Sesterterpenes from the Sponge *Dysidea* sp.

Xiaoxia Yang[a], Zhiyu Shao[a,b], and Xingqun Zhang[a,b]

[a] College of Chemistry, Chemical Engineering and Biotechnology, Donghua University, Shanghai 201620, China
[b] Key Laboratory of Science & Technology of Eco-Textile, Ministry of Education, Donghua University, Shanghai 201620, China

Reprint requests to Prof. Dr. X. Zhang. Fax: +86-21-67792608. E-mail: xqz@dhu.edu.cn

Z. Naturforsch. **2010**, *65b,* 625 – 627; received December 23, 2009

The acetone extract of the sponge *Dysidea* sp. was subjected to chromatography techniques for fractionation and purification. A new sesterterpene, scalarester (**1**), and four known scalaranes, *viz.* scalarin (**2**), scalaradial (**3**), desacetylscalaradial (**4**), and desacetoxyscalaradial (**5**), were obtained. Their structures have been elucidated by means of spectroscopic data interpretation, mainly 1D and 2D NMR and mass spectrometry.

Key words: Sesterterpene, Sponge, *Dysidea* sp., Scalarane

Introduction

Scalarane sesterterpenes are marine metabolites found either in sponges or in mollusks eaters of sponges. Many scalarane compounds play important ecological roles and also possess interesting biological properties, such as anti-inflammatory [1], antimicrobial [2], platelet aggregation inhibitory [3], and cytotoxic activities [4]. As part of our studies of biologically active metabolites of sponges, we now report the isolation and structural elucidation of one new sesterterpene, scalarester (**1**), and four known scalaranes (**2** – **5**) from *Dysidea* sp.

Dysidea sp. is a large genus widely distributed in tropical and subtropical waters around the world. We made a collection of the sponge *Dysidea* sp. from Sanya, Hainan Province, China.

Results and Discussion

Chromatography of the acetone fraction of the sponge *Dysidea* sp. resulted in the isolation of one novel sesterterpene (Fig. 1), scalarester (**1**), and four known sesterterpenes, scalarin (**2**), scalaradial (**3**), desacetylscalaradial (**4**), desacetoxyscalaradial (**5**).

Compound **1** was isolated as a colorless viscous oil. The molecular formula, $C_{28}H_{42}O_5$, was established from HREIMS and ^{13}C NMR data. DEPT-^{13}C NMR spectra (Table 1) showed twenty-eight carbon signals comprising seven methyls, seven methylenes, seven methines, and seven quaternary carbons, in which the

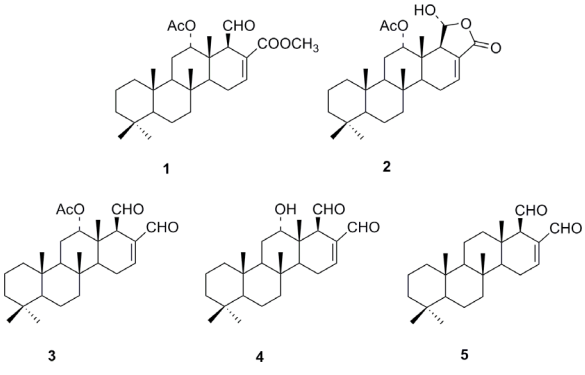

Fig. 1. Structures of scalarester (**1**), scalarin (**2**), scalaradial (**3**), desacetylscalaradial (**4**), and desacetoxyscalaradial (**5**).

functionalities of one aldehyde carbonyl (δ_C = 201.9, C-25), one acetoxy group (δ_C = 169.8, C-26), one methyl ester carbonyl (δ_C = 167.8, C-24) and one trisubstituted double bond (δ_C = 127.5, 142.6) were distinguishable. The ^1H NMR spectrum showed one doublet signal for an aldehyde group at δ_H = 9.50 (1H, d, J = 3.67 Hz), one singlet for an olefinic hydrogen at δ_H = 7.15, two broad signals for tertiary carbon hydrogen atoms at δ_H = 4.80 and 3.59, one singlet for a methyl ester groups at δ_H = 3.71, one singlet for an acetoxyl group at δ_H = 2.16, and five singlets for methyl groups at δ_H = 0.95, 0.92, 0.83, 0.80, and 0.79. The signal at δ_H = 3.71 (3H, s) correlated with the carbon at δ_C = 167.8 in the HMQC spectrum and the carbon at δ_C = 127.5 in the HMBC spectrum (Fig. 2), which indi-

Table 1. ^{13}C NMR (125 MHz) chemical shifts for **1**, **2** and **3** in $CDCl_3$.

