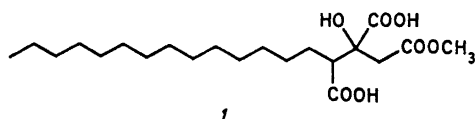


The Structure of Caperatic Acid

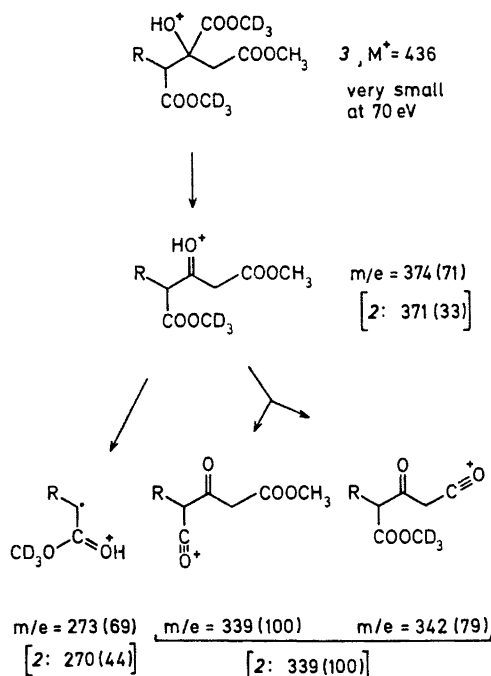
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The lichen compound caperatic acid (**1**) was first isolated from *Parmelia caperata* in 1897,¹ and has subsequently been found in many other lichens.²⁻⁵ Zopf⁶ isolated an acid believed to be **1** from *Cetraria glauca* and *Mycoblastus sanguinarius*, and we have now confirmed that **1** can be isolated from the former species. Asano and Ohta found that the acid is a monomethyl ester of 2-hydroxy-1,2,3-heptadecanetricarboxylic acid,⁹ but the position of the methyl ester group has hitherto been unknown. We now report that caperatic acid has the structure **1**.



This result is based upon a comparison of the mass spectra of the trimethyl ester **2** and its corresponding *d*₄-ester **3** (Scheme 1), and



Scheme 1.

Acta Chem. Scand. B 29 (1975) No. 8

also upon a chemical degradation of **1**. In the upper parts of the mass spectra of **2** and **3** there are, respectively, three and four prominent peaks, and from the *m/e* values of these peaks, the structure of caperatic acid was deduced (Scheme 1). Support for the degradations shown in Scheme 1 was obtained from high resolution mass spectrometry of **2** and from the existence of analogous prominent peaks in the mass spectra of homologous trimethyl alkylcitrate.⁷

In a corroborative chemical degradation, **1** was oxidized with sodium bismuthate, a reagent which oxidizes α -hydroxy carboxylic acids to aldehydes or ketones.⁸ An NMR spectrum of the crude reaction product suggested that its major component was methyl 3-oxo-octadecanoate, the decarboxylation product of the initially formed β -keto carboxylic acid.

A CD investigation has shown that caperatic acid forms a complex with molybdate (VI) at pH 5.7.⁷ This demonstrates that **1** contains a free α -hydroxy carboxylic acid group.⁹

Experimental. Melting points are corrected. The NMR spectrum was recorded on a Varian XL-100 spectrometer and the mass spectra on a Varian MAT 311 instrument using the direct inlet system.

Isolation of 1 from Cetraria glauca. From 300 g of fresh lichen, collected 30 km north-east of Stockholm, 1.6 g of **1** was isolated. After four recrystallisations from ethanol the product melted at 132.5–134°C (lit.⁶ m.p. 132–133.5°C) [α]_D²⁵ –15.5° (*c* = 0.9, dioxane). An authentic sample of **1**, isolated from *Parmelia caperata*, was obtained from L. Tibell, University of Uppsala, and this sample showed [α]_D²⁵ –15.7° (*c* = 0.6, dioxane). The optical rotations of **1** have previously been measured in chloroform,^{9,10} but we found that all samples of **1** were only slightly soluble in ordinary ethanol-stabilized chloroform (*c* < 0.1). Reaction with diazomethane in ether solution afforded the trimethyl ester **2**, m.p. 55–56°C (from ethanol), lit.⁶ m.p. 56.5–57.5°C. MS: *m/e* (rel. intensity) 371 (33), 339 (100), 270 (44), 101 (48), 87 (49), 43 (37).

The *d*₄-ester **3** was prepared by reaction of **1**-*d*₃ with diazomethane-*d*₂. The former reactant was obtained by dissolving **1** in a mixture of CH₃OD (99% isotopic purity) and dry ether, followed by evaporation of the solvent. Diazomethane-*d*₂ was prepared largely after Hecht and Kozarich,¹¹ but the *N*-nitrosomethylurea was replaced with *N*-methyl-*N*-nitroso-*p*-toluene-sulfonamide and, instead of using the dimethoxyethane solution, dry ether was added and the diazomethane-*d*₂ was distilled together with ether into a flask containing a little D₂O (99.7% isotopic purity). The water in the receiving flask was frozen out and the ethereal layer was then added to **1**-*d*₃. The resulting ether solution was washed with water, dried (Na₂SO₄) and concentrated. The product **3** was crystallised from ethanol, m.p. 55.5–

56.5°C. MS: 374(71), 342(79), 339(100), 273(69), 101(33), 90(42).

Bismuthate oxidation of 1. A mixture of **1** (55 mg), sodium bismuthate (56 mg), and glacial acetic acid (2 ml) was warmed (35°C, 80 min) with stirring in a stoppered flask. The resulting solution was poured into a mixture of cold water (100 ml) and ether (50 ml). The ether layer was repeatedly washed with sodium hydrogen carbonate solution and then twice with water. After drying (Na_2SO_4) and concentration of the ether layer, and finally drying in a vacuum desiccator over night, a residue (27 mg) was obtained. The NMR spectrum of this residue (CDCl_3) displayed singlets at $\delta=3.66$ and 3.38, and triplet at $\delta=2.46$ (integrals approximately 35, 18 and 21 mm, respectively), which indicate the partial structure $-\text{CH}_2-\text{CH}_2-\text{CO}-\text{CH}_2-\text{COOCH}_3$. No peaks from an isomeric β -keto ester could be detected.

Acknowledgements. We thank Professor Rolf Santesson, Naturhistoriska Riksmuseet, Stockholm for identifying the lichen material, Dr. Leif Tibell, University of Uppsala, for a gift of caperatic acid, and Dr. Lennart Kenne for the MS investigations. This work was supported by the Swedish Natural Science Research Council.

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Received June 27, 1975.