Konakhin, a Novel Type of Degraded Sesterterpene; Isolation from a Marine Sponge of Senegal

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An unidentified sponge collected off Konakhè, near Dakar, contains a novel type of degraded linear sesterterpene, konakhin (+)-**1**, formally deriving from the replacement by chlorine of the carbonyl carbon in the tetronic moiety of fasciculatin (−)-**2**, the main terpene of this sponge.

Sesterterpenes[1] have been rare natural products until the study of the marine sponges of the order Dictyoceratida and the nudibranch molluscs, that feed on them,[2] which have given a wide variety of compounds of this class and degraded derivatives.[3]

We report here on a novel type of degraded sesterterpene isolated from an undetermined marine sponge collected at −30 m off Konakhè, near Dakar. The compound, konakhin (+)-**1**,† is a colourless oil, $[\alpha]_D^{20}$ + 6.0 (*c* 0.1, $CHCl_3$) whose molecular formula $C_{24}H_{37}ClO_3$ was derived from ^{13}C NMR and mass spectra.‡ The partial structure from the furanic ring up to C-7 rests on the superimposition of ^{13}C and ^{1}H NMR§ signals with the corresponding signals of fasciculatin (−)-**2**; this is the main terpene of our sponge, already isolated from the Mediterranean sponges *Ircinia fasciculata*[4] and *Ircinia variabilis*[5] and assigned the *Z*-1 configuration.[6] The remaining portion of (−)-**1** is supported by NMR spectra, which reveal keto, CHOH, and CHCl groups from the characteristic signals at δ 207.96 s, 84.22 d and 55.39 d, respectively. That the latter two groups represent C-3-H(OH) and C-2-HCl stems from the heterocorrelation of the δ(C) 84.22 d with the δ(H) 4.53 d and the δ(C) 55.39 d with the δ(H) 4.29 dq. The C-6-H-C-5-H_2 group is supported by an ABX pattern where the δ(H) values 2.83 and 2.57 and J_{AB} 19 are consistent with a keto group at C-4; changing to $CDCl_3$ as solvent, the OH group becomes a br, s at δ(H) 2.22, indicating an intramolecular hydrogen bond

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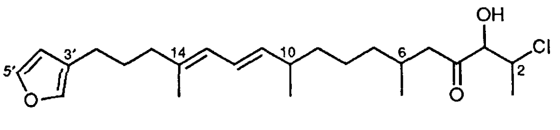
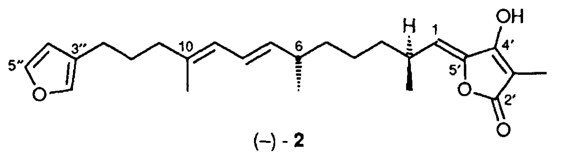
† *Ca.* 0.006% on dry sponge weight after ethanol extraction, evaporation, flash chromatography on Merck Kieselgel 60 with n-hexane–AcOEt and acetylation of the most polar fractions with Ac_2O–pyridine. (MeOH) λ_{max}/nm 238 (ε 22 000); IR (neat) ν_{max}/cm^{-1} 3480s, 1720m.

‡ ^{13}C NMR spectrum ($CDCl_3$, 75.43 MHz, H-bearing C assigned by HETCOR) δ 20.96 (q, C-1), 55.39 (d, C-2), 84.22 (d, C-3), 207.96 (s, C-4), 48.38 (t, C-5), 27.95 (d, C-6) 36.85 (t, C-7), 24.75 (t, C-8), 37.34 (t, C-9), 37.01 (d, C-10), 138.49 (d, C-11), 124.70 (d, C-12), 125.11 (d, C-13), 135.97 (s, C-14), 39.34 (t, C-15), 28.11 (t, C-16), 24.38 (t, C-17), 20.63 (q, *Me*-C-6), 19.51 (q, *Me*-C-10), 16.51 (q, *Me*-C-14), 138.77 (d, C-2′), 124.98 Cs, C-3′), 110.97 (d, C-4′), 142.63 (d, C-5′). EIMS (*m*/*z*, %) 410/408 (1/3 $M^{+\cdot}$), 395/393 (7/21, $M^{+\cdot}$ − Me), 372 (14, $M^{+\cdot}$ − HCl), 357 (57, $M^{+\cdot}$ − Me − HCl), 135 (100). High resolution EIMS *m*/*z* 408.2410 ($C_{24}H_{37}ClO_3$ requires 408.2431).

