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SHORT COMMUNICATION

THE STRUCTURE OF A NEW DEPSIDONE FROM THE LICHEN *PARMELIA LIVIDA*

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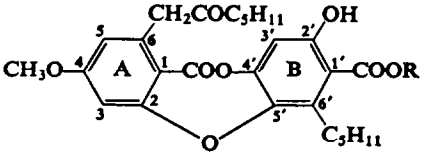
Abstract—A new depsidone, obtained as a minor constituent of *Parmelia livida* Tayl., is proven to be 4-*O*-methylphysodic acid.

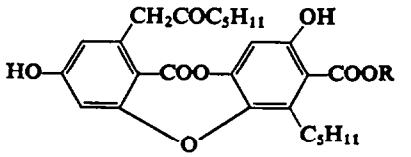
INTRODUCTION

THE lichen *Parmelia livida* Tayl. was examined microchemically and reported to contain atranorin and an unknown substance.[1] A large sample of this species has been extracted and the unidentified component is currently under investigation. The present report concerns the characterization of another lichen acid isolated by column chromatography from the mother liquor after separation of the bulk of the major constituents. Two recrystallizations of the combined fractions containing the new substance yielded 0·35 per cent of the acid based on the air-dry weight of the plant material.

The new substance shows a u.v. spectrum typical of a depsidone and similar to the spectrum of physodic acid (III) isolated from *Hypogymnia physodes* (L.) Nyl. and from *Cetraria ciliaris* Ach. An elemental analysis of the new depsidone agrees with the formula ($C_{27}H_{32}O_8$) for a monomethyl physodic acid derivative. The NMR spectrum is also similar to that of physodic acid (III), but it shows one less phenolic hydrogen and a good singlet at 3·86 ppm for an *O*-methyl substituent. Peaks assigned to the various methylene groups are identical for the two compounds. The i.r. spectrum of the new depsidone lacks the band found at 3300 cm^{-1} in the spectrum of physodic acid due to the phenolic hydroxyl at the



(I) R = H
(II) R = CH_3



(III) R = H
(IV) R = CH_3

4-position which is sterically incapable of intramolecular H-bonding with a carbonyl oxygen. The data provide strong evidence for the identity of the new compound as 4-*O*-methylphysodic acid (I).

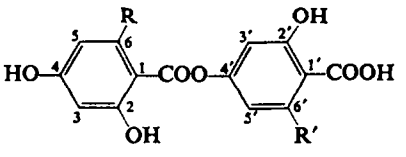
A negative reaction with aqueous calcium hypochlorite shows that the new depsidone probably does not have free *meta*-oriented phenolic hydroxyls. After treatment with 10%

[1] W. L. CULBERSON, *Am. J. Botany* **48**, 168 (1961).

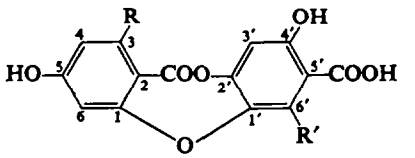
KOH, however, aq. calcium hypochlorite produces a bright red coloration because hydrolysis of the ester link proceeds rapidly due to enol-lactone formation and this product contains free *meta*-oriented hydroxyls in the B-ring.

To verify the structure of the new depsidone, the methyl ester II was prepared and found to be identical to the dimethyl derivative of physodic acid (III). This derivative was previously prepared from physodic acid by Asahina and Nogami[2] who reported a melting point (117–119°) considerably lower than that found in the present study (124·5–125·0°), and a methoxyl analysis but no elemental analysis. The methyl ester of physodic acid is easily obtained and the melting point agrees with that reported by Asahina and Nogami,[2] but the dimethyl derivative is difficult to purify when prepared from physodic acid and diazomethane. The intramolecularly H-bonded phenolic group at position 2′ is expected to resist methylation allowing preferential formation of the 4-*O*-methyl ether, but enol-lactonization of the depsidone ester link can also occur under the conditions of this reaction.[3] A crude product (m.p. 116–118°) from the reaction of physodic acid and diazomethane was purified by repeated recrystallizations giving a small yield of pure dimethyl derivative II identical to the methyl ester of the new depsidone.

