matic hydrogens and the δ hydrogen.[10] The data indicate the magnetic axis to pass approximately through the δ carbon and the aromatic C(2)–hydrogen bond and piperine to possess a freely rotating aromatic ring (on the nmr time scale) with preponderant rotamer population as depicted in **1**.

As the increasing dissimilarity of the aminomethylene hydrogens and carbons with increasing concentration of europium agent indicates (Figures 1 and 2), lanthanide association freezes piperine into unique rotamers.[11] After a 1:1 piperine–Eu(dpm)$_3$ concentration ratio is reached, chemical shifts change drastically, as complexation at the methylenedioxy group commences (Figures 1 and 2).

Pmr solvent effects are slight, but distinct. All Δ_{Eu} values are of the same sign and of nearly the same magnitude, when normalized to the Δ_{Eu} value of the 2-aminomethylene hydrogens, for carbon tetrachloride and chloroform solutions. The lower absolute magnitude of chloroform's Δ_{Eu} values reflects less tendency toward complexation in this solvent in view of its competing hydrogen bonding property (Table I). Chloroform's H bonding may be responsible also for the earlier separation of the aminomethylene signals in chloroform than in carbon tetrachloride and the sharper breaks in the Δ_{Eu} plots (hence, the more selective complexation) in carbon tetrachloride than in chloroform (Figures 1 and 2).

(10) In view of the experimental error of ±0.2 for the cmr δ values and the low cmr $\Delta_{Eu} - \Delta_{La}$ values the cmr Δ_{Eu} data are not as revealing about the θ dependence as the corresponding pmr data.

(11) Not only is the piperidine unit affected in this manner, but the olefinic side chain behaves in this fashion. The sharp signals due to the hydrogens of α-C and β-C undergo initial line broadening and subsequent resharpening on addition of Eu(dpm)$_3$.

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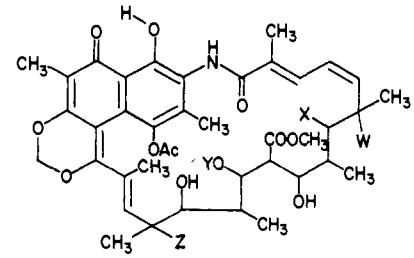
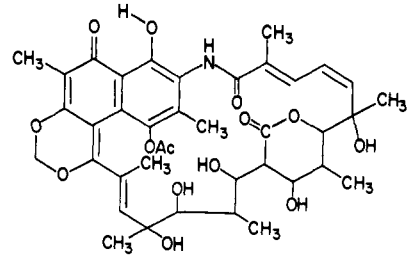
Chemistry of the Streptovaricins. VIII. Structures of Streptovaricins A, B, D, E, F, and G[1a]

Sir:

In other communications we have assigned a revised structure, **3**, to streptovaricin C ($C_{40}H_{51}NO_{14}$), the most abundant component of the streptovaricin complex.[1a] The activities of the individual components of the complex as inhibitors of pox virus[2] and leukemia virus[3] vary widely,[2b,3b] as do their antibacterial activities,[4] and streptovaricin C is by no means the most active in all these tests. In the present report we assign structures to streptovaricins A (**1**, $C_{42}H_{53}NO_{16}$),[5a-c] B (**2**, $C_{42}H_{53}NO_{15}$),[5a,b] D (**4**, $C_{40}H_{51}NO_{13}$),[5a,b] E (**5**, $C_{40}H_{49}NO_{14}$),[5a,b] F (**6**, $C_{39}H_{47}NO_{14}$),[5b] and G (**7**, $C_{40}H_{51}NO_{15}$),[5a,b]

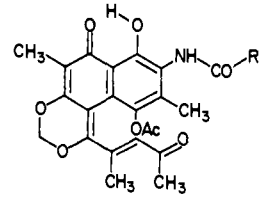


1(A), W = OH; X = H, OH; Y = Ac; Z = OH
2(B), W = H; X = H,OH; Y = Ac; Z = OH
3(C), W = H; X = H,OH; Y = H; Z = OH
4(D), W = H; X = H,OH; Y = H; Z = H
5(E), W = H; X = =O; Y = H; Z = OH
7(G), W = OH; X = H,OH; Y = H; Z = OH



6(F)

Electronic spectra of the streptovaricins indicate a common chromophore for the antibiotics[6] and osmium tetroxide–sodium periodate oxidation of streptovaricins A–C and E–G (but not D) give the same aromatic compound, streptovarone (**8**).[1a,7,8] Moreover, high-resolution mass spectral data indicate the common structural unit a for streptovaricins A–C and E–G (but not D), since the most prominent peaks in the mass spectra of prestreptovarone (**9**)[7-9]—those at *m/e* 390.133



