contains an extra ketonic carbonyl group (δ_C 206.1) and lacks the characteristic H-7β triplet. Comparison of the ^{13}C NMR shifts of **11** and **13** supports the assignment of structure **10** for piscidinol E.

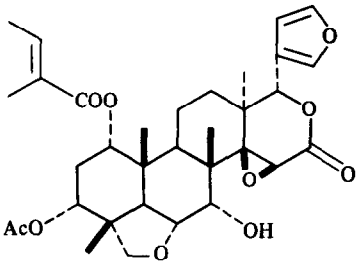
Piscidinol C (**8**), $C_{32}H_{46}O_8$, mp 215°, is 16-deoxypiscidinol D. It forms the tetra-acetate (**14**) and the triacetate (**15**). Comparison of the spectroscopic properties of **14** and **15** with the corresponding acetates (**11** and **12**) of piscidinol D confirms their close relationship. The main difference lies in the resonances associated with ring D. The H-15 appears as a doublet of doublets (J = 3, 1.5 Hz) due to coupling with the C-16 methylene group.

Oxidation of piscidinol C (**8**) with Jones reagent afforded two products, the more polar being the 7,11-diketone (**16**) and the less polar the corresponding 1,2-epoxide (**17**) (δ_H 3.44, 4.08, AB*q*, J = 4.7 Hz, H-1, H-2). The C-24 secondary hydroxyl is resistant to oxidation under the conditions used.

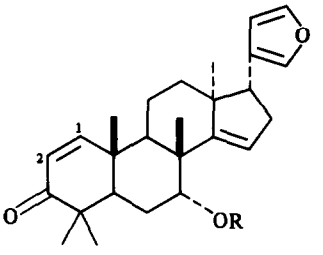
Extraction of the fruit of *Walsura piscidia* afforded a new tetranortriterpenoid, piscidofuran (**18**), $C_{33}H_{42}O_{10}$,



16
17 1,2 - epoxy



18



19 R = H
20 R = Ac
21 R = H; 1,2 - dihydro

mp 225°, whose spectroscopic properties (see Table 1 and Experimental) revealed the presence of the characteristic β-substituted furan and ring D epoxylactone, four tertiary methyl groups, a primary–secondary ether [δ_H 3.47, 3.25 (AB*q*, J = 9 Hz, 2H-28), 4.02 (*dd*, J = 12, 3 Hz, H-6)], a secondary hydroxyl group [δ_H 3.5 (*d*, J = 3 Hz, H-7)] and two secondary esters [δ_H 5.15, 5.05 (both *t*, J = 3 Hz, H-1, H-3)], namely a tiglate and an acetate. Irradiation of the secondary ether terminus (H-6) caused the simultaneous collapse to singlets of the proton (H-7) attached to the carbon bearing the secondary hydroxyl group and a doublet (J = 12 Hz, H-5) at δ2.5. These chemical shift and coupling data are consistent with structure **18** for piscidofuran. The tiglate ester is placed at C-1 by analogy with salannin which has the same structural features in rings A and B [7]. As expected, the secondary hydroxyl group failed to react under mild acetylation conditions.

Chromatography of the bark extract yielded 7-deacetoxy-7-hydroxyazadirone (**19**) which was identified by comparison with published data and by acetylation to azadirone (**20**) [8]. Later fractions afforded a crystalline mixture of **19** and its 1,2-dihydro derivative (**21**) (*m/z* 396, 394). These could not be separated but mild hydrogenation of the mixture over Pd/C gave pure **21**.

EXPERIMENTAL

All mps are uncorr. IR spectra were recorded using KBr discs or in CCl_4 solns. ^{1}H NMR spectra were measured in $CDCl_3$ solns on Perkin–Elmer R32 (90 MHz, int. standard TMS at δ0) and Bruker WP200SY (200 MHz, int. standard $CHCl_3$ at δ7.25) instruments.

The leaves, fruit and bark of *Walsura piscidia* were collected on the outskirts of Madras and Kodikarai (Point Calimere), Tanjore district, India in July and were shade-dried. Reference samples of plant material are deposited in the Herbarium of the Captain Srinivasa Murti Research Institute, India.

