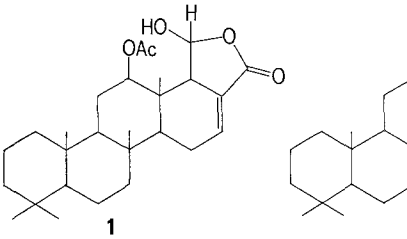
terpenes **1** and **2** with the fern sesterterpene, cheilanthatriol (**3**), recently isolated by HAFIZULLAH et al.[3].

In our further search for constituents of marine sponges, we have now isolated a third tetracarbocyclic sesterterpene from *Cacospongia mollior*, which proved to have the structure **4**, closely related to scalarin (**1**) and deoxoscalarin (**2**) and accordingly named scalaradial.



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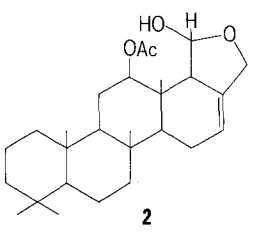

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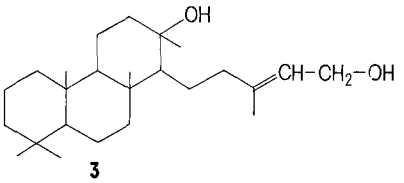

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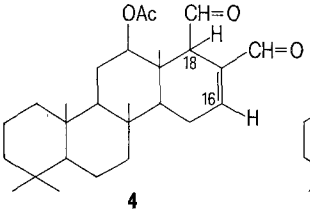

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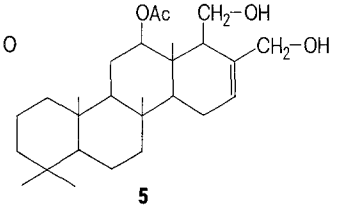


5

By essentially the same procedure as reported in previous papers[4], the fresh tissues (300 g, dry weight) of *Cacospongia mollior*[5] were extracted with acetone to give a brown oil (7 g), which was directly chromatographed on silica gel. Elution with 40–70°-light petroleum and increasing amounts of ether afforded the crystalline scalaradial (200 mg), which was recrystallized from ethanol, m.p. 111–113°; $[\alpha]_D$ + 47.3° (c, 0.9; CH_3OH). The physical properties of scalaradial thus obtained are listed below[6].

Scalaradial (**4**): $C_{27}H_{40}O_4$ [*m/e* 428 (very small, M^+)]; λ_{max} (MeOH) 231 nm (ε, 3,340); ν_{max} (nujol) 2720, 1735, 1725, 1682 and 1650 cm^{-1}; δ (C_6D_6) 0.62, 0.66, 0.70, 0.82 and 0.88 (each 3H, s), 1.91 (3H, s), 3.56 (1H, m), 4.90 (1H, m), 6.26 (1H, m), 9.20 (1H, s) and 9.60 (1H, d, J = 4Hz) ppm.

The IR- and UV-spectra of it coupled with NMR signals at δ 9.60, 9.20 and 6.26 ppm indicate the presence of a disubstituted α, β-unsaturated aldehyde, and a simple aldehyde group. The arrangement of the 2 aldehyde groups as shown in **4** can be confirmed with the aid of double resonance experiments: irradiation at the centre of the olefinic multiplet at δ 6.26 (H-16) caused the signal at δ 3.56 (H-18) to collapse to a sharp doublet (J = 4Hz); in the reverse experiment irradiation at δ 3.56 (H-18), the olefinic multiplet at δ 6.26 (H-16) collapsed to a triplet (J = 4Hz) and transformed the aldehyde doublet at δ 9.60 into a sharp singlet; finally irradiation at δ 9.60 collapsed the multiplet at δ 3.56 (H-18) to a doublet (J = 3Hz).

Furthermore, scalaradial contains an acetoxy group, as indicated by IR-(ν_{max} 1735 cm^{-1}) and NMR-(δ 1.91 and 4.90 ppm) spectra, and 5 *tert* – methyl's (NMR). This, together with above spectral evidence, suggests a close relationship with both scalarin (**1**) and deoxoscalarin (**2**).

The mass spectrum showed strong peaks at *m/e* 191 (100%) and 205 (65%) also apparent as the highest peaks in the spectra of both **1** and **2**, and corresponding to cleavage of 8–14 and 9–11 bonds and 8–14 and 11–12 bonds, respectively. All these data indicate that the new sesterterpene is most favourably represented by formula **4**, which has been confirmed by conversion of scalaradial, on sodium borohydride reduction, into the diol **5** identical (TLC, NMR, MS) with the diol derived from deoxoscalarin (**2**) on the same reaction[2].

Riassunto. Si descrive l'isolamento di un nuovo sesterterpene tetracarbociclico, scalaradiale, dalla spugna *Cacospongia mollior*, per il quale si dimostra la struttura **4**, strettamente correlata alla scalarina (**1**) e alla deoxoscalarina (**2**), precedentemente ottenute dalle spugne *Cacospongia scalaris* e *Spongia officinalis*, rispettivamente.