The new depsidone from *P. livida* is named as a derivative of physodic acid to avoid introducing another trival name. While a satisfactory numbering system for naming lichen depsides (V) has been proposed[4] and used for the new lichen substance, methyl 3,5-dichlorolecanorate,[5] there is no established system for naming new depsidones as derivatives of known lichen depsidones. Unfortunately when the rings are numbered as a cyclic system based on the parent compound, depsidone (VI),[6] the numbers of equivalent positions in depsides and depsidones do not coincide. Thus the 4-hydroxyl of the depside becomes the 5-hydroxyl of



(V)



(VI)

the depsidone. Also, biosynthetically equivalent positions in ring A and ring B of the same compound have different numbers so that the alkyl group is substituted at position 3 in ring A and at position 6′ in ring B, for example. If the same numbering system is used for depsides and depsidones (as in I), these problems are solved and visuallization of structures is greatly simplified. The lichen depsidone is then considered nomenclaturally as well as biosynthetically as a 2-*O*,5′-dehydro derivative of a depside instead of as an unrelated heterocyclic system.

EXPERIMENTAL

All melting points are corrected and were determined with a Hoover Capillary Melting Point Apparatus (Arthur Thomas Co.). Ultraviolet spectra were obtained with a Bausch & Lomb Spectronic 505. Infrared spectra were determined with a Perkin–Elmer Infracord.

[2] Y. ASAHINA and H. NOGAMI, *Ber. Deut. Chem. Ges.* **67**, 805 (1934).
[3] Y. ASAHINA and S. SHIBATA, *The Chemistry of Lichen Substances*. Japan Society for the Promotion of Science (1954).
[4] S. NEELAKANTAN, R. PADMASANI and T. R. SESHADRI, *J. Sci. Ind. Res. (India)* **20B**, 510 (1961).
[5] G. BENDZ, J. SANTESSON and C. A. WACHTMEISTER, *Acta Chem. Scand.* **19**, 1188 (1965).
[6] F. M. DEAN, *Naturally Occurring Oxygen Ring Compounds*, p. 567. Butterworths, London (1963).

NMR spectra were supplied by Nuclear Magnetic Resonance Specialities, New Kensington, Pennsylvania, the mass spectrum is by Morgan-Schaffer Corporation, Montreal, Canada, and elemental analyses are by Clark Microanalytical Laboratory, Urbana, Illinois.

Isolation of 4-O-methylphysodic Acid (I)

Parmelia livida was collected in February, 1965, from the upper branches of freshly felled oaks between Quail Roost and Rougemont, Durham County, N. Car. (W. L. Culberson No. 11, 680). The lichen (58·2 g), freed of adhering bark and air-dried, was extracted in a soxhlet with anhydrous, peroxide-free ether for 4 days. Concentration of the extract gave 205 mg (0·35 per cent) of crude atranorin and 768 mg (1·3 per cent) of a new lichen acid currently under investigation. The thick brownish mother liquor was evaporated to dryness and the residue was dissolved in benzene. The solution (about 5 ml) was filtered and applied to a silicic acid column. Elution with benzene (1·7 l.) removed some atranorin. The new depsidone was eluted with 10% anhydrous ethyl ether in benzene. Three recrystallizations of the combined fractions from benzene–acetone–light petrol yielded 201 mg (0·35 per cent) of colourless plates; m.p. 151–152°, colourless melt with no gas evolution. The compound gave a single spot (R_f 0·46) by thin-layer chromatography (SiO_2) with hexane–ether–formic acid (5:4:1 v/v) as a solvent. (Found: C, 66·90; H, 6·48. $C_{27}H_{32}O_8$ required: C, 66·93; H, 6·66%; mol.wt. 484·6.) A mass spectrum showed a rapid thermal decarboxylation to an ion of mass 440 corresponding to a parent ion with mass 484.