Isolation of piscidinols A–E. Coarsely powdered leaves (8 kg) were exhaustively extracted with *n*-hexane and $CHCl_3$ by cold percolation. The two extracts were found to be similar on TLC (C_6H_6–EtOAc, 4:1 and 1:1) and were combined. The total extract (50 g) was chromatographed over silica gel (800 g) and eluted with *n*-hexane, C_6H_6 and increasing quantities of EtOAc in C_6H_6. Fractions eluted with *n*-hexane contained fats. Elution

Table 1. ^{13}C NMR chemical shifts ($CDCl_3$ solutions) of compounds **8**, **9**, **11**, **13**, **15** and **18**

Carbon No.	8*	15†	9*	11†	13†	18*	
1	160.7	158.2	161.9	157.9	156.3	78.3	
2	123.6	124.3	123.3	124.5	124.8	25.8	
3	205.0	203.7	205.2	203.6	202.3	72.7	
4	40.8	40.5	40.8	40.5	40.3	39.1	
5	45.3	45.4	45.6	45.5	48.5	40.3	
6	24.2	23.5	24.5	23.5	35.6	73.5	
7	71.3	73.9	72.2	74.1	206.1	72.0	
8	44.3	42.4	44.2	42.6	51.6	44.6	
9	40.1	43.7	45.3	43.4	51.6	35.7	
10	44.3	44.3	44.2	44.3	44.8	42.2	
11	66.6	69.9	66.4	69.3	69.0	13.9	
12	46.0	40.2	46.1	39.2	39.0	30.2	
13	46.2	45.4	46.1	46.1	46.6	40.3	
14	160.7	158.0	166.9	166.2	159.0	70.1	
15	119.1	118.6	121.7	119.5	126.1	56.1	
16	33.4	33.6	73.8	76.9	76.7	167.3	
17	54.1	54.1	56.8	55.3	55.1	71.5	
20	39.7	40.1	36.5	36.8	36.6	120.7	
21	90.7	90.3	91.4	90.1	90.1	141.2	
22	44.3	43.1	44.2	42.6	42.8	110.0	
23	207.9	208.0	208.0	207.0	207.0	142.9	
24	80.5	80.1	81.3	80.3	80.3	—	
25	72.2	72.0	72.2	71.9	71.9	—	
	29.7	29.3	29.7	29.0	29.7	18.8	
C–Me	26.8	26.6	26.8	26.6	26.2	18.5	
	26.2	26.2	25.9	26.3	26.2	17.5	
	24.7	24.4	25.2	24.6	24.9	15.9	
	21.6	21.8	24.5	23.7	24.5		
	20.1	20.1	21.6	21.8	21.6		
	19.5	19.7	20.4	20.1	19.3		
						77.8 (C-28)	Tiglate
Ac	20.9	21.3	21.1	21.2	21.2	20.9	1′ 166.9
		21.0		21.1	20.9		2′ 128.8
		20.8		20.8 (2)	20.7		3′ 137.5
							4′ 14.6
							5′ 12.4
C=O	169.6	170.0	170.2	170.0	170.2	169.1	
		169.9		169.8	169.8		
		169.0		169.2	169.0		
				169.0			

*Varian XL100 (25.16 MHz, int. standard TMS at δ0). Multiplicities determined from off-resonance decoupled spectra.

†Bruker WP200SY (50.13 MHz, int. standard $CDCl_3$ at δ77.0). Multiplicities determined from DEPT spectra.

with C_6H_6 yielded a gum which, on repeated CC over silica gel afforded sitosterol (50 mg).

Piscidinol A (**1**). Further CC of the mixture (elution with C_6H_6–EtOAc, 9:1) gave piscidinol A (**1**) (100 mg): mp 195° (ex. MeOH); $[\alpha]_D^{25}$ −90° ($CHCl_3$; *c* 1.0); IR ν_{max}^{KBr} cm^{-1}: 3550, 3425, 3350, 2950, 2860, 1690, 1650, 1460, 1380, 1370, 1285, 1240, 1210, 1150, 1026, 950, 890, 870, 800; MS *m/z*: 474 $[M]^+$; ^1H NMR (90 MHz): δ5.3 (*m*, H-7), 4.15 (*m*, H-23), 3.2 (*br s*, H-24), 1.32 (2), 1.04 (2), 1.16, 1.10, 0.86 (C–Me), 0.98 (*d*, *J* = 8 Hz, CH–Me). (Found: C, 75.65; H, 10.55. $C_{30}H_{50}O_4$ requires: C, 75.90; H, 10.55%.)