G. CIMINO, S. DE STEFANO and L. MINALE

Laboratorio per la Chimica e Fisica delle Molecole di Interesse Biologico del CNR, Via Toiano 2, Arco Felice (Napoli, Italy),
11 March 1974.

[3] K. HAFIZULLAH, A. ZAMEN, G. L. CHETTY, A. S. GUPTA and S. DEV, Tetrahedron Lett. *1971*, 4443.

[4] G. CIMINO, S. DE STEFANO, L. MINALE and E. FATTORUSSO, Tetrahedron *27*, 4673 (1971).

[5] Sponges, collected in the Bay of Naples, were obtained from the Supply Department of the Zoological Station (Naples) and identified by Professor N. SARÀ and Dr. G. PULITZER-FINALI (University of Genova) to whom the authors express their thanks.

[6] Mass spectra were recorded on an AEI MS-30 spectrometer; NMR-spectra were taken on a Varian HA-100D spectrometer; IR- and UV-spectra were determined with a Perkin-Elmer 257 and Baush and Lomb Spectronic 505 spectrophotometers, respectively.

Tiliageine: a New *Bis*benzylisoquinoline Biphenyl Alkaloid from *Tiliacora dinklagei*[1]

Tiliacora dinklagei (Menispermaceae), a woody climber indigenous to Ghana and other parts of West Africa, has been used natively as a tie for securing house parts[2] and as a medicinal in the treatment of a variety of fevers and other conditions[3]. A number of alkaloids of the *bis*-benzylisoquinoline biphenyl type have been isolated from *Tiliacora* species in India[4–6] and Africa[7,8] as well as from other Menispermaceous species around the world[9].

Chromatography of an extract of *T. dinklagei* afforded tiliageine (*I*), mp 270°; $[\alpha]_D^{25}$ + 132.6° (c 1.43, pyr.); λ_{max}^{MeOH} 212 nm (log ε 4.83), 231 (sh) (4.60), 288 (4.03), 295 (sh) (3.96); ν_{max}^{KBr} 2960 cm^{-1}, 1610, 1585, 1500, 1450, 1435, 1420, 1325, 1305, 1267, 1240, 1225, 1115, 1050, 978, 905, 870, 815; $\delta_{60\,MHz}^{CDCl_3}$ 2.34 (s) (3H) (NCH_3), 2.60 (s) (3H) (NCH_3), 3.41 (s) (3H) (OCH_3), 3.76 (s) (3H) (OCH_3), 3.81 (s) (3H) (OCH_3), 6.25–7.18 (m) (ArH); M^+ m/*e* 608 (100%) (measured 608.2869 and calculated as 608.2886 for $C_{37}H_{40}N_2O_6$), 501 (1) (measured 501.2401 and calculated as 501.2390 for $C_{30}H_{33}N_2O_5$), 417 (2) (measured 417.1942

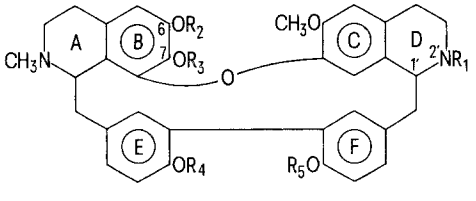
and calculated as 417.1940 for $C_{26}H_{27}NO_4$), 382 (24) (608→382, m* observed 239.9 and calculated 240.01), 381 (95), 367(20), 350 (5), 335 (5), 191 (82) (measured 191.0947 and calculated as 191.0946 for $C_{22}H_{26}N_2O_4/_2$), 175 (10), 174 (16).

Treatment of tiliageine (*I*) with acetic anhydride and pyridine afforded the oily O,O-Diacetate (*II*); λ_{max}^{MeOH} 219 nm (log ε 5.14), 284 (4.37), 304 (sh) (4.31); ν_{max}^{Film} 1765 cm^{-1} ($ArOCOCH_3$); M^+ *m/e* 692 (57%), 650 (15), 649 (12), 424 (37), 423 (100), 409 (17), 212 (23), 175 (8), 174 (15).

Treatment of tiliageine (*I*) with ethereal diazoethane gave the oily O,O-Diethyl ether (*III*) (mp of dimethiodide 228–230° d); λ_{max}^{MeOH} 208 nm (log ε 4.61), 229 (sh) (4.51), 287 (3.84), 304 (sh) (3.80); M^+ *m/e* 664 (97%), 529 (1), 473 (1), 410 (29) (664→410 m* observed 253.0 and calculated 253.16), 409 (100), 395 (36), 378 (5), 363 (3), 205 (77), 175 (24), 174 (27).