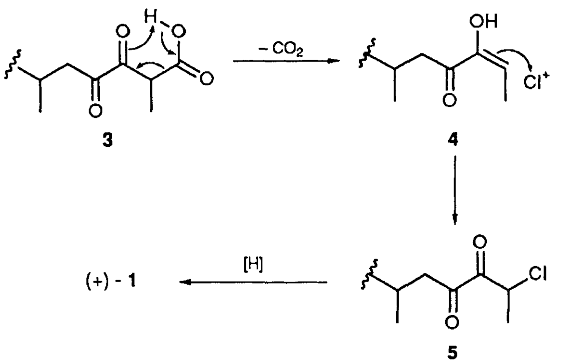
§ ^{1}H NMR spectrum (CD_3OD, 299.94 MHz, *J* in Hz) δ 1.57 (d, $J_{1,2}$ 6.8, 3H-C-1), 4.29 (dq, $J_{2,1}$ 6.8, $J_{2,3}$ 5.6, H-C-2), 4.53 (d, $J_{3,2}$ 5.6, H-C-3), 2.83 and 2.57 (AB part of ABX, J_{AB} 18.8, J_{AX} 5.1, J_{BX} 7.8, 2H-C-5), 2.00 (X part of ABX, m, H-C-6), 1.24 (series of m, 2H-C-7, 2H-C-8, and 2H-C-9), 2.15 (m, H-C-10), 5.40 (dd, $J_{11,12}$ 16.0, $J_{11,10}$ 8.3, H-C-11), 6.21 (ddd, $J_{12,11}$ 15.0, $J_{12,13}$ 10.7, $J_{12,10}$ 0.8, H-C-12), 5.77 (br, d, $J_{13,12}$ 10.7, H-C-13), 2.07 (t, $J_{15,16}$ 7.9, 2H-C-15), 1.68 (pseudo quint., *J* 7.8, 2H-C-16), 2.39 (t, $J_{17,16}$ 7.6, 2H-C-17), 7.26 (m, H-C-2′), 6.30 (m, H-C-4′), 7.37 (pseudo t, *J* 1.8, H-C-5′), 0.88 (d, $J_{Me,6}$ 6.6, Me-C-6), 0.99 (d, $J_{Me,10}$ 6.6, Me-C-10), 1.73 (d, $J_{Me,13}$ 1.2, Me-C-14), (in $CDCl_3$ δ 2.22 br.s, OH).



(+) - **1**



(–) - **2**



Scheme 1

with the adjacent carbonyl group; the latter point is further supported by the fact that (+)-**1** resists acetylation in AC$_2$–pyridine at room temp.

A biogenetic route from fasciculatin to konakhin can be envisaged as in Scheme 1. Thus, decarboxylation of fasciculatin in the carboxylic form **3** may be viewed to give the enol **4** which undergoes chlorination by a haloperoxidase-provided chloronium ion[2] to afford the diketone **5** which is finally reduced to konakhin (+)-**1**. In any event, the degradation implied by the structure of konakhin (–)-**1** has no precedent and, in general, halogenated degraded terpenes are rare compounds, an example being the trinorsesquiterpene kumepaloxane, isolated from a nudibranch.[7]

In the hope to shed further light on the behaviour of tetronic acid terpenes, we are trying the difficult isolation of other unusual terpenes present in trace amounts in our sponge while carrying out degradation studies of these and model compounds; we hope to present the entire study in a full paper.

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