Piscidinol B (**6**). Further elution of the column with the same solvent yielded piscidinol B (**6**) (150 mg): mp 240° (ex. MeOH); IR ν_{max}^{KBr} cm^{-1}: 3550, 3300, 2950, 1450, 1370, 1155, 1032, 1022, 990, 820; MS *m/z*: 476 $[M]^+$, ^1H NMR (90 MHz) ($CDCl_3$ and CD_3COCD_3): δ5.3 (*m*, H-7), 4.15 (*m*, H-23), 3.6 (*m*, H-3), 3.18 (*br s*, H-24), 1.25 (2), 0.80, 0.78, 0.70, 0.60 (2) (C–Me), 0.95 (*d*, *J* = 8 Hz, CH–Me). (Found: C, 76.00; H, 10.50. $C_{30}H_{52}O_4$ requires: C, 75.65; H, 10.90%.)

Piscidinol C (**8**). The mixture eluted with C_6H_6–EtOAc (4:1 and 1:1) was rechromatographed over silica gel. Elution with C_6H_6–EtOAc (4:1) yielded piscidinol C (**8**) (500 mg): mp 215° (ex. MeOH); IR ν_{max}^{KBr} cm^{-1}: 3500, 2900, 1740, 1710, 1650, 1440, 1398, 1220, 1100, 930; MS *m/z*: 498 $[M-60]^+$; ^1H NMR (90 MHz): δ1.02, 1.05, 1.10, 1.15 (2), 1.20 (2) (C–Me), 2.12 (Ac), 3.85 (*s*, H-24), 3.95 (*t*, *J* = 3 Hz, H-7), 4.40 (*m*, H-11), 5.5 (*br t*, H-

15), 6.32 (*br s*, H-21), 5.77, 7.97 (both *d*, J = 10 Hz, H-2, H-1). (Found: C, 68.50; H, 7.85. $C_{32}H_{46}O_8$ requires: C, 68.80; H, 8.20%.)

Piscidinol D (**9**). Further elution of the column with EtOAc–C_6H_6 (4:1) gave piscidinol D (**9**) (300 mg) as a gum: IR ν_{max}^{KBr} cm^{-1}: 3420, 2960, 2920, 1735, 1710, 1650, 1380, 1230, 1010, 950; ^1H NMR (90 MHz): δ1.05 (2), 1.15, 1.21, 1.22, 1.25, 1.44 (C–Me), 2.15 (Ac), 3.89 (*s*, H-24), 4.02 (*br t*, H-7), 4.42 (*m*, H-11, H-16), 5.70 (*d*, J = 3 Hz, H-15), 6.40 (*br s*, H-21), 5.79, 8.03 (both *d*, J = 10 Hz, H-2, H-1). (Found: C, 63.80; H, 7.80. $C_{32}H_{46}O_9 \cdot 2H_2O$ requires: C, 63.95; H, 8.10%.)

