New Acetyl Derivatives from Antarctic Delisea fimbriata

Mercedes Cueto and José Darias*

Instituto de Productos Naturales y Agrobiología de Canarias, CSIC. Avda. Astrofísico Fco. Sánchez 3, Apdo. 195, 38206 La Laguna, Tenerife, Canary Islands, Spain

Aurelio San-Martín and Juana Rovirosa
Dpto. Quimica, Facultad de Ciencias, Universidad de Chile, Santiago de Chile, Chile

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Compounds with three characteristic skeletons of members of the family Bonnemaisoniaceae were found to coexist in the alga Delisea fimbriata. The two new acetates 1 and 2a were also isolated; this is the first isolation of acetates from this genus. The structures, chemical transformation, and biogenetic significance of 1 and 2a are described.

The significant in vitro antimicrobial and antifungal activity of the extracts of several species of red algae within the family Bonnemaisoniaceae has led to the search for new metabolites from collections covering a wide geographic range. Seaweed from the genera Asparagopsis, Delisea, Ptilonia, and Bonnemaisonia have been studied and have proven to be a rich source of secondary metabolites based almost exclusively on acetate biosynthesis, which appears to be characteristic of the family.1 The genus Asparagopsis has the particular property of producing halogenated substances2 whose framework contains up to four carbon atoms, including methane, acetones, propanols, butenones, and acrylic and acetic acid derivatives, while genera such as Delisea, Ptilonia, and Bonnemaisonia display a variety of polyhalogenated compounds with between seven3-6 and nine7-17 carbon atoms, with the exception of a 12-carbon-atom metabolite recently isolated.8

Here, we report on the new metabolites 1 and 2a from Delisea fimbriata (Lamour) as well as the reisolation of the polyhalogenated unsaturated ketones 3 and 4 and the fimbrolides 5-811-12 showing for the first time the coexistence of compounds derived from seven (compound 1), eight (2a, 3, and 4), and nine (5-8) carbon atom skeletons found in the same species. D. fimbriata was collected by scuba off King George Island (South Shetland, Antarctica) at a depth of 30 m. Fractions of A-C were obtained by flash chromatography of the crude algal extract. The hexane:EtOAc (9:1) fraction from the chromatography column of portion B yielded a mixture of four components from which compounds 1 and 2a were separated by recycling-HPLC.

Compound 1 was a colorless oil. The EI MS showed the molecular ion at m/z 313/315/317 with relative intensity for two bromine atoms in accordance with the empirical formula, the compound should be linear. The molecule contains a tetrasubstituted double bond and an acetyl group, because five of the 10 carbon

![Diagram](https://example.com/diagram.png)

allowed the establishment of fragment 11. The proton signal at δ 1.82 showed coupling to the doublet of triplets proton at δ 5.08, and irradiation of the methylene at δ 1.82 collapsed the signal at δ 5.08 to a doublet that possesses a coupling constant similar to that of the proton situated at δ 5.75. This shows that the two methyls at δ 5.08 and δ 5.75 are adjacent, thus allowing the partial establishment of structure 11. Consequently, the complete structure for the compound can be established as 1, where the bromine atoms are the substituents at C-1.

Compound 2a was also a colorless oil. The IR spectrum gave an absorption for an acetate group at 1743 cm⁻¹. The CIMS showed the molecular ion (M+1) at m/z 405/407/409/411 with relative intensity for three bromine atoms in accordance with the empirical formula C₁₀H₁₈Br₃O₂. The EI MS gave fragments at m/z 325/327/329 (M⁺ - Br) and m/z 83 (C₆H₁₁). The H NMR spectrum (200 MHz, CDCl₃) showed signals for the methyl group of an acetate (δ 2.15 (3H, s)) and an n-pentyl chain at δ 1.82 (2H, m), 1.32 (6H, m), and 0.96 (3H, broad s), which suggested the presence of fragment 1. Other H NMR signals appeared at δ 5.08 (1H, dt) and at δ 5.75 (1H, d, J = 3.35 Hz). Homonuclear proton-decoupling experiments

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*To whom correspondence should be addressed. Phone 34 22 256847. Fax: 34 22 260135.

atoms of the molecule form an n-pentyl chain, and because the multiplicity of the proton on the carbon-borane acetal group is a triplet, it can be stated that the substituents on the olefinic double bond are bromine and that the structure for the compound must be 2a. The structure 2a was confirmed by partial synthesis starting from 3. Reduction of 3 with NaBH₄ in methanol at room temperature for 1 h gave the alcoholic derivative 2b (δ 4.72, 1H, t, J = 6.0 Hz), which was acetylated to give a material whose ¹H NMR spectrum was identical to the natural compound.

Fraction A, eluted with hexane–EtOAc (9:1), was chromatographed on R-HPLC using chloroform as eluent, affording the known compounds 3 and 4, which have ¹H NMR data identical to those previously reported. Likewise, the other two products 5 and 6 of the fraction B were purified and their structures identified.