Treatment of tiliageine (*I*) with ethereal diazomethane afforded O,O-Dimethyltiliageine (*IV*), mp 170–172° d, λ_{max}^{MeOH} 214 nm (log ε 4.94), 229 (sh) (4.74), 288 (4.08), 293 (sh) (4.03); $\delta_{60\,MHz}^{CDCl_3}$ 2.35 (s)←(3H)←(NCH_3) 2.61 (s)←(3H)←(NCH_3), 3.39 (s)←(3H)←(OCH_3), 3.48 (s), (3H) (OCH_3), 3.79 (s) (9H) (3OCH_3), 6.18–7.71 (m) (9H) (ArH): M^+ *m/e* 636 (100%), 515 (1), 445 (1), 396 (20) (636→396, m* observed 246.2 and calculated 246.57), 395 (64), 381 (21), 198 (47), 175 (15), 174 (12); identical with O-methylfuniferine (*IV*) by direct comparison (uv, ir, nmr, ms, mp, mmp).

Thus, tiliageine is a biphenolic *bis*benzylisoquinoline biphenyl alkaloid with an identical oxygenation pattern to O-methylfuniferine (*IV*). The mass spectral fragments at *m/e* 382, 381, 367 and 191 of *I*; *m/e* 396, 395, 381 and 198 of *IV*; *m/e* 410, 409, 395 and 205 of *III*; and *m/e* 424, 423, 409 and 212 of *II* all arising from loss of rings E and F[10] establish that only one hydroxy group is in the isoquinoline (top) portion of the alkaloid. Furthermore, mass spectral fragments at *m/e* 501 of *I*; *m/e* 515 of *IV*; and *m/e* 529 of *III* arising from loss or ring E[10] establish that the phenolic group of the biphenyl system is present in ring E. Finally, mass spectral fragments at *m/e* 417 of *I*, *m/e* 445 of *IV*; and *m/e* 473 or *III* arising from loss of rings C and D[10] ascertain that ring C does not contain a hydroxy group. Therefore, of the ten structural permutations possible for tiliageine, only *I* and *V* remain for consideration. A thorough study of the nmr values of the C-6 and C-7 methoxy groups in the biphenyl alkaloids rodiasine[9] (*VI*), funiferine[7] (*VII*), ocotine[9] (*VIII*), and ocotosine[9] (*IX*) shows that chemical shifts of the C-6 methoxy groups are between δ 3.78 and 3.80 while the C-7 methoxy groups are between δ 3.31 and 3.39. Furthermore, the same comparison may be made in a number of alkaloids of both the oxyacanthine and berbamine series, where the chemical shift of the C-6 methoxy groups are between δ 3.73 and 3.83 and the C-7 methoxy groups between δ 3.02 and 3.20[11]. These data clearly indicate the presence of a C-6 methoxy group in tiliageine, which is further substantiated by the appearance of a methoxy resonance at δ 3.39 in O,O-dimethyltiliageine plus the shift of the C-6′ methoxy resonance from δ 3.41 in tiliageine to the more normal[9] δ 3.48 in O,O-dimethyltiliageine. Therefore, tiliageine may be represented as *I*. Since tiliageine, as a biphenyl alkaloid, cannot be reductively cleaved under Birch conditions to two optically active halves, the stereochemistry of the two asymmetric centers remains to be determined.



I	$R_1=R_2=R_5=CH_3$, $R_3=R_4=H$
II	$R_1=R_2=R_5=CH_3$, $R_3=R_4=COCH_3$
III	$R_1=R_2=R_5=CH_3$, $R_3=R_4=C_2H_5$
IV	$R_1=R_2=R_3=R_4=R_5=CH_3$
V	$R_1=R_3=R_5=CH_3$, $R_2=R_4=H$
VI	$R_1=R_2=R_3=R_4=CH_3$, $R_5=H$
VII	$R_1=R_2=R_3=R_5=CH_3$, $R_4=H$
VIII	$R_1=R_5=H$, $R_2=R_3=R_4=CH_3$
IX	1′,2′-dehydro-VIII

Résumé. La structure de la tiliagéine (*I*), un nouvel alcaloïde du groupe *bis*benzyleisoquinoline biphénilique extrait de *Tiliacora dinklagei*, a été déterminée par des méthodes spectrométriques et par convertion à la O-méthylfuniférine (*IV*).

A. N. TACKIE[12], D. DWUMA-BADU[13], T. T. DABRA[13], J. E. KNAPP[14], D. J. SLATKIN[14] and P. L. SCHIFF JR.[14]

Council for Scientific and Industrial Research, Accra, Ghana (West-Africa), Faculty of Pharmacy, University of Science and Technology, Kumasi, Ghana (West-Africa), and Department of Pharmacognosy, School of Pharmacy, University of Pittsburgh, 512 Salk Hall, Pittsburgh (Pennsylvania 15261, USA),
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[12] Council for Scientific and Industrial Research, Accra, Ghana (West Africa).
[13] Faculty of Pharmacy, University of Science and Technology, Kumasi, Ghana (West Africa).
[14] Department of Pharmacognosy, School of Pharmacy, University of Pittsburgh, Pittsburgh, Pennsylvania 15261 (USA).