8, R = -COCH$_3$
9, R = -C(CH$_3$)=CHCH=CHCOCH$_3$

($C_{23}H_{20}NO_5$), 324.087 ($C_{18}H_{14}NO_5$), 297.100 ($C_{17}H_{15}NO_4$), and 269.079 ($C_{16}H_{13}O_4$)—are also found in the spectra of streptovaricins A–C and E–G.[10]

(1) (a) Paper VII: K. L. Rinehart, Jr., and F. J. Antosz, *J. Antibiot.*, in press; (b) A. H.-J. Wang, I. C. Paul, K. L. Rinehart, Jr., and F. J. Antosz, *J. Amer. Chem. Soc.*, **93**, 6275 (1971).

(2) (a) N. A. Quintrell and B. R. McAuslan, *J. Virol.*, **6**, 485 (1970); (b) K. B. Tan and B. R. McAuslan, *Biochem. Biophys. Res. Commun.*, **42**, 230 (1971).

(3) (a) W. W. Brockman, W. A. Carter, L.-H. Li, F. Reusser, and F. R. Nichol, *Nature (London)*, **230**, 249 (1971); (b) W. A. Carter, W. W. Brockman, and E. C. Borden, *ibid., New Biol.*, **232**, 212 (1971); (c) E. C. Borden, W. W. Brockman, and W. A. Carter, *ibid.*, **232**, 214 (1971).

(4) (a) P. Siminoff, R. M. Smith, W. T. Sokolski, and G. M. Savage, *Amer. Rev. Tuberc. Pulm. Dis.*, **75**, 576 (1957); (b) L. E. Rhuland, K. F. Stern, and H. R. Reames, *ibid.*, **75**, 588 (1957).

(5) In agreement with the molecular formula assigned are (a) microanalyses, (b) low-resolution mass spectral data, and (c) high-resolution mass spectral data.

(6) P. K. Martin, Ph.D. Thesis, University of Illinois, 1965.

(7) K. L. Rinehart, Jr., C. E. Coverdale, and P. K. Martin, *J. Amer. Chem. Soc.*, **88**, 3150 (1966).

(8) K. L. Rinehart, Jr., P. K. Martin, and C. E. Coverdale, *ibid.*, **88**, 3149 (1966).

(9) The structure **9** shown for prestreptovarone has been revised to accord with the revised structure of streptovarone (**8**).[1a]

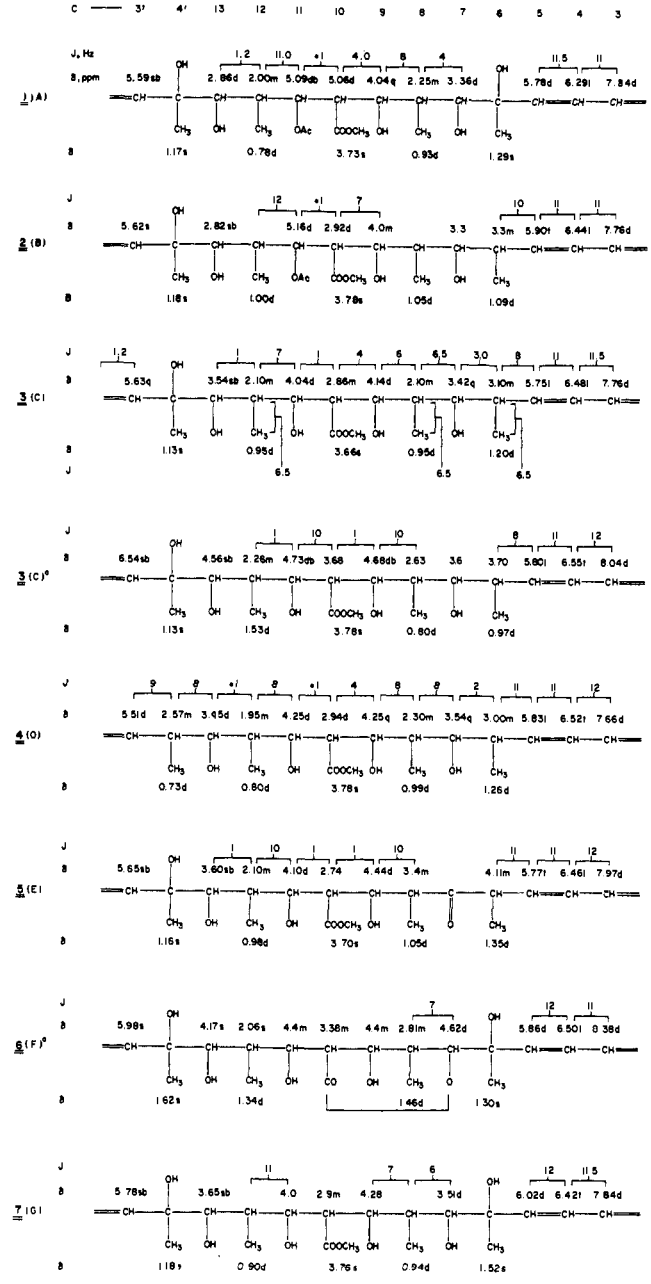
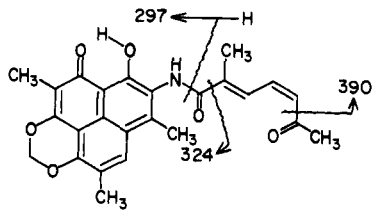