Fraction C, which eluted with hexane–EtOAc (8:2), was chromatographed on R-HPLC (CHCl₃), yielding 7 and 8, which were identical (¹H NMR) to the acetoxyfimbrolides previously isolated from D. fimbriata.

From a study of the marine chemical literature of the Bonnemaisoniaeaceae it was interesting to note that, within the family, the naturally occurring halogenated metabolites containing an acetate function appeared to be exclusive to the genera Bonnemaisonia and Ptilonia. The occurrence of the acetylated compounds 1 and 2a in Delisea is a novelty because until now the genus has been characterized by producing only polyhalogenated ketones. The compound 1 is also interesting from a biogenetic point of view. It appeared as the simplest, and probable biogenetic precursor, of most of the metabolites with a seven-carbon-atoms skeleton coming from members of the family of the red algae Bonnemaisoniaeaceae.

Experimental Section

General Experimental Procedures. Optical rotations were measured on a Perkin-Elmer Model 241 polarimeter using a Na lamp at 25 °C. IR spectra were obtained with a Perkin-Elmer 1650/FTIR spectrometer in CHCl₃ solutions. EI mass spectra (EIMS) spectra were taken on a Hewlett-Packard 5995; CIMS were determined with a Hewlett-Packard 5998 using methane as the reactive gas and HRMS on a VG Micromass ZAB-2F spectrometer. ¹H NMR and ¹³C NMR spectra were measured employing a Bruker AMX 200 instrument operating at 200 MHz for ¹H NMR and 50 MHz for ¹³C NMR, using TMS as internal standard. Recycling-HPLC separations were performed with a Japan Analytical LC-908, and the solvent utilized was chloroform. Merck silica gel 7734 and 7729 were used for column chromatography. The spray reagent for TLC was H₂SO₄·H₂O·AcOH (1:4:20).

Plant Material. D. fimbriata was collected by scuba off King George Island (South Shetland, Antarctic) at a depth of 30 m. A voucher specimen has been deposited at the Museo de Historia Natural, Santiago de Chile (no. R23878DF).

Extraction and Isolation. The dried alga (61 g) was extracted with acetone at room temperature, and the acetone extract was concentrated to give a dark green residue (404 mg). This extract was chromatographed by flash chromatography on silica gel. Fraction A, which eluted with hexane–EtOAc (9:1) (53 mg), was chromatographed on R-HPLC (CHCl₃), affording 3 (27.4 mg) and 4 (2.0 mg). Fraction B, which also eluted with hexane–EtOAc (9:1) (83.3 mg), was chromatographed on R-HPLC (CHCl₃), affording 1 (27.4 mg), 2a (2.0 mg), 5 (14.4 mg), and 6 (5.6 mg). Fraction C, which eluted with hexane–EtOAc (8:2) (98.8 mg), was chromatographed on R-HPLC (CHCl₃), affording 7 (4.7 mg) and 8 (22.8 mg).

Compound 1: colorless oil; [α]D 0° (c 0.2, CHCl₃); ¹H NMR (200 MHz, CDCl₃) δ 0.90 (3H, broad s), 1.33 (6H, m), 1.82 (2H, m), 2.15 (3H, s), 5.08 (1H, dt), 5.75 (1H, d), J = 3.55 Hz); EIMS m/z 314/316/318 [M⁺ + 1], 197/199/201 [C₃H₅Br₂], 143 [M⁺ − CH₃Br], 117/119 [C₃H₂Br], 83 [C₃H₁₁].

Compound 2a: colorless oil; [α]D 0° (c 0.28, CHCl₃); IR (CHCl₃) ν max 1743 cm⁻¹; ¹H NMR (200 MHz, CDCl₃) δ 0.89 (3H, broad s), 1.25 (7H, m), 1.73 (2H, m), 2.10 (3H, s), 5.70 (1H, t, J = 17.6 Hz); ¹³C NMR (50 MHz, CDCl₃) δ 13.93 (q), 20.79 (q), 22.40 (t), 24.28 (t), 31.34 (t), 32.83 (t), 74.80 (d), 91.16 (s), 128.89 (s), 169.72 (s); EIMS m/z 325/327/329 [M⁺ + Br], 283/285/287 [M⁺ − Br − (CH₂)₃ − AcOH], 83 [C₃H₁₁].

Acetylation of Compound 2b. A solution of 2b (10 mg) in dry EtOH (2 mL) was treated with NaBH₄ and stirred at room temperature for 1 h. The solution was poured into water and extracted with CHCl₃. The organic layer was washed with H₂O and dried (Na₂SO₄), and concentrated to obtain 10 mg of 2b.

Compound 2b: colorless oil; ¹H NMR (200 MHz, CDCl₃) δ 0.88 (3H, broad s), 1.32 (6H, m), 1.62 (2H, m), 4.72 (1H, t, J = 6.0 Hz); EIMS m/z 283/285/287 [M⁺ − Br], 265/267/269 [M⁺ − Br − H₂O], 223/225/227 [M⁺ − Br − H₂O − (CH₂)₃], 83 [C₃H₁₁].

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References and Notes


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