Piscidinol E (**10**). The intermediate fractions between piscidinols C (**8**) and D (**9**) were rechromatographed over silica gel. C_6H_6–EtOAc (1:1) yielded piscidinol E (**10**) as a gum (200 mg): IR ν_{max}^{KBr} cm^{-1}: 3450, 1750, 1700, 1660; ^1H NMR (200 MHz): δ1.10, 1.15, 1.20, 1.25, 1.37, 1.44, 1.46 (C–Me), 2.16 (Ac), 2.31 (*d*, J = 8.9 Hz, H-9), 3.87 (*s*, H-24), 4.41 (*dd*, J = 5.6, 3.4 Hz, H-16), 4.48 (*m*, H-11), 6.13 (*d*, J = 3.4 Hz, H-15), 6.37 (*d*, J = 1.5 Hz, H-21), 5.83, 8.10 (both *d*, J = 10.5 Hz, H-2, H-1). Prep. TLC of the crude acetylation product of **10** gave the triacetate **13** as a gum; IR $\nu_{max}^{CCl_4}$ cm^{-1}: 3595, 3540, 1755 (sh), 1742, 1722, 1680; ^1H NMR (200 MHz): δ1.07, 1.11, 1.18, 1.23, 1.36, 1.39 (2) (C–Me), 2.02, 2.11, 2.14 (Ac) 2.55 (*d*, J = 10 Hz, H-9), 3.85 (*s*, H-24), 5.26 (*dd*, J = 5.8, 3.4 Hz, H-16), 5.44 (*m*, H-11), 6.20 (*d*, J = 3.4 Hz, H-15), 6.22 (*d*, J = 2.9 Hz, H-21), 5.81, 7.22 (both *d*, J = 10.5 Hz, H-2, H-1). (Found: C, 65.80; H, 7.30. $C_{36}H_{48}O_{11}$ requires: C, 65.85; H, 7.30%.)

Piscidofuran (**18**). Coarsely powdered fruit of *Walsura piscidia* was exhaustively extracted with *n*-hexane followed by $CHCl_3$. The total extract was chromatographed over silica gel and the column eluted with *n*-hexane, C_6H_6 and mixtures of C_6H_6–EtOAc as above. Waxy material was removed by elution with *n*-hexane. Elution with C_6H_6–EtOAc (4:1) gave piscidofuran (**18**) (200 mg): mp 225° (ex. MeOH); IR ν_{max}^{KBr} cm^{-1}: 3420, 2910, 1770, 1740, 1710, 1510, 1380, 1250, 1165, 1110, 1050, 900, 880, 830, 750; MS *m/z*: 598 $[M]^+$; ^1H NMR (90 MHz): δ7.35 (H-21, H-23), 6.9 (*m*, H-3'), 6.35 (H-22), 5.5 (*s*, H-17), 5.15, 5.05 (both *t*, J = 3 Hz, H-1, H-3), 4.02 (*dd*, J = 12, 3 Hz, H-6), 3.8 (*s*, H-15), 3.5 (*d*, J = 3 Hz, H-7), 3.47, 3.25 (ABq, J = 9 Hz, 2H-28), 2.5 (*d*, J = 12 Hz, H-5), 1.9 (*m*, tiglate Mes), 2.0 (Ac), 1.2, 1.1, 1.05, 0.92 (C–Me). (Found: C, 66.40; H, 7.40. $C_{33}H_{42}O_{10}$ requires: C, 66.20; H, 7.65%.)

7-Deacetoxy-7-hydroxyazadirone (**19**). Coarsely powdered bark (2 kg) was extracted with *n*-hexane and $CHCl_3$ in the cold. The combined extracts (25 g) were chromatographed over silica gel. Elution with C_6H_6–EtOAc (9:1) gave 7-deacetoxy-7-hydroxyazadirone (**19**) (500 mg): mp 203° (ex. MeOH); IR ν_{max}^{KBr} cm^{-1}: 3550, 1670; MS *m/z*: 394 $[M]^+$; ^1H NMR (90 MHz): δ7.35 (H-21, H-23), 7.10, 5.70 (both *d*, J = 10 Hz, H-1, H-2), 6.25 (H-22), 5.55 (*m*, H-15), 4.0 (*m*, H-7), 1.12, 1.10, 1.05, 1.0, 0.95 (C–Me). (Found: C, 79.30; H, 8.40. $C_{26}H_{34}O_3$ requires: C, 79.20; H, 8.65%.) Later eluates with the same solvent gave a crystalline compound, mp 160°, which proved to be a mixture of **19** and its 1,2-dihydro derivative (**21**); IR ν_{max}^{KBr} cm^{-1}: 3550, 1700, 1670; MS *m/z*: 396, 394.