4-*O*-methylphysodic acid gives a bright blue-violet colour with 1% alcoholic $FeCl_3$ solution. It dissolves in 10% KOH without coloration but the solution turns bright wine-red when treated with aq. $Ca(OCl)_2$. There is no coloration with aq. $Ca(OCl)_2$ alone. The compound is easily soluble in acetone, ether and ethanol and moderately soluble in benzene. Infrared (nujol), V/cm: 1740 (depsidone C=O), 1735 (ketone C=O), 1650 (bonded COOH) and 1620 and 1575 (benzenoid). Ultraviolet (95% ethanol), λ_{max} (log ϵ): 211 (4·67), 260 (4·15). λ_{min} (log ϵ): 247 (4·14). NMR (acetone-d_6), δ ppm: 0·90 (terminal methyls of alkyl side-chains, 6 protons), 1·50 (intermediate methylenes of alkyl side-chains, 12 protons), 2·52 (methylene attached to C=O and to another methylene, triplet, $J=7$ c/s, 2 protons), 3·28 (methylene attached to benzene ring and to another methylene, triplet, $J=7$ c/s, 2 protons), 3·86 (*O*-methyl, 3 protons), 4·06 (methylene attached to C=O and to benzene ring, singlet, 2 protons), 6·66–6·84 (3 aromatic protons), 11·00 (1 phenolic proton).

Methyl 4-O-methylphysodate (II)

An ether solution (3 ml) of 4-*O*-methylphysodic acid (14·7 mg) was cooled in an ice bath and treated with diazomethane in ether until the yellow colour just persisted. Evaporation of most of the ether gave colourless plates which were recrystallized from ethyl ether–light petrol yielding 9·6 mg (63 per cent) of the methyl ester (II), m.p. 124·5–125·0°. (Found: C, 67·35; H, 6·73. $C_{28}H_{34}O_8$ required: C, 67·45; H, 6·87%.) Infrared (nujol), V/cm: 1745 (depsidone C=O), 1735 (ketone C=O), 1670 (bonded $COOCH_3$) and 1620 and 1575 (benzenoid). A mixed melting point with methyl-4-*O*-methylphysodate from physodic acid was not depressed.

Methyl Physodate (IV)

An ether solution (50 ml) of physodic acid (101 mg) from *Cetraria ciliaris* was cooled in an ice bath and methylated with diazomethane in ether. The crude product after evaporation

of the solvent was washed with small volumes of petroleum ether and of benzene and recrystallized from ethyl ether–light petrol yielding the methyl ester (IV) (73 mg, 70 per cent), m.p. 159–160°. The product was recrystallized from ethanol–water, m.p. 159–161° (reported[2] m.p. 156–157°). (Calcd. for $C_{27}H_{32}O_8$: C, 66·93; H, 6·66. Found: C, 66·92; H, 6·57%.) Infrared (nujol), V/cm: 3300 (OH), 1740 (depsidone C=O), 1700 (ketone C=O), 1660 (bonded $COOCH_3$) and 1625 and 1580 (benzenoid).

Methyl 4-O-methylphysodate (II) from Physodic Acid (III)

A solution of physodic acid (93 mg) in a mixture of acetone (5 ml) and ether (10 ml) was treated with etherial diazomethane (2 ml) until the yellow colour persisted. Excess diazomethane solution (2·5 ml) was then added and the reaction was stirred until colourless. Evaporation of the solvent gave a gummy product which crystallized from ether–light petrol and recrystallized from ethanol–water and ethyl ether–light petrol yielding the dimethyl derivative II (17·6 mg, 17 per cent); m.p. 122·5–123° (reported[2] m.p. 117–119°). The i.r. spectrum of this product is identical to that of the methyl ester of the new depsidone from *P. livida*.

Acknowledgements—The lichen used in this study was collected and identified by William L. Culberson and prepared for extraction by M. P. Freeman. This investigation was supported by U.S. Public Health Service Research Grant GM-08345 from the Division of General Medical Sciences, National Institutes of Health.