The Structure of Ceroplasteric Acid and Ceroplastol I. Sesterterpenes from an Insect Wax

Sir:

The scale insect *Ceroplastes albolineatus*, in common with other members of the genus, secretes a wax as protection against desiccation. Saponification of the wax gave *n*-alkyl alcohols, ceroplastol I,[1] *n*-alkanoic acids, and ceroplasteric acid ($C_{25}H_{38}O_2$; $[\alpha]_D$ +87°; ν_{max} (film) 874 cm^{-1} (exocyclic methylene)). Ceroplasteric acid is readily isolated by countercurrent distribution (aqueous methanol, hexane) and is best characterized by reduction to the previously isolated ceroplastol I[1] ($C_{25}H_{40}O$; 3,5-dinitrobenzoate mp 111–112°, $[\alpha]_D$ +73°;[2] 4-bromobenzoate mp 101–102°, $[\alpha]_D$ +83°; 4-toluate mp 101°).

The nmr spectrum[2] of ceroplasteric acid clearly reveals four methyl groups and four vinyl hydrogens by resonances at 0.80 (doublet, J = 6.5 cps, $CH_3CH<$), 0.90 (singlet, $CH_3C\lessdot$), 1.63 (singlet, $-(CH_3)C=$), 1.84 (singlet, $=C(CH_3)COOH$), 4.88 (doublet, J = 8 cps, $CH_2=C<$), 5.52 (triplet, J = 8 cps, $=CHCH_2-$), and 6.92 ppm (triplet, J = 8 cps, $-CH_2CH=C(COOH)-$). The mass spectrum of ceroplastol I 4-bromobenzoate shows, in addition to a molecular ion at *m/e* 538, a peak at *m/e* 229 ($M^+ - BrC_6H_4(COOH)C_8H_{13}$) indicative of a C_8 side chain. The reaction of ceroplastol I 4-bromobenzoate with 3-chloroperbenzoic acid gave a trisepoxide (M^+ 586); the double bonds were therefore all accounted for by the nmr spectrum. Ceroplasteric acid ($C_{25}H_{38}O_2$ (seven units of unsaturation)) and ceroplastol I ($C_{25}H_{40}O$ (six units of unsaturation)) are therefore tricyclic.

The absence of a six-membered carbocyclic system is inferred from the results of palladium–charcoal-catalyzed dehydrogenation of ceroplastol I which led to products gaseous at 20° and not to aromatic compounds. Ozonolysis of ceroplastol I 3,5-dinitrobenzoate, followed by treatment with zinc dust in acetic acid, gave formaldehyde (2,4-dinitrophenylhydrazone mp and mmp 167°), hydroxyacetone dinitrobenzoate mp 140° (compared with an authentic sample prepared from bromoacetone and sodium 3,5-dinitrobenzoate in dimethylformamide), and acetone (2,4-dinitrophenylhydrazone mp and mmp 128°). The acetone presumably arises by zinc–acetic acid hydrogenolysis of hydroxyacetone 3,5-dinitrobenzoate.

The molecular structure and absolute configuration of ceroplastol I has been determined by X-ray crystallographic analysis of the 4-bromobenzoate. The crystals were colorless prisms elongated along the *c* axis. The lattice constants and space group determined from precession photographs using Cu Kα radiation were a = 18.67, b = 21.74, c = 7.021 Å; $P2_12_12_1$, with four molecules in the unit cell. Three-dimensional diffraction data were recorded on multiple film equiinclination Weissenberg photographs taken with Cu Kα radiation of the layers 0–5 about the *c* axis and 0–3 about the *a* axis. A total of 2590 independent observed structure factors were derived by visual estimation of the intensities using calibrated intensity scales prepared for each axis.

The structure was solved by the heavy atom method and refined by several cycles of block matrix least-squares calculations excluding hydrogen atoms. Anisotropic thermal parameters were allowed for all atoms. The final R value was 0.13.

The molecular structure and the bond lengths found in the 4-bromobenzoate are shown in Figure 1. The absolute configuration was determined by the anomalous dispersion method taking into account the dispersion of Cu Kα radiation by the bromine atoms. Comparison of about 20 Bijvoet pairs of reflections clearly indicated the absolute configuration of the molecule as in I and Figure 1.