Acetylation of piscidinol A (**1**). Piscidinol A (**1**) (60 mg) in dry pyridine (2 ml) was treated with Ac_2O at room temp. for 12 hr. The usual work-up afforded the acetate **3** (40 mg): mp 226° (ex. MeOH); IR ν_{max}^{KBr} cm^{-1}: 3520, 1740, 1710; MS *m/z*: 558 $[M]^+$; ^1H NMR (90 MHz): δ5.45 (*m*, H-23), 5.3 (*m*, H-7), 4.88 (*br s*, H-24), 2.18, 2.02 (Ac), 1.2, 1.15, 1.08, 1.0, 0.95 (2), 0.78 (C–Me), 0.98 (*d*, J = 8 Hz, CH–Me). (Found: C, 73.70; H, 9.65. $C_{34}H_{54}O_6$ requires: C, 73.80; H, 9.65%.)

Piscidinol A acetonide (**4**). Piscidinol A (**1**) (50 mg), in dry Me_2CO (10 ml) containing dry $CuSO_4$ (50 mg), was heated on a water bath for 30 hr. Filtration and removal of solvent afforded the acetonide **4** (50 mg): mp 130° (ex. MeOH); IR ν_{max}^{KBr} cm^{-1}: 3300, 1650; MS *m/z*: 514 $[M]^+$: ^1H NMR (90 MHz): δ5.3 (*m*, H-7), 3.95 (*m*, H-23), 3.46 (*d*, J = 8 Hz, H-24), 1.35 (2), 1.2, 1.12, 1.08, 1.0, 0.98, 0.78 (C–Me), 0.95 (*d*, J = 8 Hz, CH–Me). (Found: C, 77.00; H, 10.50. $C_{33}H_{54}O_4$ requires: C, 77.05; H, 10.50%.)

Sodium periodate oxidation of piscidinol A (**1**). Piscidinol A (**1**) (100 mg) in MeOH was treated with $NaIO_4$ (25 mg) in H_2O (3 ml) and the soln left at room temp. for 48 hr. The crude product, obtained by evaporation of the solvent, was chromatographed over silica gel. Elution with C_6H_6–EtOAc (9:1) gave the aldehyde **5** (70 mg): mp 135° (ex. Et_2O–hexane); IR $\nu_{max}^{CCl_4}$ cm^{-1}: 2988, 2710, 1730, 1710; MS *m/z*: 384 $[M]^+$; ^1H NMR (90 MHz): δ9.75 (*t*, CHO), 5.3 (*m*, H-7), 1.1, 1.02, 1.0, 0.99, 0.85 (C–Me). (Found: C, 80.75; H, 10.40. $C_{26}H_{40}O_2$ requires: C, 81.25; H, 10.40%.)

Mercury (II) *oxidation of piscidinol A* (**1**). Piscidinol A (**1**) (100 mg) and $Hg(OAc)_2$ (150 mg) were dissolved in glacial HOAc (15 ml) and left at room temp. for 24 hr. Filtration and removal of solvent afforded the diene **2** (50 mg): mp 190° (ex. MeOH); MS *m/z*: 472 $[M]^+$; UV λ_{max} nm (ε): 232 (13 600), 240 (14 200), 247 (9600). (Found: C, 76.10; H, 10.15. $C_{30}H_{48}O_4$ requires: C, 76.25; H, 10.20%.)

Sodium borohydride reduction of piscidinol A (**1**). A soln of piscidinol A (**1**) (50 mg) and $NaBH_4$ (80 mg) in EtOH (20 ml) was stirred at room temp. for 24 hr. Dilution with H_2O, acidification with dil. HCl and extraction with CH_2Cl_2 yielded a gum which was chromatographed over silica gel. Elution with C_6H_6–EtOAc (4:1) gave a compound identical in all respects with piscidinol B (**6**).

Acetylation of piscidinol B (**6**). Piscidinol B (**6**) (100 mg) was treated with Ac_2O (2.5 ml) in dry pyridine (2 ml) at room temp. for 4 hr. The normal work-up gave the acetate **7** (70 mg): mp 145° (ex. MeOH); MS *m/z*: 602 $[M]^+$; ^1H NMR (90 MHz): δ5.35 (*m*, H-23), 5.25 (*m*, H-7), 4.88 (*br s*, H-24), 4.52 (*m*, H-3), 2.15, 2.02, 2.0 (Ac), 1.2, 1.15, 1.02, 1.0, 0.82, 0.75, 0.72, (C–Me), 0.98 (*d*, J = 8 Hz, CH–Me). (Found: C, 71.50; H, 9.55. $C_{36}H_{58}O_7$ requires: C, 71.75; H, 9.65%.)