	1	**2**	**3**		**1**	**2**	**3**
C-1	39.5	39.6	39.6	C-2	17.8	17.9	17.9
C-3	41.3	41.4	41.4	C-4	33.2	33.2	33.2
C-5	56.3	56.4	56.4	C-6	18.2	18.4	18.3
C-7	41.8	41.9	41.9	C-8	36.6	37.7	36.7
C-9	51.6	52.4	51.7	C-10	37.7	37.2	37.8
C-11	21.7	22.3	21.8	C-12	74.8	74.5	74.8
C-13	40.3	36.8	40.2	C-14	49.0	49.7	49.4
C-15	23.1	24.1	24.2	C-16	142.6	135.3	153.0
C-17	127.5	128.0	138.2	C-18	53.3	50.8	52.1
C-19	33.2	33.2	33.2	C-20	21.3	21.4	21.3
C-21	16.6	16.2	16.6	C-22	16.2	16.0	16.2
C-23	15.2	15.0	15.4	C-24	167.8	167.8	193.0
C-25	201.9	98.9	201.1	C-26	169.8	171.2	169.8
C-27	21.9	21.4	21.4	C-28	52.3	–	–

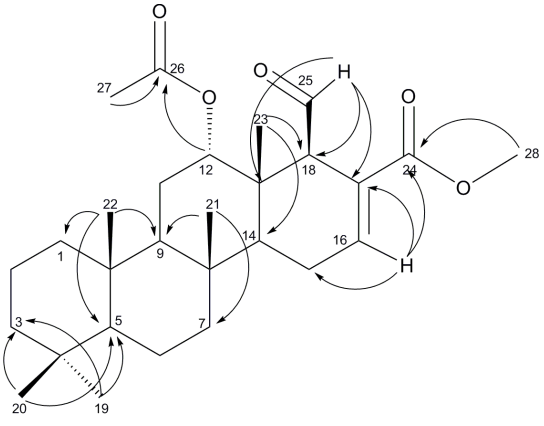

Fig. 2. The key HMBC correlations of scalarester (**1**).

cated the attachment of the methyl ester group at C-24. The signal at δ_H = 7.15 (1H, m) was assigned to H-16 from the HMBC correlation of H-16/C-17, and the signal at δ_H = 2.16 was assigned to H-27 from the HMBC correlation of H-27/C-26. The ^{1}H NMR and ^{13}C NMR spectra of compound **1** were similar to those of scalarin and scalaradial (Table 1). The ^{1}H NMR spectrum of **1** displayed a methyl ester groups at δ_H = 3.71 (3H, s), and the ^{13}C NMR spectrum one aldehyde group at δ_C = 201.9 (C-25) and a methyl ester carbonyl group at δ_C = 167.8 (C-24) and 52.3 (C-28). A detailed analysis of the 2D NMR data indicated the structure deduced for **1** (scalarester) as shown in Fig 1.

Compounds **2**–**5** were isolated as colorless powders. Based on ^{1}H NMR, DEPT-^{13}C NMR data and mass spectrometry the structures of the four compounds were established as scalarin, scalaradial, desacetylscalaradial and desacetoxyscalaradial, respectively. They have previously been isolated and characterized from the sponge *Cacospongia scalari*s. The structures of **2**–**5** were confirmed by comparing their spectral data with those presented in references [5–8].

Experimental Section

General

NMR spectra were measured on a Bruker DRX-400 spectrometer with the residual $CDCl_3$ signal (δ_H = 7.26 ppm, δ_C = 77.0 ppm) as an internal standard. ESIMS spectra were recorded on a Q-TOF Micro LC-MS mass spectrometer. HR-EIMS spectra were performed on a Micromass Q-TOF spectrometer. Melting points were determined on a Fisher-Johns micromelting point apparatus and were uncorrected. Silica gel (200–300 mesh) was purchased from Qingdao Marine Chemical Co. (Qing-dao, China). All solvents used for extraction and isolation were of analytical grade, purchased from Sinopharm Chemical Reagent Co., Shanghai, China.

Animal material

Specimens of *Dysidea* sp. were collected from Sanya, Hainan Province, China, in South China Sea, in 2006, and kept frozen prior to extraction. The sponge material was identified as *Dysidea* sp. by Dr. Zaizhong Chen from Shanghai Ocean University. A voucher specimen (registry No Dsp-03) was deposited at the Chemistry and Biological Engineering Department, Donghua University.