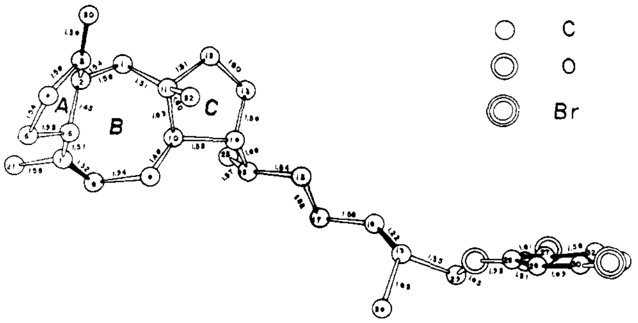
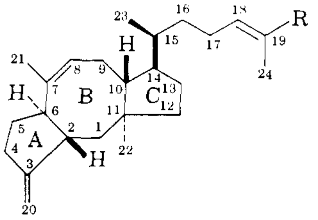


Figure 1. Molecular structure of ceroplastol I 4-bromobenzoate (I).



I, R = $CH_2OCOC_6H_4Br$
II, R = COOH
III, R = CH_2OH

The determination of the crystal structure of the 4-bromobenzoate reveals the structure of ceroplasteric acid as II and ceroplastol I as III. Ceroplasteric acid is therefore 6α-10β-11α-ophiobola-3(20),7,18-trien-25-oic acid and is a close relative of the ophiobolins.[3–6] Ophiobolin A proved to be the first example of a sesterterpene (C_{25}).[7,8] The several ophiobolins known to date, ophiobolin A[3] from *Cochliobolus miyabeanus* and *Helminthosporium* species, ophiobolin B (zizanin B[9]) and ophiobolin C (zizanin A[9]) from *Helminthiosporium* species, and ophiobolin D (cephalonic acid[10]) from

---

[1] T. Rios and F. Colunga, *Chem. Ind.* (London), 1184 (1965).

[2] Optical rotations were measured in chloroform. Chemical shifts are given in δ values relative to tetramethylsilane.

[3] S. Nozoe, M. Morisaki, K. Tsuda, Y. Iitaka, N. Takahashi, S. Tamura, K. Ishibashi, and M. Shirasaka, *J. Am. Chem. Soc.*, 87, 4968 (1965).

[4] L. Canonica, A. Fiecchi, M. G. Kienle, and A. Scala, *Tetrahedron Letters*, 1211 (1966).

[5] M. Morisaki, S. Nozoe, and Y. Iitaka, *Acta Cryst.*, in press.

[6] K. Tsuda, S. Nozoe, M. Morisaki, K. Hirai, A. Itai, S. Okuda, L. Canonica, A. Fiecchi, M. G. Kienle, and A. Scala, *Tetrahedron Letters*, 3369 (1967).

[7] S. Nozoe, M. Morisaki, K. Tsuda, and S. Okuda, *ibid.*, 3365 (1967).

[8] L. Canonica, A. Fiecchi, M. G. Kienle, B. M. Ranzi, and A. Scala, *ibid.*, 3035 (1966).

[9] S. Nozoe, K. Hirai, and K. Tsuda, *ibid.*, 2211 (1966).

cephalosporium caerulens, have a unique tricyclic system composed of fused five-, eight- and five-membered rings. The junction between rings A and B and between B and C in ceroplasteric acid and ceroplastol I, however, are both found to be *trans*, in contrast to the *cis*/*trans* disposition in ophiobolins A, B, and C. Furthermore, the absolute configurations at C_6, C_{10}, and C_{11} are opposite to those found in ophiobolins A, B, and C. In ophiobolin D, the situation is the same as in the other ophiobolins except that around C_6 which forms a double bond to C_7.

Yoichi Iitaka, Ichiro Watanabe[11]
Faculty of Pharmaceutical Sciences, University of Tokyo
Hongo, Tokyo, Japan

Ian T. Harrison, Shuyen Harrison
Syntex Research
Palo Alto, California

Received December 8, 1967

---

(10) A. Itai, S. Nozoe, K. Tsuda, S. Okuda, Y. Iitaka, and Y. Nakayama, *Tetrahedron Letters*, 4111 (1967).

(11) Research Fellow from Yoshitomi Seiyaku Co. Ltd.