Acetylation of piscidinol C (**8**). Piscidinol C (**8**) was acetylated under the usual conditions. The crude product was chromatographed over silica gel. Elution with C_6H_6–EtOAc (9:1) gave the triacetate **15**: mp 220° (ex. MeOH); IR $\nu_{max}^{CCl_4}$ cm^{-1}: 3590, 3540, 1765, 1743, 1720 (sh), 1680; ^1H NMR (200 MHz): δ1.05, 1.07, 1.14, 1.19, 1.20, 1.24 (2) (C–Me), 1.96, 2.11, 2.15 (Ac), 2.26 (*dd*, J = 12, 3 Hz, H-5), 2.46 (*m*, 2H-22), 2.53 (*d*, J = 9.7 Hz, H-9), 3.86 (*s*, H-24), 5.25 (*t*, J = 2.5 Hz, H-7), 5.33 (*dd*, J = 3.5, 1.5 Hz, H-15), 5.41 (*ddd*, J = 9.7, 6, 1.5 Hz, H-11), 6.20 (*d*, J = 2 Hz, H-21), 5.78, 7.16 (both *d*, J = 10.5 Hz, H-2, H-1). (Found: C, 66.50; H, 7.55. $C_{38}H_{52}O_{11}$ requires: C, 66.65; H, 7.60%.) Elution with C_6H_6–EtOAc (4:1) yielded the tetra-acetate **14**: mp 160° (ex. MeOH); IR $\nu_{max}^{CCl_4}$ cm^{-1}: 1765, 1743, 1735, 1680; ^1H NMR (200 MHz): δ1.04, 1.07, 1.13, 1.20, 1.24, 1.35, 1.61 (C–Me), 1.95 (2), 2.10, 2.16 (Ac), 2.27 (*dd*, J = 12, 3 Hz, H-5), 2.42 (*m*, 2H-22), 2.54 (*d*, J = 9.5 Hz, H-9), 5.16 (*s*, H-24), 5.25 (*t*, J = 2.5 Hz, H-7), 5.32 (*dd*, J = 3, 1.5 Hz, H-15), 5.41 (*ddd*, J = 9.5, 6, 1.5 Hz, H-11), 6.20 (*d*, J = 2 Hz, H-21), 5.79, 7.14 (both *d*, J = 10.5 Hz, H-2, H-1). (Found: C, 67.25; H, 7.60. $C_{36}H_{50}O_{10}$ requires: C, 67.30; H, 7.80%.)

Acetylation of piscidinol D (**9**). Acetylation of piscidinol D (**9**) (500 mg) afforded a mixture which was chromatographed over silica gel. C_6H_6–EtOAc (9:1) eluted the tetra-acetate **11** (40 mg): mp 260° (ex. Et_2O–hexane); IR $\nu_{max}^{CCl_4}$ cm^{-1}: 3590, 3540, 1748, 1720 (sh), 1680; ^1H NMR (200 MHz): δ1.05, 1.07, 1.20, 1.21, 1.24, 1.26, 1.42 (C–Me), 1.93, 1.99, 2.13, 2.16 (Ac), 2.26 (*dd*, J = 12, 4 Hz, H-5), 2.43 (*m*, 2H-22), 2.66 (*d*, J = 10 Hz, H-9), 2.69 (*dddd*, J = 11, 10, 8, 2.9 Hz, H-20), 3.87 (*s*, H-24), 5.26 (*dd*, J = 5.7, 3.2 Hz, H-16), 5.27 (*t*, J = 2.5 Hz, H-7), 5.39 (*ddd*, J = 10, 5.7, 2.5 Hz, H-