Extraction and isolation

The bodies of the sponge *Dysidea* sp. (85 g, dry wt. after extraction) were chopped, then soaked in acetone (800 mL) and extracted at r. t. with sonication for 1 h. The filtered acetone solution was evaporated under reduced pressure, and the residue was extracted four times with ether (4 × 100 mL). The solvent was evaporated to give an oily residue (3.2 g), which was subjected to silica gel column chromatography using a petroleum ether-EtOAc gradient as eluent. The fraction was eluted with petroleum ether-EtOAc (9:1) to give compound **5** (6.1 mg, 0.007 % of dry material). The fraction eluted with petroleum ether-EtOAc (8.5:1.5) was further purified by preparative TLC (silica gel) to yield compound **3** (18 mg, 0.021 % of dry material), compound **4** (12 mg, 0.014 % of dry material) and compound **1** (4.5 mg, 0.005 % of dry material). The fraction eluted with petroleum ether-EtOAc (8:2) was re-chromatographed on a silica gel column eluting with petroleum ether-EtOAc (7.5:2.5) to give compound **2** (5.1 mg, 0.006 % of dry material).

*Scalarester (**1**)*

Colorless oil, $[\alpha]_D$ = +44.2 (c = 0.01, CH_3OH). – ^{1}H NMR ($CDCl_3$, 400 MHz): δ = 9.50 (1H, d, J = 3.67 Hz,

H-25), 7.15 (1H, m, H-16), 4.80 (1H, m, H-12), 3.71 (3H, s, H-28), 3.59 (1H, m, H-18), 2.16 (3H, s, H-27), 0.95 (3H, s), 0.92 (3H, s), 0.83 (3H, s), 0.80 (3H, s), 0.79 (3H, s). – ^{13}C NMR ($CDCl_3$, 150 MHz): δ = 201.9 (C-25), 169.8 (C-26), 167.8 (C-24), 142.6 (C-16), 127.5 (C-17), 74.8 (C-12), 56.3 (C-5), 52.3 (C-28), 51.6 (C-9), 49.0 (C-14), 41.8 (C-7), 41.3 (C-3), 40.3 (C-13), 39.5 (C-1), 37.7 (C-10), 36.6 (C-8), 33.2 (C-4), 33.2 (C-19), 23.1 (C-15), 21.9 (C-27), 21.7 (C-11), 21.3 (C-20), 18.2 (C-6), 17.8 (C-2), 16.6 (C-21), 16.2 (C-22), 15.2 (C-23). – MS ((+)-ESI): *m/z* = 459 $[M+H]^+$, 481$[M+Na]^+$. – HRMS ((+)-EI): *m/z* = 458.3015 (calcd: 458.3032 for $C_{28}H_{42}O_5$, $[M]^+$).

*Scalarin (**2**)*

Colorless powder, m. p. 133 – 135 °C. – ^{1}H NMR ($CDCl_3$, 400 MHz): δ = 6.82 (1H, d, *J* = 2.89 Hz, H-16), 5.69 (1H, br, H-25), 4.92 (1H, m, H-12), 3.12 (1H, s, H-18), 2.08 (3H, s, H-27), 0.96 (3H, s), 0.85 (3H, s), 0.84 (3H, s), 0.81 (3H, s), 0.79 (3H, s). – ^{13}C NMR ($CDCl_3$, 150 MHz): δ = 171.2 (C-26), 167.8 (C-24), 135.3 (C-16), 128.0 (C-17), 98.9 (C-25), 74.5 (C-12), 56.4 (C-5), 52.4 (C-9), 50.8 (C-18), 49.7 (C-14), 41.9 (C-7), 41.4 (C-3), 39.6 (C-1), 37.7 (C-8), 37.2 (C-10), 36.8 (C-13), 33.2 (C-4), 33.2 (C-19), 24.1 (C-15), 22.3 (C-11), 21.4 (C-20), 21.4 (C-27), 18.4 (C-6), 17.9 (C-2), 16.2 (C-21), 16.0 (C-22), 15.0 (C-23). – MS ((+)-ESI): *m/z* = 445 $[M+H]^+$, 467 $[M+Na]^+$.

*Scalaradial (**3**)*

Colorless needless, m. p. 110 – 112 °C. – ^{1}H NMR ($CDCl_3$, 400 MHz): δ = 9.51 (1H, d, *J* = 3.9 Hz, H-25), 9.45 (1H, s, H-24), 7.05 (1H, dd, *J* = 5.4, 2.2 Hz, H-16), 4.75 (1H, d, *J* = 1.9 Hz, H-12), 3.50 (1H, s, H-18), 2.14 (3 H, s, H-27), 0.96 (3H, s), 0.95 (3H, s), 0.83 (3H, s), 0.79 (3H, s), 0.77 (3H, s). – ^{13}C NMR ($CDCl_3$, 150 MHz): δ = 201.1 (C-25), 193.1 (C-24), 169.8 (C-26), 153.0 (C-16), 138.2 (C-17), 74.8 (C-12), 56.5 (C-5), 52.1 (C-18), 51.8 (C-9), 49.4 (C-14), 41.9 (C-7), 41.4 (C-3), 40.2 (C-13), 39.7 (C-1), 37.8 (C-10), 36.7 (C-8), 33.2 (C-4), 33.2 (C-19), 24.2 (C-15), 21.9 (C-11), 21.5 (C-27), 21.3 (C-20), 18.4 (C-6), 17.9 (C-2), 16.7 (C-21), 16.2 (C-22), 15.4 (C-23). – MS ((+)-ESI): *m/z* = 429 $[M+H]^+$, 451 $[M+Na]^+$.