Figure 1. Nmr spectral parameters ($CDCl_3$ solutions except where noted; superscript a denotes pyridine-d_5 solutions) for compounds discussed in the text. Abbreviations of multiplicities are: s = singlet, d = doublet, t = triplet, q = quartet, p = pentet. Funds contributing to the purchase of the HA-220 nmr spectrometer were provided by the National Science Foundation.

(10) Photoprestreptovarone (**10**, $C_{25}H_{23}NO_6$),[5b] formed by photolysis[11] of prestreptovarone (**9**), contains these ions in its mass spectrum.



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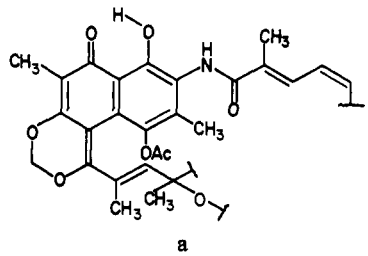
(11) R. J. Schacht and K. L. Rinehart, Jr., *J. Amer. Chem. Soc.*, **89**, 2239 (1967).

Since the structural unit a is common to streptovar-



a

icins A–C and E–G, differences among the antibiotics must arise in their aliphatic side chains, presumably in the degree of oxygenation, oxidation, and acetylation.[8] This can be clearly seen in their nmr spectra (Figure 1); particular points of variation include (1) the occurrence of the C-6 methyl group as a singlet for **1**, **6**, and **7** instead of a doublet; (2) the downfield shift of H-7 and lack of methoxyl absorption for **6**; (3) the downfield shift of H-6 and H-8 for **5**; (4) the downfield shift of H-11 for **1** and **2**; (5) the occurrence of H-13, H-3′, and the methyl group (C-5′) on C-4′ as doublets for **4**.

Chemical properties are in agreement with these conclusions from nmr data. Streptovaricin G, like A, has a hydroxyl at C-6 and reacts with 2 mol of periodate to give prestreptovarone;[8] streptovaricins B and E, like streptovaricin C, have no C-6 hydroxyl, consume 1 mol of periodate, and do not give prestreptovarone;[8] streptovaricin F also consumes only 1 mol of periodate, due to its lactone group at C-7; streptovaricin D is inert to periodate.

Streptovaricin G has one acetate fewer than streptovaricin A;[8] both are converted on acetylation with acetic anhydride–pyridine to streptovaricin A diacetate ($C_{46}H_{57}NO_{18}$),[5a,b,6] mp 202–204°. Streptovaricin B has one acetate more than streptovaricin C;[8] both give streptovaricin C triacetate ($C_{46}H_{57}NO_{17}$),[5a,b,12] mp 230–231°, on acetylation. Streptovaricin E is converted to streptovaricin C on sodium borohydride reduction.

Acknowledgment. This investigation was supported in part by Public Health Service Research Grants, No. AI-01278 and AI-04769, from the National Institute of Allergy and Infectious Diseases. We also thank Dr. A. D. Argoudelis, The Upjohn Co., for partially purified samples of the streptovaricin components, as well as Dr. M. F. Grostic, The Upjohn Co., and Dr. G. E. Van Lear, the Purdue Mass Spectrometry Center, for some of the high-resolution mass spectral data.

(12) K. L. Rinehart, Jr., H. H. Mathur, K. Sasaki, P. K. Martin, and C. E. Coverdale, *ibid.*, **90**, 6241 (1968).

(13) Recipient of a National Institutes of Health Postdoctoral Fellowship (AI 43866) from the National Institute of Allergy and Infectious Diseases.

(14) Recipient of a National Institutes of Health Predoctoral Fellowship (GM 29289) from the National Institute of General Medical Sciences; Monsanto Summer Fellow.

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Received July 28, 1971