11), 5.68 (*d*, J = 3.2 Hz, H-15), 6.26 (*d*, J = 2.9 Hz, H-21), 5.79, 7.17 (both *d*, J = 10.5 Hz, H-2, H-1). (Found: C, 65.0; H, 7.40. $C_{38}H_{52}O_{12}$ requires: C, 65.15; H, 7.40%.) Elution with C_6H_6–EtOAc (4:1) eluted the penta-acetate **12** (30 mg) as a gum: IR $\nu_{max}^{CCl_4}$ cm^{-1}: 1748, 1680; ^1H NMR (200 MHz): δ1.05, 1.07, 1.20, 1.24, 1.37, 1.41, 1.62 (C–Me), 1.92, 1.96, 2.00, 2.12, 2.17 (Ac), 2.28 (*dd*, J = 11.5, 3.5 Hz, H-5), 2.65 (*d*, J = 9.8 Hz, H-9), 2.7 (*m*, H-20), 5.16 (*s*, H-24), 5.23 (*dd*, J = 6.9, 3.3 Hz, H-16), 5.25 (*t*, J = 2.5 Hz, H-7), 5.41 (*m*, H-11), 5.69 (*d*, J = 3.3 Hz, H-15), 6.24 (*d*, J = 3 Hz, H-21), 5.78, 7.15 (both *d*, J = 10.5 Hz, H-2, H-1). (Found: C, 64.50; H, 7.25. $C_{40}H_{54}O_{13}$ requires: C, 64.70; H, 7.30%.)

Oxidation of piscidinol C (**8**). Piscidinol C (**8**) (80 mg) in Me_2CO at 0° was treated with excess Jones reagent. The usual work-up afforded a crude product which showed two spots on TLC. These were separated by prep. TLC to give the 7,11-diketone **16**: ^1H NMR (200 MHz): δ1.11, 1.14, 1.19, 1.22, 1.25, 1.36, 1.62 (C–Me), 2.18 (Ac), 3.08 (*s*, H-9), 3.85 (*s*, H-24), 6.07 (*dd*, J = 3.4, 1.6 Hz, H-15), 6.14 (*br s*, H-21), 5.90, 7.33 (both *d*, J = 10.2 Hz, H-2, H-1); MS m/z: 536.2758, $C_{32}H_{40}O_7$ $[M-H_2O]^+$ requires: 536.2774; and the corresponding 1,2-epoxide **17**: ^1H NMR (200 MHz): δ1.02, 1.10, 1.20, 1.25, 1.27, 1.35, 1.46 (C–Me), 2.17 (Ac), 3.31 (*s*, H-9), 3.44, 4.08 (both *d*, J = 4.7 Hz, H-1, H-2), 3.85 (*s*, H-24), 6.00 (*dd*, J = 3.4, 1.5 Hz, H-15), 6.15 (*br s*, H-21); MS m/z: 552.2730, $C_{32}H_{40}O_8$ $[M-H_2O]^+$ requires: 552.2723.

Acetylation of 7-deacetoxy-7-hydroxyazadirone (**19**). Acetylation of **19** (100 mg) afforded azadirone (**20**) (70 mg): mp 130° (ex. MeOH); MS m/z: 436 $[M]^+$; ^1H NMR (90 MHz): δ7.32 (H-21, H-23), 7.10, 5.78 (both *d*, J = 10 Hz, H-1, H-2), 6.22 (H-22), 5.33 (*t*, J = 3 Hz, H-7), 5.27 (*m*, H-15), 1.93 (Ac), 1.2, 1.18, 1.02 (2), 0.78 (C–Me), identical with an authentic sample. (Found: C, 77.0; H, 8.05. $C_{28}H_{36}O_4$ requires: C, 77.05; H, 8.25%.)

Hydrogenation of the mixture of **19** *and* **21**. The mixture (100 mg) in MeOH was hydrogenated over 10% Pd/C for 2 hr. The usual work-up gave 1,2-dihydro-7-deacetoxy-7-hydroxyazadirone (**21**) (80 mg): mp 160° (ex. MeOH); IR ν_{max}^{KBr} cm^{-1}: 3500, 1700; MS m/z: 396 $[M]^+$; ^1H NMR (90 MHz): δ7.4 (H-21), 7.3 (H-23), 6.3 (H-22), 5.55 (*m*, H-15), 4.0 (*m*, H-7), 1.2, 1.1, 1.05, 1.0, 0.8 (C–Me), identical with an authentic sample. (Found: C, 78.75; H, 9.05. $C_{26}H_{36}O_3$ requires: C, 78.80; H, 9.10%.)

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