Additions and Corrections

The Photoisomerization of the 2,3-Dihydrooxepin Ring. Long-Range Coupling in Some 2-Oxabicyclo[3.2.0]hept-6-enes [*J. Am. Chem., Soc.*, **87**, 3417 (1965)]. By Leo A. Paquette, James H. Barrett, Robert P. Spitz, and Ross Pitcher. Department of Chemistry, The Ohio State University, Columbus, Ohio, and the Varian Associates Application Laboratory, Pittsburgh, Pennsylvania.

The calculations concerning the carbon–chlorine bond anistropy effects should read as follows

$$[1 - 3(\cos 39.5°)^2] = -0.788$$

$$\frac{\Delta\sigma_{\text{XIII}}}{\Delta\sigma_{\text{Va}}} = \frac{(2.92)^3(+0.427)}{(2.32)^3(-0.788)} = -1.08$$

$$\Delta\sigma_{\text{Vc}}(\text{calcd}) = -\frac{0.45}{1.08} = -0.417$$

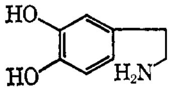
Also, the legends a and b in Figure 4 should be reversed.

Nuclear Magnetic Resonance Spectroscopy. Magnetic Nonequivalence Due to Slow Inversion in Amines [*J. Am. Chem. Soc.*, **87**, 4089 (1965)]. By Dean L. Griffith and John D. Roberts. Gates and Crellin Laboratories of Chemistry, California Institute of Technology, Pasadena, California.

The legend to Figure 3 should read: Variation of E_a for nitrogen inversion of N-benzyl-O,N-dimethylhydroxylamine with solvent dielectric constant.

Electrochemical Studies of the Oxidation Pathways of Catecholamines [*J. Am. Chem. Soc.*, **89**, 447 (1967)]. By M. D. Hawley, S. V. Tatawawadi, S. Piekarski, and R. N. Adams. Department of Chemistry, University of Kansas, Lawrence, Kansas 66044.

Table II contains several errors. The structure of dopamine is



The two bottom lines should read as shown below

$pK_a{}^c$	9.90	9.78	9.75	10.63	9.87
$k_2{}^{a,b}$	7.7×10^4	3.8×10^2	6.4×10^2	1.6×10^2	1.2×10^4

[c] G. P. Lewis, *Brit. J. Pharmacol.*, **9**, 488 (1954).

Novel Analgesics and Molecular Rearrangements in the Morphine–Thebaine Group. III. Alcohols of the 6,14-*endo*-Ethenotetrahydrooripavine Series and Derived Analogs of N-Allylnormorphine and -norcodeine [*J. Am. Chem. Soc.*, **89**, 3281 (1967)]. By K. W. Bentley and D. G. Hardy. Research Laboratories, Reckitt and Sons Ltd., Kingston-upon-Hull, England.

In the abstract, line 1, for IV and V read III and IV; line 4, for XI and XII read VII and VIII; lines 5 and 6, for XIII and XII read IX and VIII.

Novel Analgesics and Molecular Rearrangements in the Morphine–Thebaine Group. V. Derivatives of 7,8-Dihydrocyclohexeno[1′,2′:8,14]codeinone [*J. Am. Chem. Soc.*, **89**, 3303 (1967)]. By K. W. Bentley, D. G. Hardy, C. F. Howell, W. Fulmor, J. E. Lancaster, J. J. Brown, G. O. Morton, and R. A. Hardy, Jr. Research Laboratories, Reckitt and Sons Ltd., Kingston-upon-Hull, England, and The Organic Chemical Research Section, Lederle Laboratories, Division of American Cyanamid Co., Pearl River, New York.

On page 3307, in formula XVIII, the C—R′ bond should be C---R′. The question marks alongside the arrows between formulas XVIII and XXI and between formulas XXI and XXV should be deleted.

Nuclear Magnetic Resonance Studies in the 6,14-*endo*-Ethenotetrahydrothebaine Series [*J. Am. Chem. Soc.*, **89**, 3322 (1967)]. By William Fulmor, John E. Lancaster, George O. Morton, John J. Brown, Charles F. Howell, Carol T. Nora, and Robert A. Hardy, Jr. Organic Chemical Research Section, Lederle Laboratories, Pearl River, New York 10965, and the Research Service Department, Central Research Laboratories, Stamford, Connecticut, Divisions of American Cyanamid Company.

On page 3322, footnote 3 should read as follows: H. Rapoport and P. Sheldrick, *ibid.*, **85**, 1636 (1963), have used a slightly different numbering for a closely related system.