*Desacetylscalaradial (**4**)*

Colorless powder, m. p. 198 – 200 °C. – ^{1}H NMR ($CDCl_3$, 400 MHz): δ = 9.54 (1H, d, *J* = 4.8 Hz, H-25), 9.47 (1H, s, H-24), 7.05 (1H, dd, *J* = 5.4, 2.2 Hz, H-16), 3.60 (1H, brs, H-12), 3.46 (1H, s, H-18), 0.92 (3H, s), 0.85 (3H, s), 0.82 (3H, s), 0.80 (3H, s), 0.77 (3H, s). – ^{13}C NMR ($CDCl_3$,150 MHz): δ = 204.9 (C-25), 193.3 (C-24), 153.9 (C-16), 138.1 (C-17), 71.7 (C-12), 56.2 (C-5), 52.7 (C-18), 50.7 (C-9), 48.7 (C-14), 41.9 (C-7), 41.4 (C-3), 40.2 (C-13), 39.5 (C-1), 37.7 (C-10), 36.7 (C-8), 33.2 (C-4), 33.2 (C-19), 24.6 (C-15), 24.21 (C-11), 21.3 (C-20), 18.4 (C-6), 18.0 (C-2), 16.3 (C-21), 16.2 (C-22), 15.4 (C-23). – MS ((+)-ESI): *m/z* = 387 $[M+H]^+$, 409 $[M+Na]^+$.

*Desacetoxyscalaradial (**5**)*

Colorless powder, m. p. 201 – 203 °C. – ^{1}H NMR ($CDCl_3$, 400 MHz): δ = 9.53 (1H, d, *J* = 4.6 Hz, H-25), 9.46 (1H, s, H-24), 7.04 (1H, dd, *J* = 5.4, 2.2 Hz, H-16), 2.80 (1H, brs, H-12), 0.95 (3H, s), 0.91 (3H, s), 0.84 (3H, s), 0.83 (3H, s), 0.80 (3H, s). – ^{13}C NMR ($CDCl_3$,100 MHz): δ = 202.0 (C-25), 193.1 (C-24), 154.4 (C-16), 138.0 (C-17), 60.9 (C-9), 60.7 (C-18), 56.4 (C-5), 54.2 (C-14), 42.0 (C-3), 41.6 (C-7), 41.1 (C-12), 39.8 (C-1), 37.8 (C-13), 37.4 (C-10), 36.9 (C-8), 33.2 (C-4), 33.2 (C-19), 24.3 (C-15), 21.3 (C-20), 18.5 (C-2), 18.0 (C-6), 17.0 (C-23), 17.1 (C-11), 16.4 (C-22), 16.1 (C-21). – MS ((+)-ESI): *m/z* = 371 $[M+H]^+$, 393 $[M+Na]^+$.

Acknowledgement

This work was supported by Key Laboratory of Science & Technology of the Eco-Textile Foundation, Ministry of Education, Donghua University.

[1] A. Fontana, E. Mollo, J. Ortea, M. Gavagnin, G. Cimino, *J. Nat. Prod.* **2000**, *63*, 527 – 530.
[2] S. Wonganuchitmeta, S. Yuenyongsawad, N. Keawpradub, A. Plubrukarn, *J. Nat. Prod.* **2004**, *67*, 1767 – 1770.
[3] M. Nakagawa, Y. Hamamoto, M. Ishihama, S. Hamasaki, M. Endo, *Tetrahed. Lett.* **1987**, *28*, 431 – 434.
[4] J. Song, W. Jeong, N. Wang, H.-S. Lee, C. J. Sim, K.-B. Oh, J. Shin, *J. Nat. Prod.* **2008**, *71*, 1866 – 1871.
[5] E. Fattorusso, C. Magno, C. Santacroce, D. Sica, *Tetrahedron* **1972**, *28*, 5993 – 5997.
[6] G. Cimino, S. De Stefano, L. Minale, *Experientia* **1974**, *30*, 846 – 847.
[7] F. Yasuda, H. Tada, *Experientia* **1981**, *37*, 110 – 111.
[8] S. De Rosa, R. Puliti, A. Crispino, A. De Giulio, C. A. Mattia, L. Mazzarella, *J. Nat. Prod.* **1994**, *57*, 256 – 262.