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HETERONEMIN, A NEW SCALARIN TYPE SESTERTERPENE FROM THE SPONGE HETERONEMA ERECTA

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The occurrence of sesterterpenes in nature is somewhat unusual but recently an increasing number of examples have been reported. Many of the latest examples have been obtained from sponges of the order Dictyoceratida[1-5]. The genera *Ircinia*, *Spongia*, *Hippospongia* and *Cacospongia* have yielded an array of sesterterpenes and a series of C_{21} terpenes postulated as degraded sesterterpenes. The sponge species which have yielded sesterterpenes and other isoprenoid compounds contain little, if any, sterol despite the fact that many other orders of the Demospongia contain sterols as the dominant isoprenoid[2]. This could imply that, in general, the Dictyoceratida produce mevalonate derived compounds primarily by head to tail addition and that the tail to tail dimerisation of two farnesyl residues is not a favoured process.

Three closely related tetracyclic sesterterpenes have been reported, scalarin (1)[3] and scalaradial (3)[5] from species of *Cacospongia* and deoxyscalarin (2)[4] from *Spongia officinalis* and *C.scalaris*. We now report a new member of this series, heteronemin (4), from the sponge *Heteronema erecta*.

Heteronemin (4) m.p. 176.5-177° crystallised directly from the petroleum ether extract of the freeze-dried sponge in 1% yield. Microanalysis indicated a formula $C_{29}H_{44}O_6$ whereas no molecular ion was observed in the mass spectrum and the first fragment ion occurred at m/e 428 ($C_{27}H_{40}O_4$, M^+-CH_3COOH). The major fragment ion at m/e 191 ($C_{14}H_{23}$ by high resolution) was also the reported major fragment ion in (1) - (3) and suggested the partial structure (5).

The 100 MHz. ^1H n.m.r. spectrum of heteronemin (4) in deutochloroform showed the presence of two acetate groups at δ 2.08 (6H,s), five quaternary methyl groups between δ0.74-0.83 and a low field resonance at δ 6.68 (1H,bs).

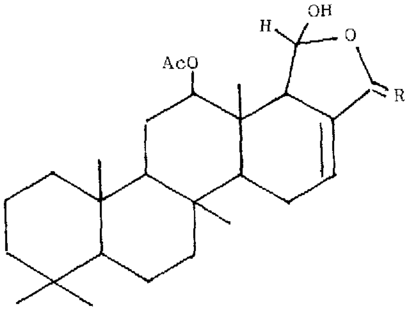
Oxidation of (4) gave the monoketone (6) m.p. 192-192.5° in high yield. Pyrolysis of this ketone in vacuo at 225° resulted in the clean elimination of two moles of acetic acid to give the vinyl furan (7) m.p. 163-164° as the sole product. The structure of this compound followed from the ^1H n.m.r. spectrum in carbon tetrachloride which showed two α-furan resonances (δ7.60,1H,bs.; 7.12,1H,bs.), two resonances due to double bond protons δ6.43,(1H,d. of d.,J=10Hz, 3Hz); 5.68 (1H, d. of d.,J=10Hz, 2.5Hz), a $CH_2-\overset{O}{\overset{\|}{C}}$ group (δ2.75-2.35, 2H,m.) and a one proton multiplet at δ2.26 (C_{14}-H). Irradiation of the signal at δ2.26 caused the collapse of the resonances at δ6.43 and 5.68 to doublets (J=10Hz.) and irradiation at δ6.43 resulted in the collapse of the signal at δ 5.68 to a doublet (J=2.5Hz.). These results, coupled with the u.v. spectrum (λmax 238, ε 11,600) supported partial structure (8). Further support came from the high resolution mass spectrum which showed major fragment ions at m/e 191 ($C_{14}H_{23}$) and 132 (C_9H_8O) which can be rationalised by cleavages A and B in (7). The ketonic function must therefore lie in ring C and the positioning of this group at C_{12} was suggested by the occurrence of large fragment ions at m/e 159 and 161.

Full support for this structure was obtained from the europium shifted (Euroshift F) ^{1}H n.m.r. spectrum of (7) in carbon tetrachloride. The relative shifts of various proton resonances were in the order C_{11}-$H_{eq.}$ > C_{11}-H_{ax} > C_{19}-H > C_{14}-H ∿ C_9-H ∿ C_{13}-CH_3 > C_{15}-H ∿ C_{16}-H > C_{20}-H which confirmed the ketonic group as the co-ordination site of the shift reagent. The europium expanded ^{1}H n.m.r. spectrum (0.3 mole shift reagent) clearly showed the separate proton resonances of C_9-H, C_{11}-H_{ax} and C_{11}-H_{eq} at δ2.84, 4.86 and 5.48 as a broad doublet (J=14Hz.), a triplet (d. of d.;J=14Hz) and a broad doublet (J=14Hz) respectively. Irradiation of the doublet at δ2.84 collapsed the triplet to a doublet and sharpened the doublet at δ5.48. Irradiation of the triplet at δ4.86 collapsed both doublets at δ2.84 and 5.48 to broad singlets. These results confirmed the presence of the carbonyl group at C_{12} and indicated that, since C_9-H was only coupled to C_{11} protons, then C_{10} and C_8 must be tetrasubstituted as required in (7).

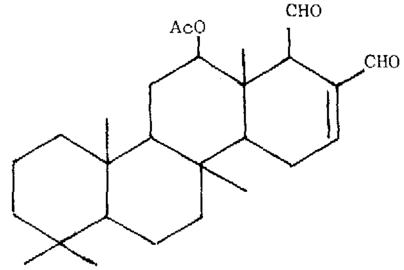
The mass spectra of the ketone (6) and furan (7) were almost identical in the lower mass region and both gave a base peak at m/e 132. The pentacyclic structure of (7) confirmed the presence of five rings in heteronemin which must contain, therefore, only one double bond. The ^{1}H n.m.r. spectrum of the ketone (6) in deuterochloroform was similar to that of the parent compound except that the 1 proton H-$\overset{|}{\underset{|}{C}}$-OH signal at δ 3.36 in (4) disappeared and a two proton multiplet of protons adjacent to carbonyl appeared at δ2.75-2.4 and the one proton multiplet at δ2.36 now appeared at δ2.92. Other low field resonances appeared at δ5.38 (1H,m.); 6.54 (1H,d,J=2.2Hz.); 6.17 (1H, d. of d. J=1.8Hz) and two acetate signals at δ2.11 (3H,s) and 2.08 (3H,s). Irradiation of the multiplet at δ2.92 collapsed the signal at δ6.54 to a singlet, the signal at δ6.17 to a doublet and also simplified the complex signal at δ5.38. Irradiation at δ5.38 also collapsed the δ6.17 signal to a doublet. This data together with chemical shifts was consistent with the partial structure (9) and thus (4) for heteronemin.

Support for this structure came from the controlled pyrolysis of heteronemin at 225° for two minutes which gave a mixture of compounds from which the vinyl furan (10) m.p. 137-139° and the monoacetylated furan (11) m.p. 187-187.5° could be separated. The structure of (11) followed from the ^{1}H n.m.r. spectrum which showed two furan signals at δ7.34, 7.18, a multiplet at δ5.68 (=$\overset{|}{C}$-$\overset{|}{C}$H-OAc), a doublet of doublets at δ3.60 (-$\overset{H}{\underset{|}{C}}$-OH) and the methyl singlet of an acetyl group at δ2.07.

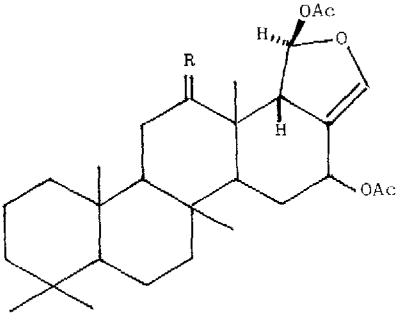
Some stereochemistry of (4) was inferred from spectral data. The peak widths at half peak height of the protons at C_{12} and C_{16} in the ^{1}H n.m.r. spectrum of (4) were 15Hz and 16.5Hz. respectively and were, therefore, representative of axial protons. Therefore both the C_{12} hydroxyl and the C_{16} acetoxy groups of (4) were equatorial. The small coupling constant (2.2Hz.) between C_{18} and C_{19} protons strongly suggested a



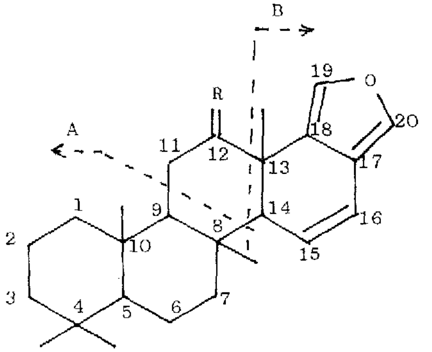
(1) R = O (2) R = H_2



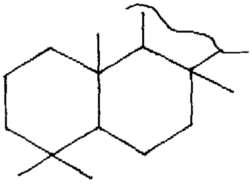
(3)



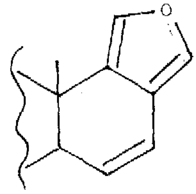
(4) R = H,OH (6) R = O



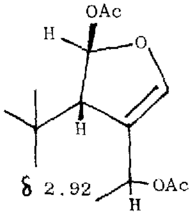
(7) R = O (10) R = H, OH



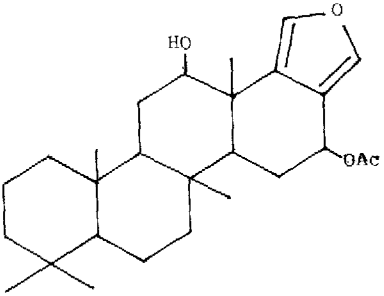
(5)



(8)



(9)



(11)

trans-orientation and this was supported by the very ready elimination of acetic acid from both (4) and (6) which requires a *cis*-relationship of the C_{18} proton with the C_{19} acetoxy group.

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